Sept. 23, 1952 W. E. BUSSE ET AL 2,611,504

HANGER FOR FLOATING ROOFS

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Fig. 1.

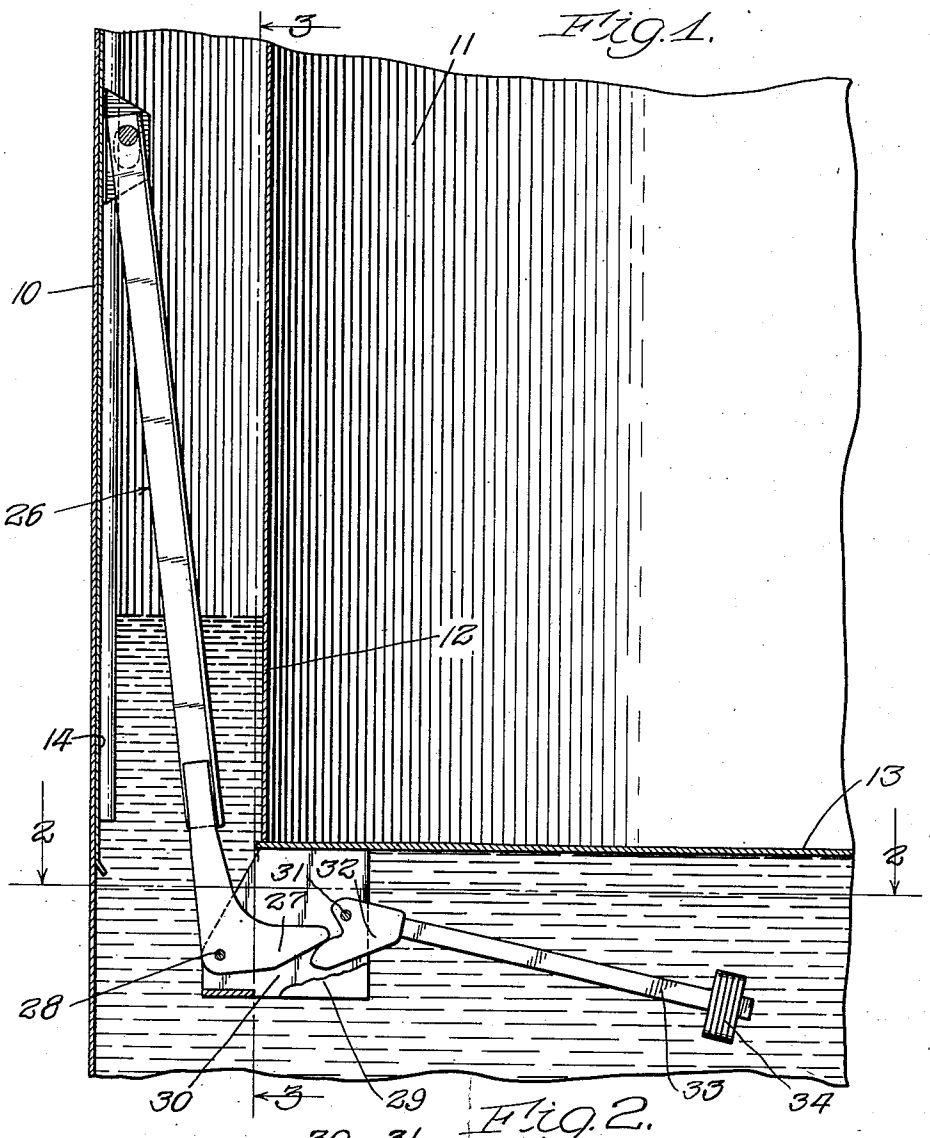
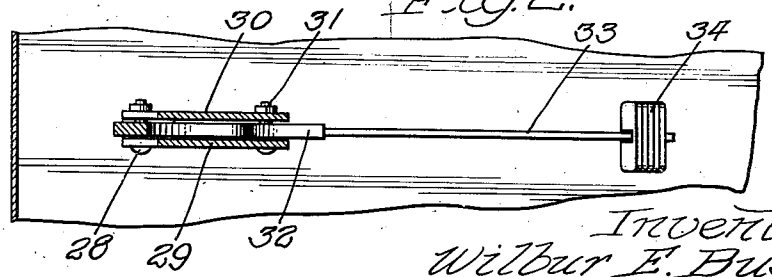


Fig. 2.



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Fig. 3.

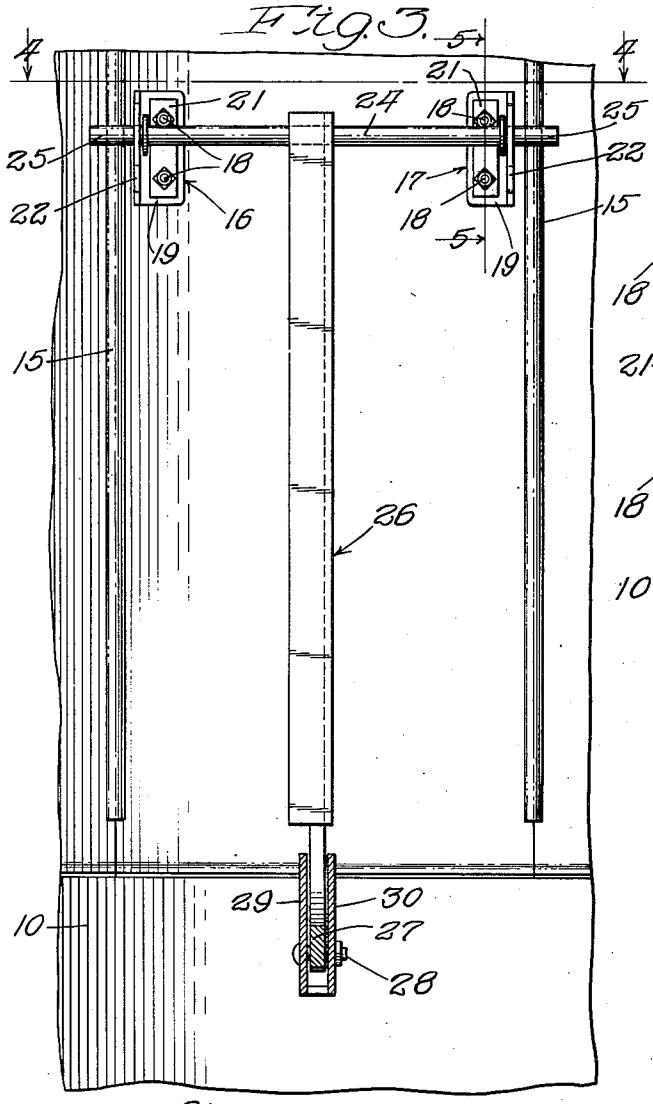


Fig. 5.

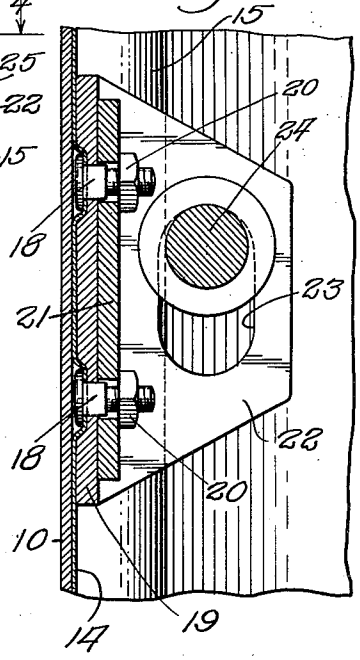
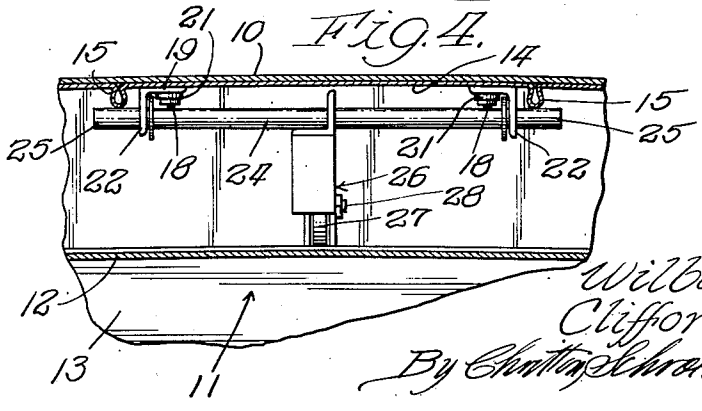


Fig. 4.



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Fig. 6.

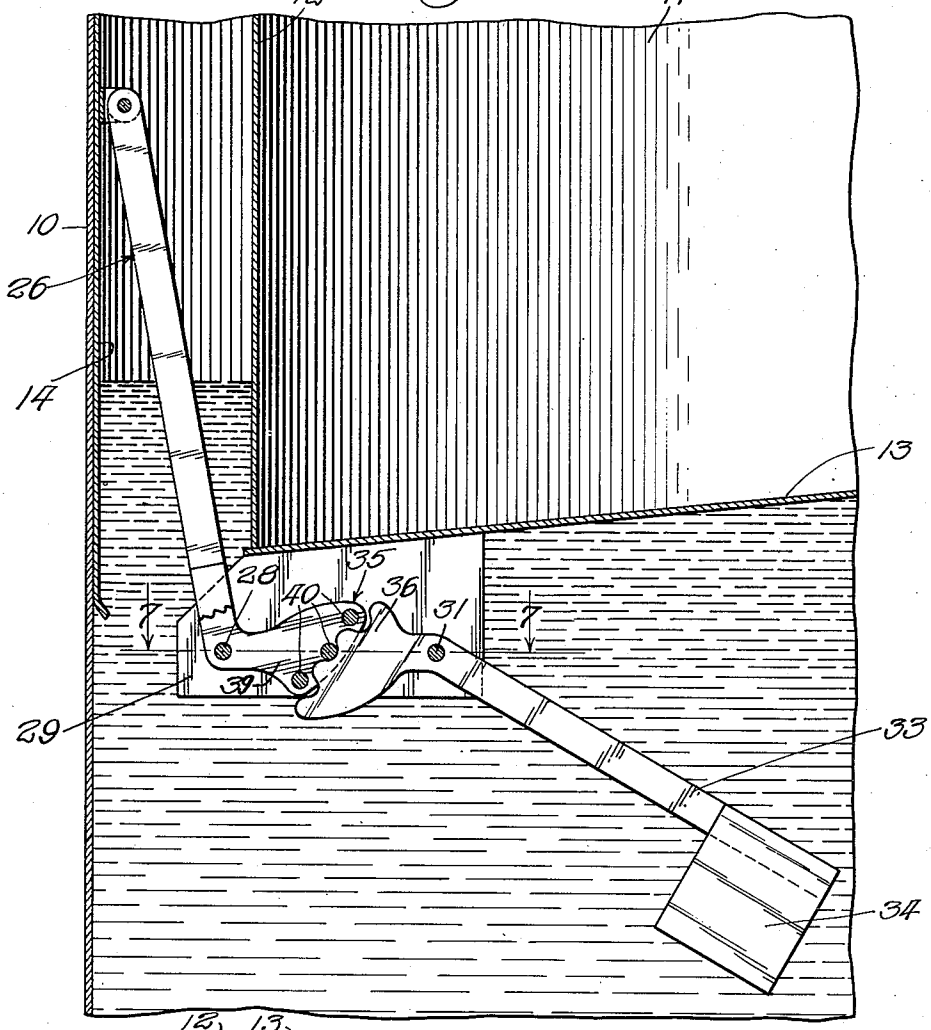


Fig. 8.

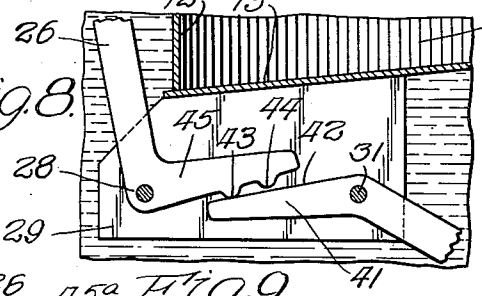


Fig. 7.

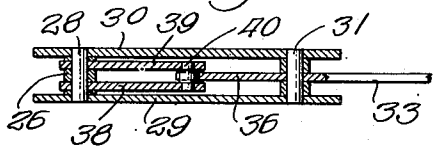
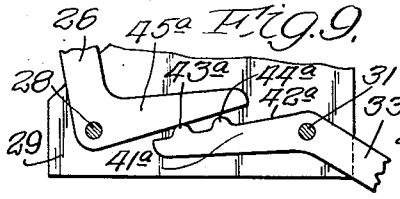


Fig. 9.



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UNITED STATES PATENT OFFICE

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HANGER FOR FLOATING ROOFS

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Application June 3, 1947, Serial No. 752,018

11 Claims. (Cl. 220—26)

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This invention relates to floating roof tanks, and more particularly to a new and improved hanger means for supporting the shoes of a floating roof tank against the side walls of the tank.

Floating roof tanks adapted for storing volatile liquids, such as petroleum products, generally comprise a cylindrical tank and a roof within the tank floating upon the liquid contained therein. The roof is generally made of lesser diameter than the inner diameter of the tank to assure free vertical movement of the roof with changes in the level of the liquid, and accordingly means must be provided for sealing the space between the edges of the roof and the tank to prevent excessive loss of liquid through evaporation and to prevent contamination of the stored products by rainfall, dust, and the like.

The space between the roof and the side walls are generally sealed by providing a plurality of shoes supported by the roof and adapted to slidably contact the inner walls of the tank. An annular seal of flexible material is usually included to seal the space between the shoes and the roof. Various means have been employed to support the shoes against the side walls of the tank, many of which have been extremely complicated in nature.

We have invented, and are herein disclosing and claiming, a new and improved shoe hanger means possessing novel and desirable features.

The invention will be described in the embodiment shown in the accompanying drawings in which:

Fig. 1 is a vertical section through a portion of a floating roof tank showing a portion of the roof, the side walls of the tank, and disclosing the hanger device of our invention;

Fig. 2 is a horizontal section along lines 2—2 of Fig. 1;

Fig. 3 is a side elevation of a portion of the device adjacent the shoe;

Fig. 4 is a horizontal section along lines 4—4 of Fig. 3;

Fig. 5 is a vertical section along lines 5—5 of Fig. 3;

Fig. 6 is a view like Fig. 1 of a modified form of the device;

Fig. 7 is a vertical section along lines 7—7 of Fig. 6; and

Figs. 8 and 9 are views of the lower portion of the roof showing two modified forms of the apparatus shown in Figs. 1 and 6.

Referring now to the drawings, 10 indicates a side wall of a liquid storage tank in which a roof 11 floats, the roof having a side wall 12 and a bottom 13. A plurality of shoes 14 are supported by means hereinafter more fully described, against the side walls of the tank. The shoes are constructed of flexible metal sheets and are provided with vertical stiffening means in the form of vertical flexures 15 in the shoe. These flexures permit some expansion and contraction of the shoe and also serve as vertical reenforcements for the shoe.

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A pair of brackets 16 and 17 are secured to the shoe adjacent its upper portion by bolts 18. Each bracket is provided with a flat portion 19 adapted to be held between the surface of the shoe and a washer plate 21 against which the nuts 20 are drawn. Each bracket is further provided with an upstanding web 22 having a vertical slot 23 formed therein. Extending through the slot 23 is a horizontal crossbar 24. The crossbar is generally cylindrical in shape and is permissibly rotatable and vertically slidable within the slots. The outer ends 25 of the crossbar press against the inner edge of the vertical flexures 15.

Welded to the crossbar 24 a point generally midway between the two brackets is a main shoe hanger member 26. The shoe hanger is in the form of an angle iron which extends downwardly from its point of connection to the crossbar to a first cam 27.

The first cam is pivoted at 28 between a pair of plates 29 and 30 welded to the bottom of the roof. Also pivoted to the plates 29 and 30, at 31, is a second cam 32 engaging the first cam and having secured thereto a lever 33. A plurality of weights 34 are removably secured to the lever 33.

With the roof in the position shown in Fig. 1, the lever 33 is elevated from a freely hanging position by means of the cam means just described. Movement of the roof away from the side wall 10 would cause the hanger means 26 to rotate in a counterclockwise direction, which rotation would be transmitted to the lever through the cams and cause the lever to rotate in a clockwise direction toward a freely hanging position thereby to decrease the force exerted by the lever by reduction of its moment. If, however, the roof were to move toward the side wall from the position shown in Fig. 1, the cooperation of the hanger and cam would raise the lever 33 toward a horizontal position in which the force exerted by the lever would attain maximum. The forces exerted by the lever are transmitted by the cams to the shoes to press the shoes outwardly against the side walls. It can be seen that a further effect of the lever arm is to create a centering

force tending to return the roof to center within the tank.

In the modified form shown in Figs. 6 to 9 inclusive, similar reference numerals have been employed to indicate similar parts, the main difference being in the means transmitting the force exerted by the lever to the shoe.

In Fig. 6, gear means designated **35**, replace the cam means shown in the previous embodiment. The gear means comprise a gear segment **36** connected to the end of the lever **33** having a plurality of teeth adapted to engage a second gear member **37**. The member **37** is connected to the lower end of the shoe hanger **26** inwardly of the pivot **28** and comprises two substantially parallel plates **38** and **39**. The plates are provided with circular rods **40** extending therebetween to act as teeth and adapted to engage the teeth of the segment **36**, as shown.

In the embodiment shown in Fig. 8, a somewhat modified cam arrangement is shown comprising a first member **41** connected to the lever **33** on the opposite side of the pivot **31** having a flat upward face **42** adapted to press against two raised portions **43** and **44** on the under side of a cam member **45** connected to the shoe hanger **26**.

In the embodiment shown in Fig. 9, the raised portions **43***a* and **44***a* are provided on the lower face **42***a* rather than on the upper member **45***a*.

It can be seen that the weight of the shoes is transmitted by the hanger means to the roof to exert a horizontal force thereagainst tending to move the roof away from the side walls. The magnitude of the force exerted by the shoes depends upon the angular position of the hanger **26**. For example, movement of the roof away from the side walls causing the hanger to rotate in a counterclockwise direction moves the hanger means towards a horizontal position thereby increasing the inward horizontal force exerted against the roof. Conversely movement of the roof towards the shoe and side wall causes the hanger **26** to approach a vertical position, in which position the horizontal force exerted thereby becomes zero.

As is clear from the foregoing, the distance between the point of pivot **28** of the cam or gear member to the roof and the point of contact with the other cam or gear member supporting the lever arm varies with various positions of the lever arm. In the embodiment shown in Fig. 1 where the cam arrangement is employed, the point of contact of the cam member **27** with the cooperating cam member **32** moves outwardly with increasing distance between the roof and the side walls to shorten the lever arm presented by the cam **27**, that is, to shorten the distance between said point of contact and the point of pivot **28**. The reverse is true upon decreasing distance between the roof and side walls. The force exerted by the lever arm increases in a two-fold manner as the roof approaches the wall as elevation of the lever arm increases its moment while at the same time the distance between the point of contact of the cams and the point of pivot **28** increases, increasing that lever arm also. In the embodiment shown in Figs. 8 and 9 there are but two points of contact, that is, the point **43** and the point **44**, hence the lever arm is of one distance when the point **43** is in contact and changes to a second and longer distance when the right hand point **44** is in contact with the member **41**. In the embodiment shown in Fig. 6, as many different lever arms may be provided as is desired.

In the particular embodiment shown, there are three determined by the position of the three teeth **40**.

It can also be seen from the foregoing that the movement of the roof towards the side wall decreases the horizontal force exerted by the hanger means and shoes while at the same time the horizontal force exerted by the lever increases. The reverse is, of course, true upon the movement of the roof away from the side walls. We prefer to construct the means transmitting the force of the lever to the shoe whether such means be in the form of cams, gear segments or the other arrangements shown, so that the force exerted by the lever arm with increasing distance between the roof and the side walls decreases at least as rapidly (and preferably more rapidly) as the force exerted by the shoe increases with such increasing distance. In the preferred arrangement, therefore, the sum of the horizontal forces tending to move the roof away from the side walls decreases with increasing distance between the roof and walls of the tank.

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, the roof having a lower portion normally immersed in the liquid stored in the tank and one or more shoes adapted to slidably contact the side walls of the tank, means for supporting the shoes including a hanger having one end connected to the upper portion of the shoe and having the other end pivotally connected to the lower portion of the roof, a separate gravity operated weighted lever arm having one end free and having its other end pivoted to the lower portion of the roof and camming means interconnecting the roof end of the hanger and the pivoted end of the lever for elevating the lever arm from a position hanging freely from its point of pivotal connection to the roof, said camming means transmitting the force exerted by the lever in its elevated position into outward pressure of the hanger against the shoe and increasing the force with decreasing distance between the roof and tank side wall.

2. The apparatus of claim 1 in which the camming means includes a first cam attached to the hanger and operatively engaging a second cam attached to the lever arm and the force exerted by the lever arm varies inversely as the distance from the roof to the side walls.

3. The apparatus of claim 1 in which the camming means include a first gear means attached to the roof end of the hanger and operatively engaging a second gear means attached to the pivoted end of the lever arm, and the force exerted by the lever arm varies inversely as the distance from the roof to the side walls.

4. In a liquid storage tank having a floating roof, the roof having a lower portion normally immersed in the liquid stored in the tank and one or more shoes having vertical stiffening means and adapted to slidably contact the side walls of the tank, means for supporting the shoes comprising: a hanger having one end pivotally connected to the shoe, said connection including a crossbar attached to the hanger and bearing against the stiffening means, the other end of

the hanger being pivotally connected to the lower portion of the roof, a separate gravity operated weighted lever arm having one end free and having its other end pivotally connected to the lower portion of the roof and camming means interconnecting the roof end of the hanger and the pivoted end of the lever for elevating the lever arm from a freely hanging position, said camming means transmitting the force exerted by the lever in the elevated position into outward pressure of the hanger against the shoe.

5. Apparatus of the character described in claim 4 including a pair of brackets secured to the shoe, said brackets being provided with elongated slots and said cross-bar extending through said slots.

6. In a liquid storage tank having a floating roof, the roof having a lower portion normally immersed in the liquid stored in the tank and one or more shoes adapted to slidably contact the side walls of the tank, means for supporting the shoes comprising a hanger having one end pivotally connected to the upper portion of the shoe and having the other end pivotally connected to the lower portion of the roof, said hanger extending inwardly and downwardly from said point of connection to said second point of connection whereby the weight of the shoe exerts an outward force to press the shoes against the side walls, a separate gravity operated weighted lever arm having one end free and having its other end pivoted to the lower portion of the roof, a first cam attached to the other end of the hanger operatively engaging a second cam attached to the pivoted end of the lever arm, said cams elevating the lever arm from a freely hanging position and transmitting the force exerted by the lever in its elevated position into outward pressure of the hanger against the shoe, said force exerted by the lever arm varying inversely as the distance between the roof and the side walls, and the outward force exerted by the weight of said shoe varying directly as the distance between the roof and the side walls, said cams being so constructed and arranged to decrease the outward force exerted by the lever arm with increasing distance between the roof and side wall at least as rapidly as the outward force exerted by the shoe increases with such increasing distance.

7. The apparatus of claim 6 in which the first and second cam have an area of contact between the pivots connecting the hanger and lever to the roof, said cams being arranged to change the position of said area of contact relative to said pivots and to increase the distance between the area and the pivot connecting the hanger to the roof when the lever moves toward horizontal position.

8. In a liquid storage tank having a floating roof having a lower portion normally immersed in the liquid stored in the tank and one or more shoes adapted to slidably contact the side walls of the tank, means for supporting the shoes comprising a hanger having one end pivotally connected to the upper portion of the shoe and having the other end pivotally connected to the lower portion of the roof, said hanger extending inwardly and downwardly from said point of connection to said second point of connection whereby the weight of the shoe exerts an outward force to press the shoes against the side walls, a separate gravity operated weighted lever arm having one end free and having the other end pivoted to the lower portion of the roof, a first gear means attached to the other end of the hanger operatively engaging a second gear means attached to the pivoted end of the lever arm, said gear means elevating the lever arm from a freely hanging position and transmitting the force exerted by the lever in its elevated position into outward pressure of the hanger against the shoe, said force exerted by the lever arm varying inversely as the distance between the roof and the side walls, and the outward force exerted by the weight of said shoe varying directly as the distance between the roof and the side walls, said gear means being so constructed and arranged to decrease the outward force exerted by the lever arm with increasing distance between the roof and side wall at least as rapidly as the outward force exerted by the shoe increases with such increasing distance.

9. In a liquid storage tank having a floating roof and one or more shoes adapted to slidably contact the side walls of the tank, means for supporting the shoes comprising: a hanger having its upper end connected to the shoe and having its lower end pivotally connected to the roof, a separate gravity operated weighted lever arm having one end free and having its other end pivoted to the lower portion of the roof and camming means interconnecting the lower end of the hanger arm to the pivoted end of the lever arm to elevate the lever from a freely hanging position, said camming means transmitting the force exerted by the lever in its elevated position to said hanger whereby to urge said hanger toward rotation about its lower end to press the shoe against the side wall of the tank and to change the distance between the pivot of said hanger and the point of application of said force inversely to the distance between the roof and the side wall of the tank.

10. In a liquid storage tank having a floating roof, the roof having a lower portion normally immersed in the liquid stored in the tank and one or more shoes adapted to slidably contact the side walls of the tank, means for supporting the shoes comprising a hanger having one end pivotally connected to the upper portion of the shoe and having the other end pivotally connected to the lower portion of the roof, said hanger extending inwardly and downwardly from said point of connection to said second point of connection whereby the weight of the shoe exerts an outward force to press the shoes against the side walls, a separate gravity operated weighted lever arm having one end free and having its other end pivoted to the lower portion of the roof, a camming means comprising teeth attached to the other end of the hanger operatively engaging a second camming means attached to the pivoted end of the lever arm, said camming means elevating the lever arm from a freely hanging position and transmitting the force exerted by the lever in its elevated position into outward pressure of the hanger against the shoe, said force exerted by the lever arm varying inversely as the distance between the roof and the side walls, and the outward force exerted by the weight of said shoe varying directly as the distance between the roof and the side walls, said camming means being so constructed and arranged to decrease the outward force exerted by the lever arm with increasing distance between the roof and side wall at least as rapidly as the outward force exerted by the shoe increases with such increasing distance.

11. The apparatus of claim 10 in which the camming means comprising teeth and the sec-

ond camming means have an area of contact between the pivots connecting the hanger and lever to the roof, said camming means being arranged to vary the position of said area of contact with relation to said pivots and to increase the distance between said area and the pivot connecting the hanger to the roof when the lever moves toward horizontal position.

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