May 4, 1943. J. H. WIGGINS 2,318,135

SEAL FOR FLOATING TANK ROOFS

Filed May 24, 1940 3 Sheets-Sheet 1

FIG. 1.

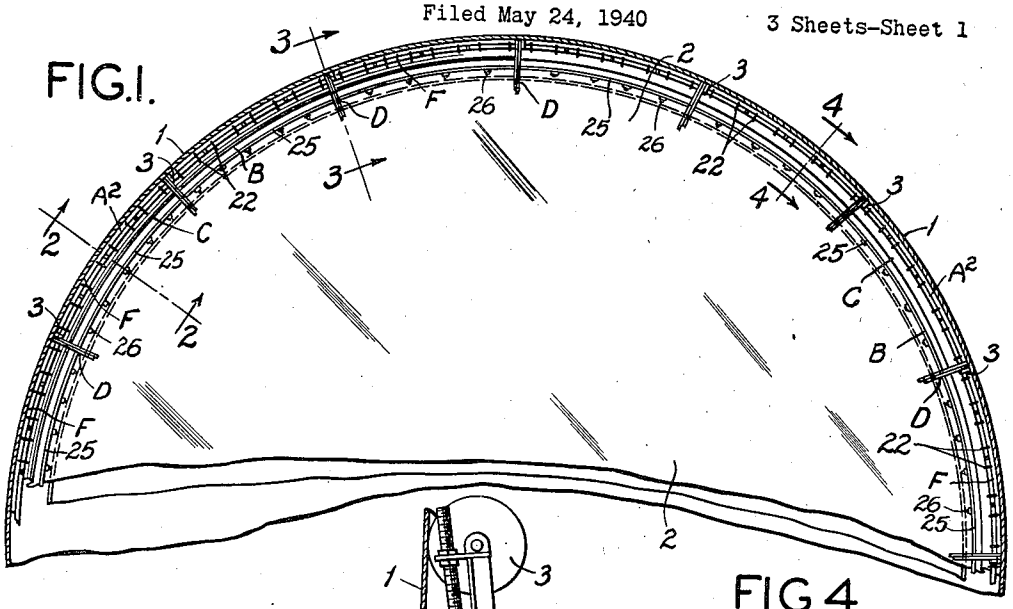


FIG. 2.

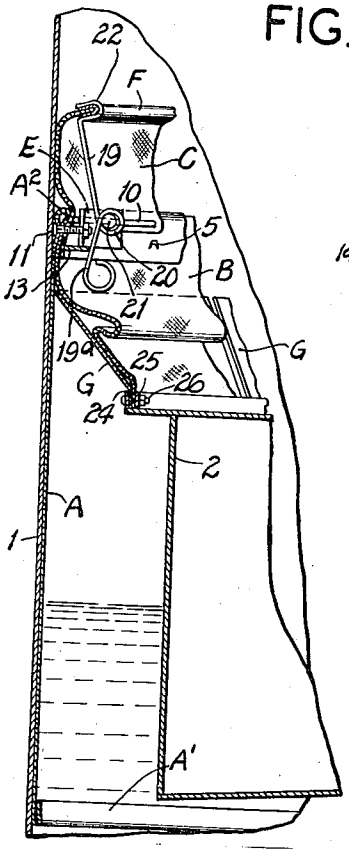


FIG. 3.

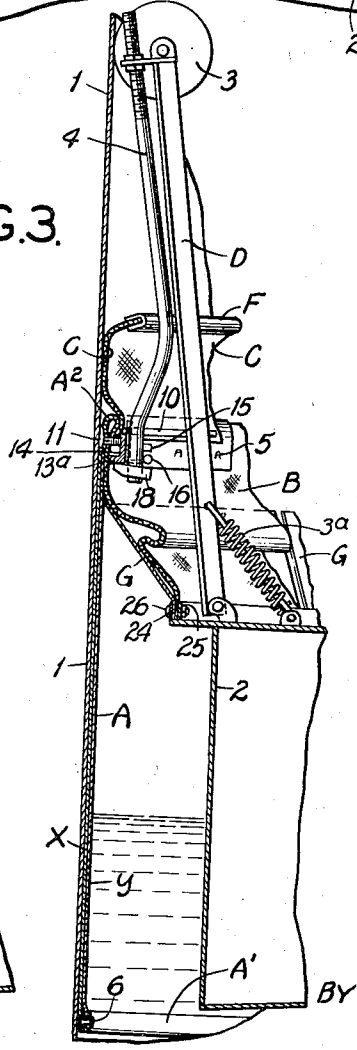


FIG. 4.

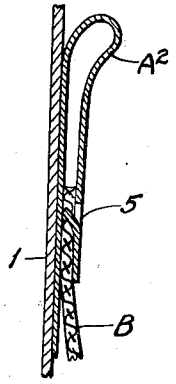
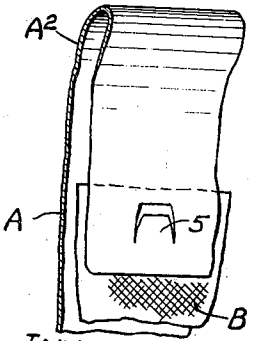


FIG. 5.



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Filed May 24, 1940 3 Sheets-Sheet 2

FIG. 6.

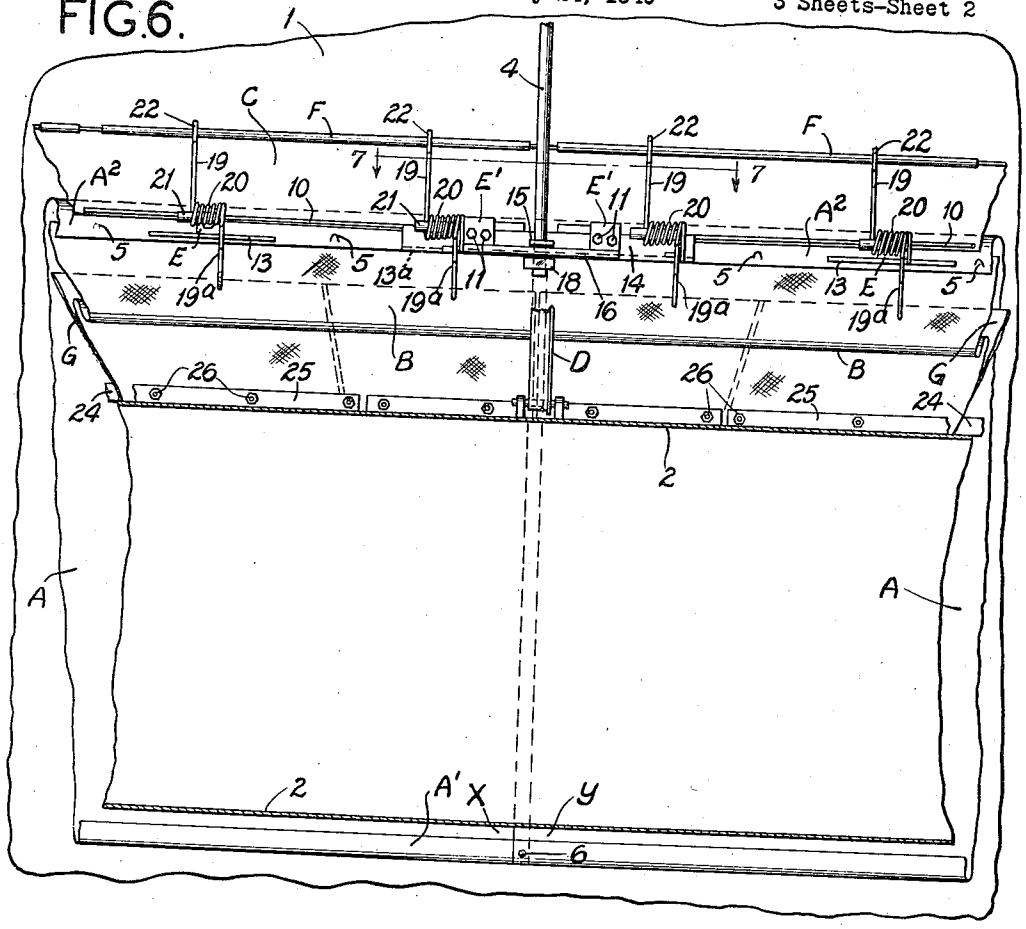
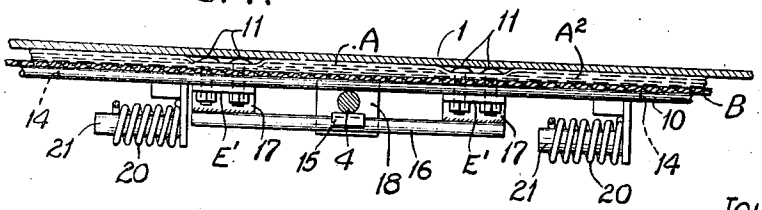


FIG. 7.



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Filed May 24, 1940 3 Sheets-Sheet 3

FIG. 8.

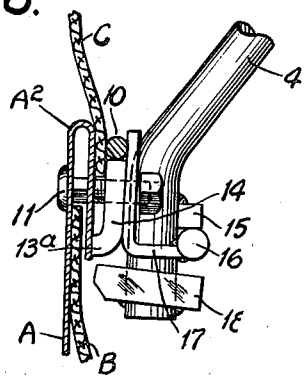


FIG. 9.

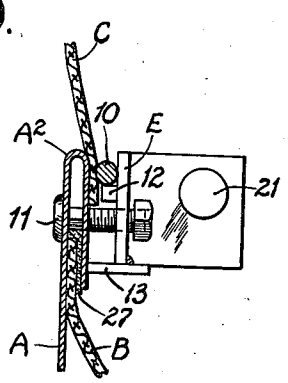
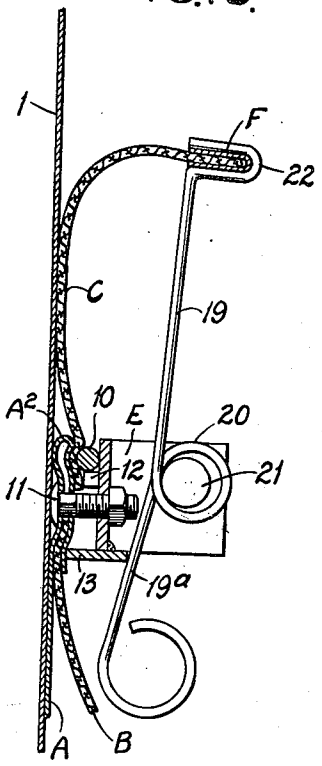


FIG. 10.



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UNITED STATES PATENT OFFICE

2,318,135

SEAL FOR FLOATING TANK ROOFS

John H. Wiggins, Chicago, Ill.

Application May 24, 1940, Serial No. 337,021

4 Claims. (Cl. 220—26)

This invention relates to floating tank roof seals of the general type, that comprise an annular shoe supported by swinging hangers on the floating roof, and arranged in sliding engagement with the side wall of the tank, and a primary seal usually constructed from an annular-shaped piece of gas-tight fabric attached to said shoe and to the peripheral portion of the floating roof, so as to serve as a closure for the annular space between the roof and the side wall shoe.

The main object of my present invention is to provide a floating tank roof seal of the general kind mentioned, whose side wall shoe is suspended from the roof hangers in a novel manner that insures easy movement of the shoe relatively to the tank side wall when the roof rises and falls, and which effectively breaks the shoe away from the tank side wall in case ice forms between said parts.

Figure 1 of the drawings is a fragmentary top plan view of a tank roof seal constructed in accordance with my invention.

Figure 2 is a vertical sectional view, taken on the line 2—2 of Figure 1, for the purpose of illustrating the general arrangement of the floating roof, the side wall shoe and the primary seal and secondary seal.

Figure 3 is a vertical sectional view, taken on the line 3—3 of Figure 1, for the purpose of illustrating how the suspending links or rods on the roof hangers are attached to the side wall shoe.

Figure 4 is a vertical sectional view, taken on the line 4—4 of Figure 1, showing how the top edge of the fabric constituting the primary seal is embraced by and tightly gripped between the folded or turned over portion at the top edge of the shoe that also acts as a strengthening means for the top edge of the shoe.

Figure 5 is a perspective view of the parts shown in Figure 4.

Figure 6 is a fragmentary elevational view of my improved seal, looking outwardly towards the side wall of the tank and showing the floating roof in section.

Figure 7 is a horizontal sectional view, taken on the line 7—7 of Figure 6.

Figure 8 is a vertical sectional view, illustrating the clamping plates for the primary and secondary seals loosely bolted to the side wall shoe preparatory to tightening the supporting bolts for said clamping plates to produce tight joints between the primary and secondary seals and the side wall shoe.

Figure 9 is a sectional view somewhat similar to Figure 8 but taken at a point between two roof hangers; and

Figure 10 is a sectional view, illustrating one of the fabric clamping plates after its supporting bolt has been tightened so as to draw the primary and secondary seals into gas-tight engagement with the side wall shoe, said view also showing one of the springs used to support the secondary seal and press it tightly against the tank side wall.

In the accompanying drawings which illustrate the preferred form of my invention, 1 designates a tank side wall of circular form, 2 designates a floating roof of the pontoon type, pan type, or any other type, arranged inside of said tank, so as to float on the liquid in the tank, A designates a side wall shoe arranged vertically in sliding engagement with the tank side wall, B designates a primary seal usually formed from gas-tight fabric attached to the shoe A and to the peripheral portion of the floating roof 2, so as to form a closure for the annular space between said roof and the side wall shoe, C designates a secondary seal or auxiliary seal usually formed of fabric arranged adjacent the top edge of the shoe A and adapted to press against the tank side wall 1, so as to seal the joint or space between said wall and the shoe, D designates the swinging hangers on th roof 2 arranged so that rollers or friction-reducing devices 3 at the upper ends of said hangers bear against the inner face of the tank side wall, 4 designates vertically-adjustable rods or links suspended from the upper ends of the hangers D and attached to the inner side of the shoe A, so as to suspend said shoe from the hangers in such a way as to insure proper co-operation or co-action of the shoe A with the side wall 1 of the tank, and 3a in Figure 3 designates compression springs that push the hangers outwardly.

In the form of my invention herein illustrated the side wall shoe A is constructed from relatively light gage sheet metal plates that are deformed and combined in such a manner as to overcome the necessity of attaching separate reenforcing members or strengthening elements to the shoe to impart the necessary strength of stiffness to the top and bottom edge portions of the shoe. The way in which said shoe is constructed also reduces the cost and simplifies the procedure of attaching the primary and secondary seals B and C, respectively, to the upper edge portion of said shoe. As shown in Figures 2 and 3, the shoe A is of substantial height or depth, and it is arranged vertically, in sliding engagement with the inner face of the tank side wall 1. Said shoe has sufficient circumferential

flexibility to conform to the shape or curvature of the side wall of the tank, and it may be composed of a plurality of segmental-shaped shoe members whose ends are joined together by gas-tight, flexible connections, or it may consist of a single shoe that extends practically continuously around the side wall of the tank. Preferably, the shoe A is constructed in the form of a split ring whose gap or joint is protected by a sealing device that provides for the expansion and contraction of said shoe. At the bottom edge of the shoe is an integral re-enforcing means or strengthening means A', produced by doubling, folding, bending or de-forming the metal plates from which the shoe is constructed, so as to produce a plurality of thicknesses of metal. The top edge portion of the shoe is similarly constructed or formed, so as to produce an integral re-enforcing or strengthening means A^2. This method of constructing the side wall shoe permits the doubled, folded or turned over portion A^2 at the top edge of the shoe to be used as a binding or clamping means for the top edge of the primary seal B. Usually the top edge portion of the shoe A is bent or deformed so as to produce an inverted U-shaped portion A^2 on the shoe that receives the primary seal B and forms, in effect, a metal binding for the top edge of the fabric that constitutes the primary seal B. After said fabric has been inserted in the binding produced by the turned over top edge portion of the shoe, integral prongs or claws 5 on said turned over portion may be bent into engagement with the fabric to secure or hold the same, as shown in Figures 4 and 5. Preferably, a plurality of clamping plates, hereinafter described, are used in conjunction with the integral claws or prongs 5 on the turned over top edge portion of the shoe to firmly attach or bind the primary seal to the shoe A, said clamping plates also being employed to clamp or attach the secondary seal C to the shoe.

The secondary seal is fastened to the side wall shoe preferably by a clamping ring or clamping rods 10 and a plurality of clamping plates E that act on said rod, said clamping plates being supported and attached to the shoe A by bolts 11 that project inwardly through punched holes in the doubled or turned over part A^2 at the top edge of the shoe. As shown in Figures 8, 9 and 10, the bolts 11 are so disposed that they lie between the adjacent edges of the primary seal B and secondary seal C, and the clamping ring or rods 10 is so disposed with relation to the bottom edge of the secondary seal that when the clamps E are tightened, said clamping ring 10 will be located near enough to the bottom edge of the seal to insure that said secondary seal is clamped or engaged throughout its entire circumference by the ring 10. In order to facilitate the installation of the seal, the clamping plates E are provided on their inner sides (the sides opposed to the turned over portion A^2 of the shoe) with a means that serves as a support for the clamping ring 10, when said clamping ring is dropped into position between the secondary seal and the clamping plates E preparatory to tightening the nuts on the supporting bolts 11 for said clamping plates. As shown in Figure 9, said means may comprise lugs 12 on the inner sides of the clamping plates E. The clamping plates E may be of various shapes and forms, so long as they are constructed in such a way that when they are tightened, portions of said plates will exert pressure on the clamping ring 10 and also on the outer leg of the inverted U-shaped part A^2 at the top edge of the side wall shoe. In the clamping plate E, shown in Figure 9, the portion of the plate that exerts pressure on the turned over part or fabric binding at the top edge of the shoe, consists of a horizontally disposed element or part 13, preferably of considerable length, as shown in Figure 6. Other ones of the clamping plates E, i. e., those that are arranged in the zone of the swinging hangers D, are of slightly different construction, but are provided with a part, hereinafter described, that is the equivalent of the horizontally disposed portion 13 of the clamping plate shown in Figure 9.

At the points where the roof hangers D are located, the clamping plates that act upon the clamping ring 10 are of slightly different construction. Thus, as shown in Figures 6 and 7, the two clamping plates E' and E' that are arranged at opposite sides of a hanger are joined together by a tie bar 14, so as to form a single unit that is adapted to be bolted to the shoe A by bolts 11 of the kind previously described, the tie bar 14 having a laterally-projecting portion 13^a at its bottom edge, that performs the same function as the horizontally-disposed portion 13 of the clamping plate E, shown in Figure 10. The top edge of the tie bar 14 serves as a supporting means for the clamping ring 10, and hence, performs the same function as the lug 12 on the vertically-disposed portion of the clamping plate E, shown in Figure 9. My present invention consists in attaching the suspending links 4 to the shoe A in such a way that when the roof moves downwardly, relatively to the side wall of the tank, due to a change in the level of the liquid on which the roof floats, the shoe suspending links or rods 4 will exert a thrust on the shoe in a direction tending to move the shoe inwardly away from the tank side wall. Similarly, when the roof rises or moves upwardly relatively to the tank side wall, the links 4 exert an upward pull or thrust on the shoe A in a direction tending to force the top edge of the shoe, the least possible degree, outwardly into engagement with the tank side wall. The purpose of this particular construction is to decrease friction between the shoe and the tank side wall and also break the shoe away from the side wall, in the event ice has formed between said parts. The "push down" effect on the shoe is attained by providing each of the suspending links or rods 4 at its lower end with a thrust piece or lug 15 disposed so as to engage a horizontally-disposed rod or part 16 attached to inwardly-projecting arms 17 on the clamping plates E', said rod 16 being spaced far enough away from the vertical portions of the plates E' to permit the lower end portion of the suspending link 4 to pass downwardly between the vertical portions of the plates E' and the horizontally-disposed rod 16, as shown in Figure 8. If the rod 4 moves downwardly, the thrust block 15 will exert pressure on the rod 16 in a direction tending to push the shoe A inwardly or away from the tank side wall. At the lower end of the suspending link 4 is a lug, block or thrust piece 18 disposed at an upwardly-inclined angle with relation to the part of the link 4 to which said thrust block 18 is attached, so that if the rod 4 moves upwardly, the high end of the thrust block 18 will engage the laterally-projecting portion 13^a at the bottom edge of the tie bar 14 and produce a "pull up" effect on the shoe A, or, in other words, exert pressure on the

shoe in a direction tending to force it outwardly as little as possible. It is noted that when the rod 4 pushes the shoe downwardly, the pressure is exerted on the shoe at a considerable distance from said shoe. This creates a rotating moment which pulls the top of the shoe away from the tank side wall, and thus will easily break any ice between the shoe and tank side wall. Now, when the rod 4 pulls up on the shoe, there is a rotating moment which tends to push the top of the shoe against the wall of the tank. It is desirable to make this moment as small as possible, and hence, I design the piece 18 so that the lift of rod 4 will be applied as close to the shoe as possible. Thus, I make this rotating moment as small as possible, and hence, decrease the shoe friction during upward movement. In order that the rods 4 will clear or not bear against the top edge of the secondary seal C or the means used to support said seal, I form bends in the lower end portions of the rods 4, as shown in Figure 3, said bends virtually forming recesses or pockets in the rods 4 that permit said rods to overhang the secondary seal without liability of bearing against the top edge of same.

The secondary seal C is supported and held pressed tightly against the inside face of the tank side wall by a means that comprises a plurality of spring-actuated, rockable carriers, to which the top edge portion of the secondary seal is connected. Preferably, the said carriers are formed by substantially U-shaped or channel-shaped metal members F that grip the top edge of the secondary seal, and rockable arms 19 arranged on the inner side of the shoe A and combined with torsion springs 20 that exert pressure on said arms in a way to hold the secondary seal pressed against the inner face of the side wall of the tank. Each of the channel-shaped or U-shaped members F that constitutes what I will term the body portion of a carrier, is associated with a pair of the arms 19, as illustrated in Figure 6, said carriers being arranged end to end around the entire circumference of the side wall shoe and disposed so that the secondary seal C is sustained in an upright position above the top edge of the shoe A, with a portion of said seal bearing against the tank side wall. The arms 19 are rockably mounted on horizontally-disposed pintles or fulcrum pins 21 carried by the clamps E and E', previously described. In the particular form of my invention herein illustrated each of the arms 19 is formed from a light-weight rod or piece of heavy spring wire bent to produce a torsion spring 20 provided at one end with an upwardly-projecting part that constitutes the arm 19, and provided at its opposite end with a depending part 19a that bears against the clamping plate on which the arm is mounted, and thus maintains the spring 20 under the proper tension. At the upper end of the arm 19 is a U-shaped portion 22 that forms a seat for receiving the member F that grips the top edge portion of the secondary seal C.

The bottom edge portion of the primary seal B is herein illustrated as being secured to the floating roof 2 by a means that comprises opposed clamping members on the floating roof and retaining devices for said clamping members arranged so that when said retaining devices are tightened, cement will be forced into the spaces or joints between the clamping members and the bottom edge portion of the primary seal. Said clamping means comprises an annular-shaped member 24 attached to the floating roof 2 and formed from either a flat, vertically-disposed ring or from the upright leg of an angle-shaped member on the roof, and an opposed, movable clamping member 25, formed preferably of a plurality of segmental-shaped members that are adapted to be drawn towards the stationary clamping member 24 by nuts mounted on the bolts 26 that pass horizontally through the members 24 and 25. When the clamping members 24 and 25 are arranged in spaced relationship, they co-act with the roof 2 to form a trough that is capable of holding a quantity of cement. To clamp the primary seal to the roof the bottom edge portion of said seal is positioned between the members 24 and 25 at a point above the bolts 26, and thereafter the nuts on said bolts are tightened so as to draw the movable clamping members 25 towards the stationary clamping member 24.

In order to prevent the primary seal B from assuming the form of a loop or pocket having an open end disposed so as to catch rain water or dirt, the structure herein shown is provided with a means that supports the fabric constituting the primary seal, in such a way that relative movement between the roof and the tank side wall causes said fabric to fold or double upon itself, as shown in Figures 2 and 3, without however, producing a pocket or loop open at its upper end. Said means consists of a supporting member G that projects outwardly and upwardly from the outer edge of the floating roof, and which is of such construction and arrangement that it will not interfere with the movement of the roof inwardly and outwardly towards and away from the side wall of the tank. Preferably, the support G is composed of a plurality of relatively thin or light-weight metal plates with small gaps between their ends, arranged around the entire circumference of the roof, and provided with downwardly bent portions positioned inside of the trough-like structure formed by the opposed members 24 and 25 on the roof that receive and embrace the bottom edge portion of the primary seal B.

In installing my improved seal the fabric B is slipped upwardly into the inverted U-shaped portion A^2 at the top edge of the side wall shoe and temporarily attached to same by the spurs or prongs 5 on said portion A^2. After the clamping plates E and E' have been loosely bolted to the shoe A, the clamping ring or rods 10 are dropped into position onto the said clamping plates, and the bottom edge portion of the fabric constituting the secondary seal C is positioned between said clamping ring 10 and the top edge portion A^2 of the shoe. Thereafter, when the nuts on the bolts 11 are tightened, the clamping plates E and E' will be drawn towards the overturned or doubled portion A^2 at the top edge of the shoe, thereby causing the primary seal and secondary seal to be forced into gas-tight engagement with the shoe, the pressure which the clamping plates exert on the clamping ring or rods 10 being great enough to de-form the turned over top edge portions of the shoe, as shown in Figure 10. Similarly, the portions 13 and 13a of the clamping plates de-form the turned over top edge portion of the shoe that grips the top edge of the primary seal. Usually cement will be applied to the top edge portion of the primary seal before it is positioned in the inverted U-shaped part A^2 at the top of the shoe, so as to further seal the fabric and metal

parts of the structure. The body portions F of the carriers for the secondary seal are installed by slipping them over the top edge portion of the secondary seal and binding them to said seal in any way, as for example, by de-forming the members F, or de-forming prongs on said members; and to combine the members F with the spring arms 19 it is only necessary to slip the bent portions 22 at the upper ends of said arms over the members F and then position the coiled springs 20 on the pintle pins 21. When the seal is in use, the thrust which the suspending links 4 on the roof hangers exert on the side wall shoe, during the rise and fall of the roof, overcomes any tendency of the shoe to stick to the tank side wall, due to excessive friction, and effectively breaks the shoe away from the side wall in the event ice has formed between said parts.

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

1. In a floating tank roof seal, the combination of an annular shoe adapted to act on the side wall of the tank, a floating roof, a secondary seal rockably mounted at the top edge of said shoe on the inner side of same so as to engage the tank side wall at a point above the shoe, swinging hangers on the roof arranged with their upper ends bearing against the tank side wall, and supporting links for the shoe attached to the upper ends of said hangers adjacent the point where said hangers engage the tank side wall and constructed so as to not bear against said secondary seal.

2. In a floating tank roof seal, the combination of an annular shoe adapted to act on the side wall of the tank, a floating roof, a secondary seal at the top edge of said shoe adapted to engage the tank side wall at a point above the shoe, rockable carriers for said secondary seal pivotally mounted on the inner side of the shoe, hangers on the roof arranged with their upper end portions in sliding engagement with the tank side wall, and supporting links whose lower ends are engaged with the shoe and whose upper ends are attached to the hangers in close proximity to the tank side wall, said links being constructed so as to clear the carriers for the secondary seal.

3. In a floating tank roof seal, the combination of an annular shoe adapted to act on the side wall of the tank, a floating roof, hangers on the roof that overhang the peripheral edge of the roof, shoe supporting links attached to the shoe and pivotally suspended from said hangers, co-acting "pull-up" devices on the links and shoe arranged so that when the roof moves upwardly, the outward thrust of the links on the shoe will be minimized and said links will exert a substantially direct upward pull on the shoe, the pull-up devices on the shoe being arranged at the top edge portion of same in close proximity to the inner side of the shoe, and co-acting "push-down" devices on the links and shoe arranged so that when the roof moves downwardly, said links will exert a thrust on the shoe in a direction tending to move the upper edge of the shoe inwardly, away from the tank side wall, the push-down devices on the shoe being arranged at the top edge portion of same and far enough inwardly from the inner side of the shoe to cause the downward thrust of the links on the shoe to create a rotating moment which pulls the top edge of the shoe away from the tank side wall.

4. A floating tank roof seal of the kind described in claim 3, in which the hangers are pivotally mounted and project upwardly and outwardly from the roof with their upper end portions in sliding engagement with the tank side wall.

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