

March 13, 1928.

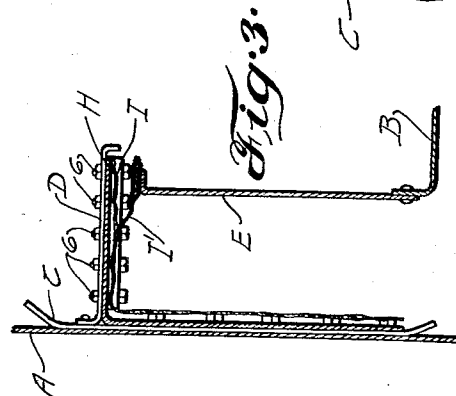
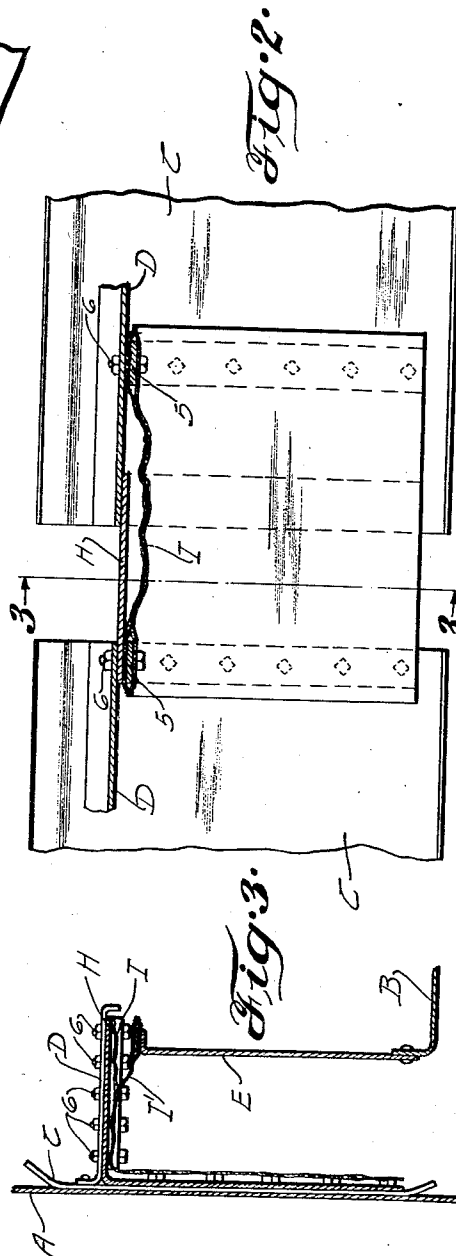
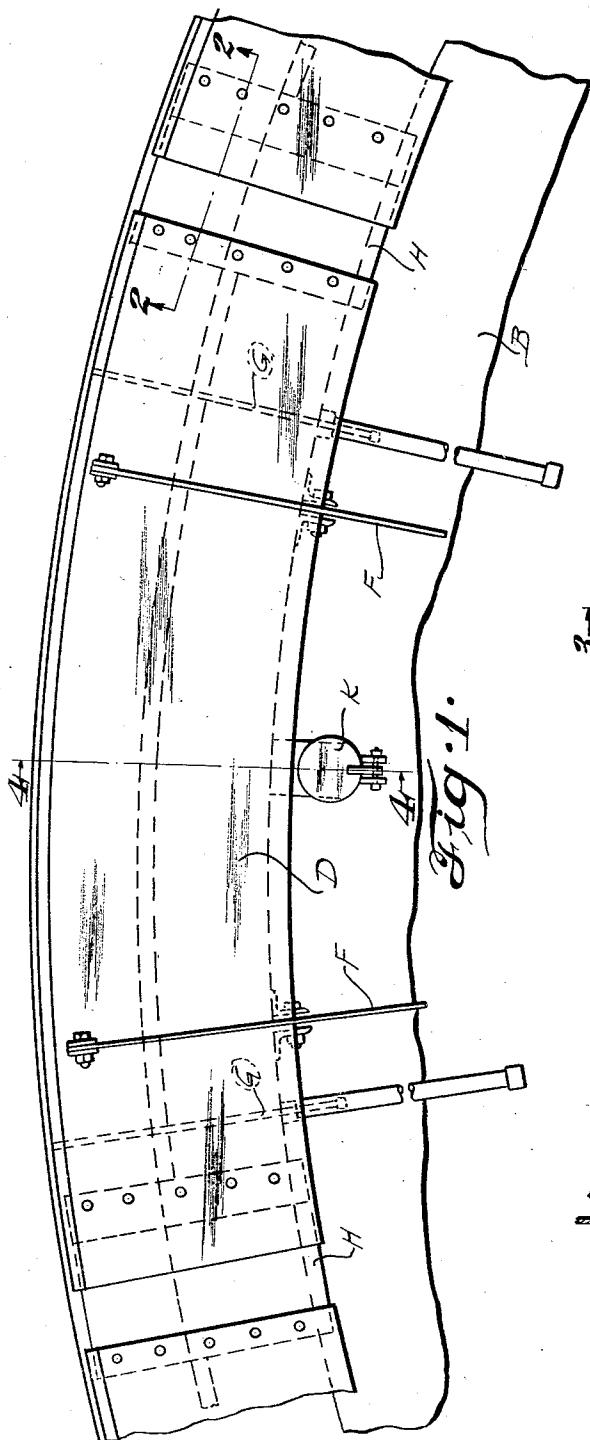
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1,662,225

FLOATING DECK FOR LIQUID STORAGE TANKS

Filed March 26, 1923

2 Sheets-Sheet 1



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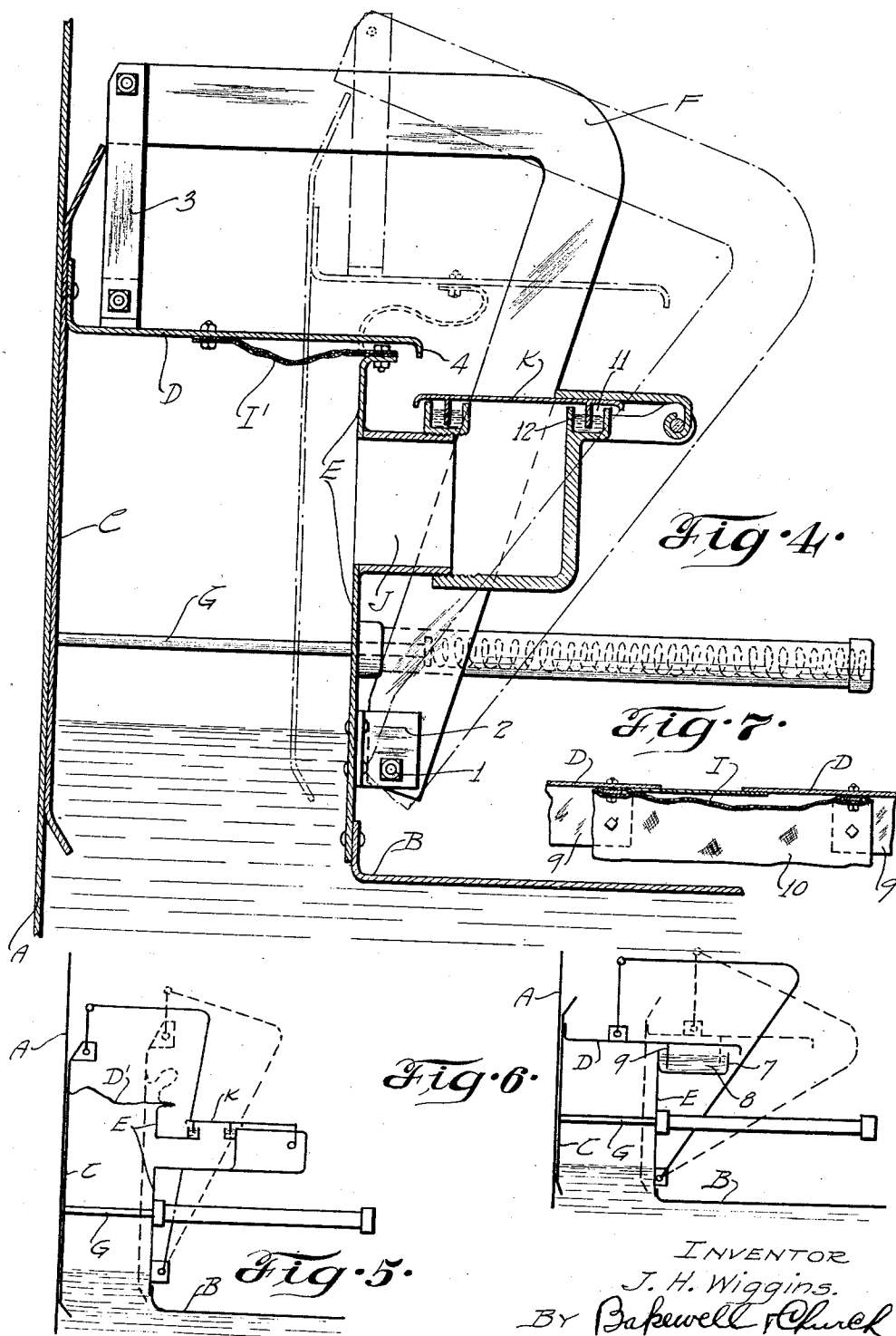
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FLOATING DECK FOR LIQUID STORAGE TANKS

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2 Sheets-Sheet 2



UNITED STATES PATENT OFFICE.

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FLOATING DECK FOR LIQUID-STORAGE TANKS.

Application filed March 26, 1923. Serial No. 627,835.

This invention relates to liquid storage tanks of the type that comprise a movable top or deck which floats upon and is supported by the liquid in the tank, and is an improvement upon the floating deck described in my U. S. Patent No. 1,493,091, dated May 6, 1924, which resulted from my application for patent Serial No. 540,847, filed March 3, 1922.

One object of my present invention is to provide a tank of the general type above referred to for storing oil and other liquid, which is of such construction that permanent gases mixed with the liquid pumped into the tank will not cause the liquid to be carried out of the tank and splashed onto the floating deck.

Another object of my invention is to provide a tank for storing volatile liquids which is of such construction that the fire hazard and the evaporation losses are reduced to a minimum.

And still another object of my invention is to provide a liquid storage tank which is of such design that relatively great variations in the diameter of the tank, due to expansion and contraction, will not influence or have any effect on the efficiency of the means that is employed to close the space between the floating deck and the side wall of the tank.

To this end I have devised a liquid storage means, which, briefly described, consists of a tank provided with a cylindrical side wall, a floating deck supported by the liquid in the tank and proportioned so that it covers the major portion of the surface of said liquid, and an annular chamber between the peripheral edge of said deck and the side wall of the tank constructed so that gases mixed with the liquid pumped into the tank will be trapped in said chamber, and subsequently allowed to escape from same through restricted openings. The annular chamber and the restricted openings just referred to are preferably of gas-tight construction, so as to reduce the fire hazard and the evaporation losses to a minimum. By "gas-tight" I mean substantially gas-tight when in normal operation. It is obvious that when, for any reason whatever, the internal gas pressure exceeds the safe limit, the vents will open and the annular chamber is no longer gas-tight. The outer side wall of said annular chamber is formed by a shoe arranged parallel to the side wall of

the tank with its lower edge portion submerged in the liquid in the tank, and in order to provide for a relatively great expansion and contraction of the tank, said shoe is composed of segmental sections sustained by long hangers carried by the floating deck and joined to each other and to the floating deck by pieces of flexible material which are preferably substantially gas-tight and fire-proof. Another annular chamber, which is open at its upper end, is formed by the outside surface of the shoe above referred to, by the inner surface of the side wall of the tank which extends parallel to said shoe and by the surface of the liquid in the tank. Said shoe is of relatively great depth, so that the open annular chamber between said shoe and the side wall of the tank will be comparatively narrow with reference to its height, so that the oil vapors which collect in said chamber will remain at the lower end of said chamber, notwithstanding the fact that the upper end of said chamber is open, due to the fact that oil vapors are about twice as heavy as air. With such a construction there is practically no circulation of air or vapor in the chamber referred to.

Figure 1 of the drawings is a top plan view of part of the variable peripheral portion of a floating deck for liquid storage tanks constructed in accordance with my present invention.

Figure 2 is a vertical sectional view, taken on the line 2—2 of Figure 1, looking in the direction indicated by the arrows.

Figure 3 is a vertical sectional view, taken on the line 3—3 of Figure 2, looking in the direction indicated by the arrows.

Figure 4 is an enlarged vertical sectional view, taken on the line 4—4 of Figure 1, looking in the direction indicated by the arrows.

Figures 5 and 6 are diagrammatic views, illustrating slight modifications that may be made in the deck without departing from the spirit of my invention; and

Figure 7 is a detail sectional view, illustrating one way of producing gas-tight joints between the various sections of the peripheral portion of a deck of the kind illustrated in Figure 6.

Referring to Figures 1 to 4 of the drawings, A designates the side wall of a liquid storage tank and B designates the central body portion of a movable top or deck that

floats upon the liquid in the tank, said central body portion being imperforate and so proportioned that it covers the major portion of the surface of the liquid in the tank.

5 The annular space between the side wall of the tank and the central body portion B of said deck is closed or protected from the atmosphere by a seal which is constructed in such a manner that it is capable of expanding and contracting sufficiently to compensate for variations in the relative position and dimensions of the deck and the side wall of the tank. In the form of my invention shown in Figures 1 to 4, said seal consists of the peripheral portion of the deck that is carried by the central body portion B of the deck and which is preferably composed of a number of segmental shoe members C that bear against the inner side of the side wall of the tank and horizontally-disposed elements D that project inwardly from said shoe members towards a vertically-disposed annular rim E on the central body portion B of the deck, the shoe members C co-operating with each other to form an annular shoe arranged parallel to the side wall of the tank in sliding engagement with same and having its lower edge portion submerged in the liquid in the tank, as shown in Figure 4.

30 The horizontally-disposed elements D that project inwardly from the shoe members C may be formed in various ways, so long as they are of such construction that they provide for the expansion and contraction of the shoe formed by the members C and will also serve as a closure for the annular space between the side wall of the tank and the vertical rim E on the periphery of the central body portion B of the deck, that is gas-tight, in that it is sufficiently tight to retard or prevent the infiltration of air into said space and also retard or prevent the free escape of gases or vapors from said space.

45 One of the novel features of my present deck consists of the means that is used for supporting or carrying the variable peripheral portion of the deck. Preferably said means consists of hinged or pivotally mounted hangers or supports F mounted on the central body portion B of the deck and combined with the various sections of the variable peripheral portion in such a way as to provide for the radial movement of said sections and insure the shoe members C remaining in parallel relationship with the side wall of the tank. As shown in Figure 1, two hangers F are provided for each section of the peripheral portion of the deck, each of said hangers consisting of a substantially elbow-shaped lever arranged with its vertical leg projecting upwardly from the central body portion B of the deck, and its horizontal leg projecting outwardly towards the side wall of the tank so as to overhang one of the sections of the variable peripheral

portion of the deck. The lower end of the vertical leg of each of the hangers F is pivotally connected at 1 to a bracket 2 on the annular rim E, and the horizontal leg of said hanger is connected by a swinging link 3 or other suitable pivotal connection with the section of the peripheral portion of the deck with which it co-operates, thereby permitting the sections of the peripheral portion of the deck to move radially without destroying the parallel relationship between the shoe members C and the side wall of the tank. In view of the fact that the vertical legs of the hangers F are comparatively long and are pivotally mounted on brackets that are arranged in close proximity to the portion of the deck which floats upon the liquid in the tank, the sections of the deck carried by said hangers are capable of moving radially with only a slight rise and fall. Such a construction is inexpensive to manufacture and it is reliable in operation, as there is very little possibility of any of the sections of the variable peripheral portion of the deck sticking in such a way as to interfere with the radial movement of said sections. In order to hold the annular shoe and the central body portion of the deck in approximately concentric relation with each other and also insure the lower edge portions of the shoe members C remaining in snug engagement with the side wall of the tank, the annular rim E on the central body portion of the deck is provided with a plurality of spring-pressed plungers G that bear against said shoe members, as shown in Figure 4.

As previously stated, it is immaterial, so far as my present invention is concerned, what type or kind of horizontally-disposed elements D are employed or used to form a closure for the annular space between the shoe members C and the rim E. In the form of my invention shown in Figures 1 to 4, inclusive, each of the shoe members C is provided with a horizontally-disposed plate D that projects inwardly from same and laps over the upper edge of the rim E on the central body portion of the deck, the inner edge of said plate being turned downwardly so as to form a drip flange 4, as shown in Figure 4. It is essential that substantially gas-tight joints be formed between the adjacent shoe members C and horizontally-disposed plates D and between said plates and the upper edge of the rim E on the central body portion B of the deck, so as to retard or prevent the free escape of gases or vapors that collect in the annular space between the rim E and the side wall of the tank and also to retard or prevent the infiltration of air into said space. In the deck shown in Figures 1 to 4 each section of the variable peripheral portion is provided at one end with an angle-shaped metallic device H that forms

a lateral extension on one end of said section which laps over and slides upon the left hand end of the adjacent section of the variable peripheral portion of the deck, and the joints
 5 between said devices H and the sections of the deck on which they slide are protected by flexible sealing devices I, as shown in Figure 2, which are preferably gas-tight and fire-proof. Preferably each of the flexible
 10 sealing devices I is composed of a plurality of layers of canvas or other fabric, treated to make it impervious to gas, and permanently combined with angle-shaped attaching devices 5 which are secured by bolts or rivets
 15 6 to the horizontally-disposed plates D and shoe members C of two adjacent sections of the peripheral portion of the deck. Such a construction permits the horizontally-disposed plates D and the shoe members C to
 20 move relatively to each other and it insures gas-tight joints between said parts, as each section of the peripheral portion of the deck is provided at one end with a metallic extension, formed by an angle-shaped device
 25 H, that laps over the opposite end of the adjacent section, and a flexible gas-tight sealing device I which extends over said extension and is connected to the end portion of the adjacent section on which said extension
 30 slides. Owing to the fact that the fabric joint protecting devices I are arranged on the inside of the deck, they are protected from the elements and from fire by the angle-shaped metal devices H which act as closures for the radially-disposed joints between the
 35 various sections of the peripheral portion of the deck. Moreover, as said fabric joint protecting devices I are combined with the relatively movable parts of the deck in such
 40 a way that no metallic parts rub against the same, said devices I will last for a long period. In the form of my invention illustrated in Figure 4 I have shown a similar fabric gas tight sealing device I' connected
 45 to the upper edge of the rim E and to the underside of the horizontally-disposed plates D for protecting the joint between the said plates and rim, the device I' being formed preferably of treated fabric and connected to the rim E and plates D in such a
 50 way that while it does not interfere with the movement of said plates relatively to each other or radially with respect to the rim E, it does effectively prevent the free and uncontrolled escape of gases or vapors from the annular space between the rim E and the side wall of the tank.

Instead of using horizontally-disposed metal plates D to close the space between the shoe members C and the annular rim E on the central body portion B of the deck, said space can be closed by a horizontally-disposed, flexible, gas-tight means D' formed of treated fabric or the like connected at its

outer edge to the shoe members C and at its inner edge to the upper edge of the rim E, as shown in Figure 5.

Another slight modification that can be made without departing from the spirit of my invention is illustrated in Figure 6, wherein the annular rim E on the intermediate portion B of the deck is provided with an annular trough 7 that contains a liquid 8 which co-operates with sealing devices 9 that project downwardly from the underside of plates D which project inwardly from the shoe members C. Each of the plates D may be provided with one or more segmental shaped, depending sealing devices 9 that are submerged or partly submerged in the liquid 8 in the trough 7 on the rim E, said sealing devices 9 effectively preventing gases from escaping from the annular space between the rim E and the side wall of the tank through the joint between the upper edge of said rim and the horizontally-disposed plates D. The radial joints between the plates D and shoe members C may be protected in the manner previously described in connection with Figures 1 to 4, and if desired, flexible gas-tight devices 10 formed of treated fabric or the like can be connected to the sealing devices 9, as shown in Figure 7, so as to produce gas-tight joints between the adjacent sealing devices 9. In other words, if the closure for the annular space between the side wall of the tank and the rim E on the central portion of the deck is formed by horizontally-disposed plates provided on their under sides with depending devices that are sealed by a body of liquid, flexible devices 10 can be provided for joining the sealing devices 9 together in such a way that gas cannot escape through the joints between the ends of same.

Due to the fact that the seal arranged between the deck and the side wall of the tank is constructed in the form of an inverted trough-shaped chamber whose lower end is open and in direct communication with the interior of the tank, any gases that bubble upwardly around the edge of the rim on the deck will become trapped in said inverted trough-shaped chamber, and any liquid that is entrained in said gases will separate from same before said gases are permitted to escape from said chamber, thereby reducing to a minimum the possibility of liquid being carried out of the tank with gases that escape to the atmosphere. In order to provide for the escape of gases from said chamber and also to prevent an abnormal pressure from developing in said annular chamber the rim E on the peripheral edge of the body portion of the deck is provided with a number of outlets J equipped with liquid sealed closures K. Preferably each of said closures K is arranged in such a way that it is capable of

opening automatically whenever an abnormal pressure or pressure in excess of a certain degree exists in the inverted trough-shaped chamber that constitutes the seal. As shown in Figure 4, each of the outlets J is formed by a horizontally-disposed tubular member projecting inwardly from the rim E and provided with a vertical discharge outlet that is surrounded by an annular well 11 which contains a liquid that will not evaporate rapidly. A hinged closure K is provided for said discharge outlet, which closure is equipped with a depending annular flange 12 that dips down into the sealing liquid in the well 11. If an explosion occurs in the tank, due to the accumulation of a large quantity of gases between the rim E and shoe C, one or more of the closures K or "explosion doors" will be thrown upwardly by the force of the explosion, thereby establishing communication between the atmosphere and the annular space between the rim E of the deck and the shoe C whose lower edge portion is submerged in the liquid in the tank.

One other feature of the construction above described that adds greatly to its commercial utility is the mounting of the shoe members C on the central body portion of the deck in such a way that it is impossible for said shoe members to move outwardly beyond a certain point, and thus cause the hangers for said shoe members to bind or fail to operate properly in instances where the side wall of the tank is abnormally out of round. In the form of the invention shown in Figure 4 the depending flanges 4 on the plates D co-operate with the upper edge of the rim E to limit the outward movement of the shoe members C, and in the form of the invention shown in Figure 5 the gastight fabric D' that is connected to the shoe members and to the upper edge of the rim E functions as a means to limit the outward movement of the shoe members. Obviously, various other means can be employed to attain this highly desirable result, and accordingly, I wish it to be understood that so far as this feature is concerned, it is immaterial what means is used to limit the movement of the shoe members outwardly away from the rim E, so long as said means does not consist of the side wall of the tank, thereby insuring the shoe members and their supporting hangers remaining in an operative condition, even when the side wall of the tank becomes abnormally out of round.

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

1. A floating deck for liquid storage tanks, comprising a central body portion that normally floats upon the liquid in the tank, a variable peripheral portion for closing the space between said central body portion and

the side wall of the tank comprising segmental shoe members arranged with their lower edge portions submerged in the liquid in the tank and having no direct connection with said central body portion, substantially the entire area of said shoe members being disposed in parallel relationship with and in sliding engagement with the side wall of the tank, and means for sustaining or supporting said shoe members from said central body portion constructed so as to permit relative movement of said shoe members and body portion without destroying the parallel relationship between said shoe members and the side wall of the tank.

2. A floating deck for liquid storage tanks, comprising a central body portion that normally floats upon the liquid in the tank, a variable peripheral portion for closing the space between said central body portion and the side wall of the tank comprising segmental shoe members having portions arranged vertically in sliding engagement with said side wall, pivotally mounted hangers on said central body portion, and pivotal connections between said shoe members and hangers that permit said hangers to move relatively to said central body portion without destroying the parallel relationship between said shoe members and the side wall of the tank.

3. A floating deck for liquid storage tanks, comprising a central body portion provided with a vertically-disposed rim, a variable peripheral portion for closing the space between said rim and the side wall of the tank comprising segmental shoe members arranged in parallel relation with the side wall of the tank and in sliding engagement with same, substantially elbow-shaped hangers pivotally connected at their lower ends to said central body portion and having their horizontal portions projecting outwardly towards the side wall of the tank, and swinging links carrying said shoe members and pivotally connected to the horizontal portions of said hangers.

4. A floating deck for liquid storage tanks, comprising a central body portion provided with a rim, a variable peripheral portion for closing the space between said rim and the side wall of the tank composed of a plurality of relatively movable sections separated from each other by radial gaps, pivotally mounted hangers on said central body portion that carry said sections, and flexible gastight sealing devices for closing the gaps between said sections and between said sections and said rim.

5. A floating deck for liquid storage tanks, comprising a central body portion normally floating on the liquid in the tank and provided with an annular rim that is spaced away from the side wall of the tank, a gastight closure for the annular space between

said rim and the side wall of the tank that is capable of expanding and contracting, and a means for venting said annular space.

5 6. A floating deck for liquid storage tanks, comprising a central body portion normally floating on the liquid in the tank and provided with an annular rim that is spaced away from the side wall of the tank, a closure for the annular space between said rim and 10 the side wall of the tank that is capable of expanding and contracting, a gas outlet leading from said annular space, a closure for said outlet that is capable of opening automatically in the event of an internal explosion in the tank, and a liquid seal for said 15 closure.

20 7. A means for storing liquid, comprising a tank provided with a side wall, a deck that normally floats on the liquid in the tank, a seal between said deck and the side wall of the tank comprising shoes which normally contact with said side wall, and flexible material combined with said shoes and with said deck so as to form an inverted 25 trough, into which air cannot easily filter from the outside and out of which air or vapor cannot escape easily to the outside.

30 8. A means for storing liquid, comprising a tank provided with a side wall, a deck that normally floats on the liquid in the tank, and a seal between said deck and the side wall of the tank constructed in the form of an inverted trough whose lower end is open and in direct communication with the interior 35 of the tank.

9. A means for storing liquid, comprising a tank provided with a side wall, a deck that normally floats on the liquid in the tank, and a seal between said deck and the side wall of the tank constructed in the form 40 of an inverted trough whose lower end is open and in direct communication with the interior of the tank, said inverted trough being so constructed that air cannot easily filter into same from the outside and air 45 and vapor cannot escape easily from same to the outside.

10. A means for storing liquid, comprising a tank provided with a side wall, a deck that normally floats on the liquid in the tank, a seal between said deck and the side 50 wall of the tank constructed in the form of an inverted trough whose lower end is open and in direct communication with the interior of the tank, and means for relieving 55 excessive internal pressure in said inverted trough.

11. A means for storing liquid, comprising a tank provided with a side wall, a deck that normally floats on the liquid in 60 the tank and provided at its peripheral edge with a rim, shoes arranged in contact with the side wall of the tank, and means co-operating with said shoes and rim to form an inverted trough that traps gases which bubble 65 from beneath said rim and prevents said gases from causing entrained liquids in same to be splashed onto the top surface of the deck.

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