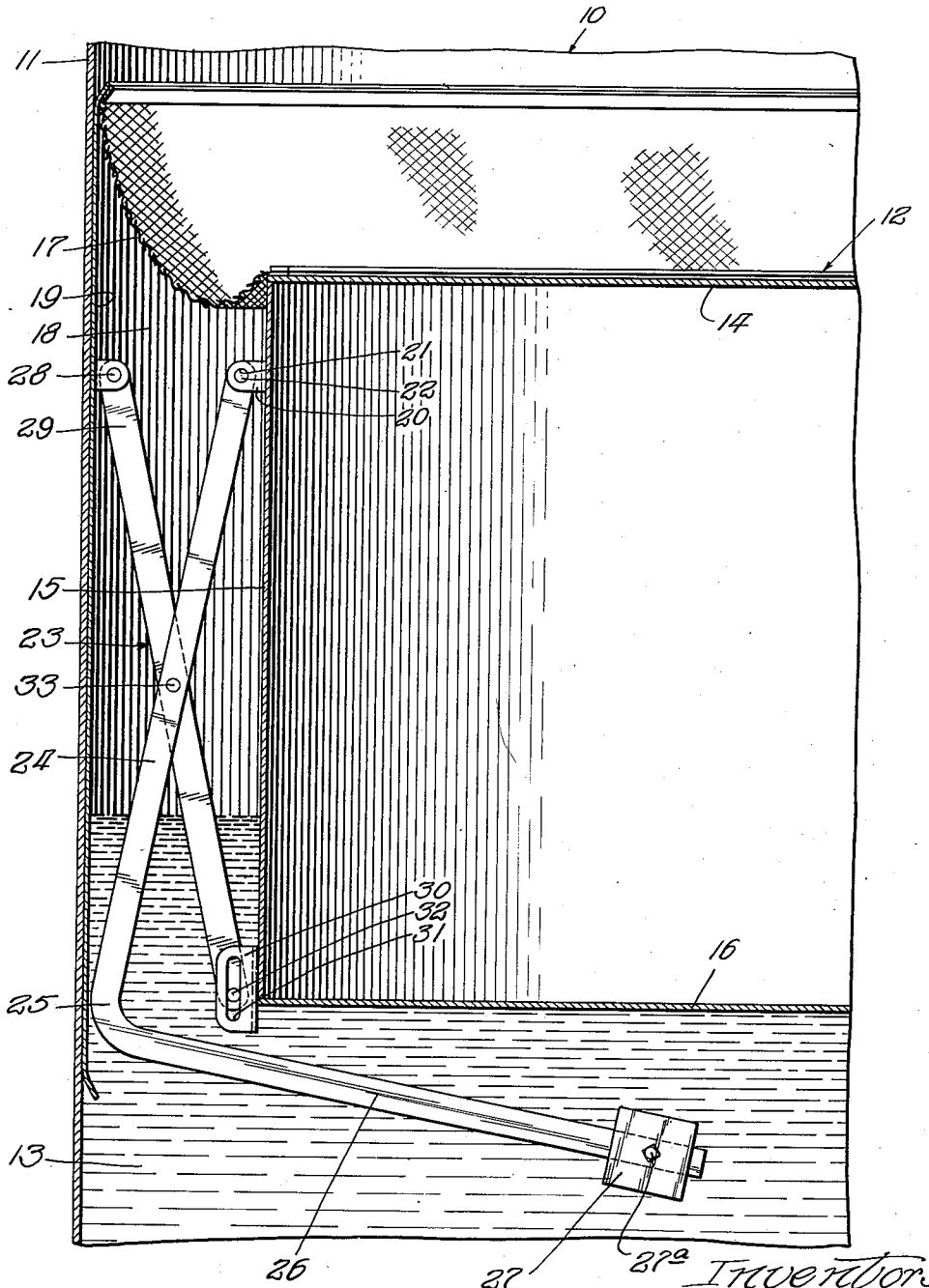
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SEAL HANGER FOR FLOATING ROOFS

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SEAL HANGER FOR FLOATING ROOFS

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This invention relates to a liquid storage tank, and more particularly to a new improved shoe supporting means for use in conjunction with a floating roof in a liquid storage tank.

Liquid storage tanks employing a floating roof as the top closure for the liquid stored therein are being widely adapted as the most efficient method of storing volatile liquids, such as petroleum products. Such floating roof tanks usually provide for a flexible seal to seal the space between the roof and a plurality of shoes which slide along the inner side walls of the tank. Numerous methods have been devised for supporting the shoes against side walls of the tank, many of which have been extremely complicated in nature.

We have invented and are herein disclosing and claiming a shoe hanger of simple design which has many advantages that will be hereinafter pointed out. This invention is an improvement upon the co-pending application of Frederick D. Moyer filed February 3, 1947, as Serial No. 726,179, now Patent No. 2,554,497, May 29, 1951.

The invention will be described in the embodiment disclosed in the accompanying drawing which is a vertical section through a liquid storage tank showing portions of the side walls, the floating roof, and the liquid stored in the tank.

Referring now to the figure, 10 indicates a liquid storage tank having a side wall 11 and a floating roof 12 floating upon the surface of the liquid 13 contained in the tank. The floating roof has a top 14, a side 15 and a bottom 16. An annular seal 17 of flexible material seals the space 18 between the side 15 of the tank and a plurality of shoes 19 which slidably contact the side wall of the tank.

A lug 20 is welded to the upper portion of the side 15 and has a hole 21 provided therein in which a pin or shaft 22 is journaled, the shaft being attached to the upper end of a lever 23 to provide a pivotal connection of the lever to the upper portion of the roof. The lever 23 has a downwardly extending portion 24, an angle 25 and an inwardly extending portion 26. A weight 27 is provided on the inwardly extending portion to exert a downward force upon the lever, and the position of the weight may be changed by sliding it along the portion 26 and clamping it in any desired position by means of the clamp 27a. Pivotally connected at 28 to the upper portion of the shoe is a shoe supporting member 29. The other end of the shoe supporting member is connected to the lower portion of the side

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15 by means of a pin and slot arrangement. As shown in the drawing, a bracket 30 is attached to the lower portion of the roof having a vertical slot 31, the sides of the slot being engaged by a pin 32 attached to the lower end of the member 29. The shoe supporting member is pivotally connected to the lever 23 at 33, as shown.

In the preferred embodiment shown, the points of connection of the member 29 to the shoe and of the lever 23 to the roof lie in the same horizontal plane and the distance along the member from the point 28 to the point 33 of connection to the lever equals the distance along the lever from that point (33) to its point of connection to the roof at 22. Also, the point 33 lies midway between the ends of the member 29.

The weight of the shoe is carried by the shoe supporting member 29 and transmitted from that member to the lever by means of the connection 33. It will be noted that the angle 25 is normally spaced from the shoe 19 and hence does not rub against the shoe. The pin and slot arrangement 31 and 32 permits vertical movement of the lower end of the shoe supporting member 29 with respect to the roof while preventing horizontal movement thereof. Practically no vertical movement of the shoe occurs with horizontal movement of the roof, and the forces set up by horizontal movement of the roof tend to return the roof to center. This latter feature can perhaps be best described by expressing the various forces in terms of formulae. For this purpose, let

(W) equal the downward force exerted by the weight 27;

(w) equal the downward force exerted by the shoe;

(H) equal the horizontal distance from the weight 27 to the pin 32;

(h) equal the horizontal distance from the pin 32 to the side wall 11 of the tank;

(V) equal the vertical distance between the point of connection of the lever to the roof at 22 and the point of contact of the pin 32 with the edges of the slot 31.

The equation of moments (R_1) about the point 33 of all the forces on the lever 23 is:

$$W(H+\tfrac{1}{2}h)-(Ww)(\tfrac{1}{2}h)-R_1(\tfrac{1}{2}V)=0$$

whence

$$R_1=\frac{2WH-wh}{V}$$

The equation of moments (R_2) about the point **22** of all the forces on the entire hanger system is:

$$WH-wh-R_2V=0$$

whence

$$R_2=\frac{WH-wh}{V}$$

R_1 is the horizontal force applied at the point **22**, outward on the lever **23** and inward on the roof; R_2 is the horizontal force applied at the point **32**, inward on the shoe supporting member **29** and outward on the roof; and R_3 is the horizontal force applied at the point **28**, inward on the shoe supporting member **29** and outward on the shoe.

Then the equation of equilibrium of horizontal forces on the hanger system is:

$$R_3+R_2-R_1=0, \text{ or } R_3+\frac{WH-wh}{V}-\frac{2WH-wh}{V}=0$$

whence

$$R_3=\frac{WH}{V}$$

As W is constant and both V and H increase with decreasing h (but H increases faster than V), the roof is maintained centered in the tank.

It can be seen from the foregoing that our hanger system has certain inherent advantages. There is practically no vertical movement of the shoe with horizontal movement of the roof. The force pushing the shoe against the shell is constant regardless of the weight of the shoe, and the force varies directly with the horizontal distance between the weight **27** and the point of connection of the member **29** to the lower portion of the roof, that is, the pin **32**. Both the outward push on the shoe and the centering force may be regulated directly by changing the position of the weight **27** on the inwardly extending portion, **26**. The outward push on the shoe acts only at the top of the shoe, that is, about the point of connection **28**, but the lower portion of the shoe is not permitted to leave the side walls a distance greater than the distance of clearance between the angle **25** and the shoe, which is generally about ¼ to ½ inch. The angle **25** does not rub on the shoe in normal operation of the roof, and any rubbing which takes place due to inward displacement of the lower portion of the shoe occurs in the liquid.

While we have shown and described our invention in its preferred embodiment, it is to be understood that it is capable of many modifications. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as disclosed in the appended claims.

We claim:

1. In a liquid storage tank having a floating roof and one or more shoes adapted to slidably contact the inner side walls of the tank, means for supporting the shoes against the side walls including a lever swingably attached to the roof, said lever having an angular portion, a portion extending downwardly in the space between the roof and the tank from the point of attachment of the roof to the angular portion and a portion extending inwardly from said angle and a rigid metallic shoe supporting member having one end pivotally connected to the shoe and having the other end pivotably connected to the roof, said connection to the roof permitting vertical movement and preventing horizontal movement of said other end with respect to the roof, said shoe supporting member being pivotally connected intermediate its ends to the downwardly extending portion of the lever and being supported thereby.

2. Apparatus of the character described in claim 1 in which said angle is normally maintained in a position spaced from the shoe.

3. Apparatus of the character described in claim 1 in which the connection of the other end of the shoe supporting member to the roof includes a bracket attached to the roof having a vertical slot therein, and a pin attached to the other end of said shoe supporting member slidably engaging the sides of the slot.

4. In a liquid storage tank having a floating roof and one or more shoes adapted to slidably contact the inner side walls of the tank, means for supporting the shoes against the side walls including a lever swingably attached to the upper portion of the roof, said lever having an angular portion immersed in the liquid, a portion extending downwardly from the point of attachment of the roof to the angular portion and a portion extending inwardly from said angle, means for exerting a downward force on said inwardly extending portion, and a shoe supporting member having one end attached to the upper portion of the shoe and having the other end connected to the lower portion of the roof, said connection to the lower portion of the roof permitting vertical movement and substantially preventing horizontal movement of said other end with respect to the roof, and said shoe supporting member being pivotally connected intermediate its ends to the downwardly extending portion of the lever.

5. Apparatus of the character described in claim 4 in which the point of connection of the lever to the roof and the point of connection of the shoe supporting member to the shoe lie in substantially the same horizontal plane whereby vertical movement of the shoe with horizontal movement of the roof is prevented.

6. Apparatus of the character described in claim 4 in which the point of connection of the lever to the roof and the point of attachment of the shoe supporting member to the shoe lie in substantially the same horizontal plane, and the distance from the point of attachment of the shoe supporting member to the shoe to its point of pivotal connection to the lever is substantially equal to the distance from said point of pivotal connection to the point of connection of the lever to the roof, whereby vertical movement of the shoe with horizontal movement of the roof is prevented.

7. In a liquid storage tank having a floating roof and one or more shoes adapted to slidably contact the inner side walls of the tank, means for supporting the shoes against the side walls including a lever swingably attached to the upper portion of the roof, said lever having an angular portion, a portion extending downwardly from the point of attachment of the roof to the angular portion and a portion extending inwardly from said angle, a weight connectable to said inwardly extending portion at a plurality of positions for exerting a downward force thereon, a shoe supporting member having one end attached to the upper portion of the shoe and having the other end connected to the lower portion of the roof, said connection to the lower portion of the roof permitting vertical movement and substantially preventing horizontal movement of said other end with respect to the roof, said member being pivotally connected intermediate its ends to the downwardly extending portion, said shoe

supporting member exerting an outward force against said shoe to hold the same against the side walls and an inward force against the roof tending to move the roof away from the side walls, said inward force varying inversely as the distance between the roof and the side walls whereby to center the roof in the tank, and said weight being connectable to said inwardly extending portion at a plurality of positions whereby to vary said forces exerted by said shoe supporting member.

8. Apparatus of the character described in claim 7 in which the point of connection of the lever to the roof and the point of attachment of the shoe supporting member to the shoe lie in substantially the same horizontal plane, and the distance along said shoe supporting member from the point of attachment to the shoe to its point of pivotal connection to the lever is substantially equal to the distance along said downwardly extending portion from said point of pivotal connection to the point of connection of the downwardly extending portion to the roof.

9. Apparatus of the character described in claim 8 in which said shoe supporting member is pivotally connected to the downwardly extending portion at a point substantially midway between its said ends.

10. In a liquid storage tank having a floating roof and one or more shoes adapted slidably to contact the inner side walls of the tank, means for supporting the shoes against the side walls including a pair of levers, one pivotally connected to the shoe and slidably connected to the roof and the other pivotally connected to the central portion of the first lever and pivotally connected to the roof, the pivotal connection of one lever to the roof and of the other lever to the shoe being in substantially the same horizontal plane and means to provide a force tending to separate the shoe and the roof which is substantially inversely proportional to the distance between the shoe and the roof whereby no vertical force acting in the plane of the shoe affects the pressure between the shoe and the side walls.

11. In a liquid storage tank having a floating roof and one or more shoes adapted slidably to contact the inner side walls of the tank, means for supporting the shoes against the side walls

including a pair of levers, one pivotally connected to the shoe and slidably connected to the roof to permit relative vertical movement and the other pivotally connected to the central portion of the first lever and pivotally connected to the roof, the pivotal connection of one lever to the roof and of the other lever to the shoe being in substantially the same horizontal plane, both connections to the roof being substantially vertically spaced from each other and means to provide a force tending to separate the shoe and the roof which is substantially inversely proportional to the distance between the shoe and the roof whereby no vertical force acting in the plane of the shoe affects the pressure between the shoe and the side walls.

12. In a liquid storage tank having a floating roof and one or more shoes adapted slidably to contact the inner side walls of the tank, means for supporting the shoes against the side walls including a pair of levers, one pivotally connected to the shoe and slidably connected to the roof and the other pivotally connected to the central portion of the first lever and pivotally connected to the roof, the pivotal connection of one lever to the roof and of the other lever to the shoe being in substantially the same horizontal plane whereby no vertical force acting in the plane of the shoe affects the pressure between the shoe and the side walls.

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