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FLOATING DECK FOR LIQUID STORAGE TANKS

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Fig. 1.

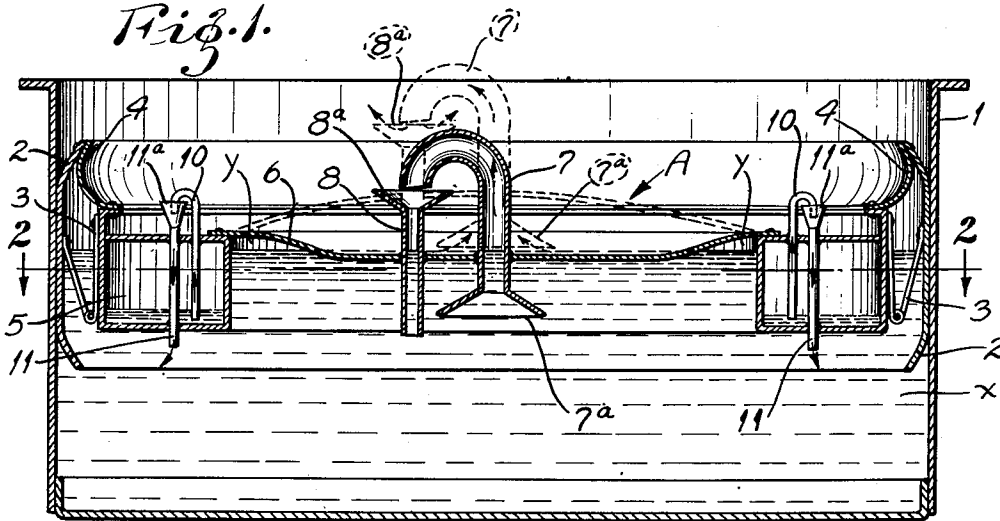
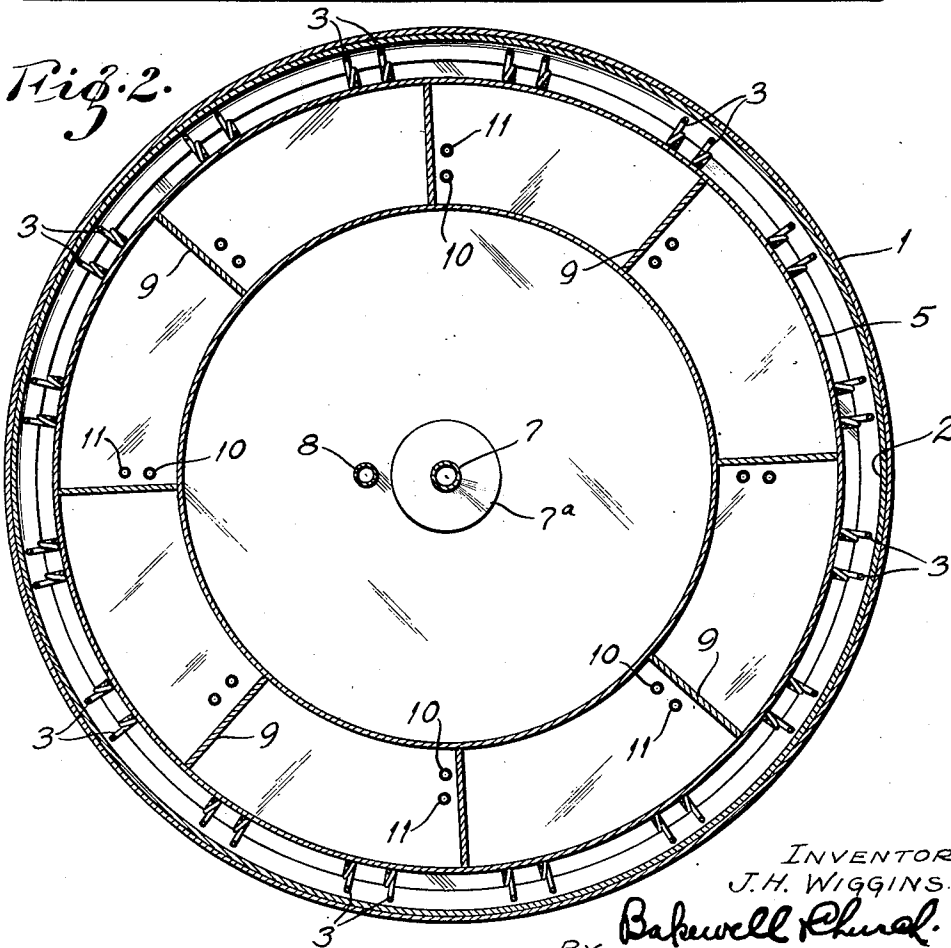


Fig. 2.



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FLOATING DECK FOR LIQUID STORAGE TANKS

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This invention relates to large metal tanks of the kind that are used in the oil fields for storing oil, and particularly, tanks of the type that are equipped with a deck or roof which floats upon and is sustained by the liquid in the tank.

One object of my invention is to provide a floating tank deck or roof which is of such construction that gases or vapors on the underside of the roof can expand to a considerable degree, and thus produce a relatively great pressure inside of the tank without liability of subjecting the roof to injurious or destructive strains and without liability of said gases escaping from the tank.

Another object is to provide a floating tank deck or roof which is equipped with a novel means for imparting sufficient buoyancy to the roof to carry the weight of same and insure the roof remaining in a substantially level or balanced condition, even though a considerable overload is concentrated on a relatively small area of the top surface of the roof, for example, an overload produced by a considerable quantity of rain water falling on the roof and running to a low point at the peripheral edge of the roof.

Another object of my invention is to provide a floating tank deck or roof that is equipped with a float or hollow member which floats upon the liquid in the tank and imparts considerable buoyancy to the roof, and a means of novel construction for automatically discharging or removing from said float liquid that leaks into the same.

And still another object of my invention is to provide a floating tank deck or roof that is equipped with a novel means for venting the vapor space of the tank in the event that a dangerous pressure develops in said space. Other objects and desirable features of my invention will be hereinafter pointed out.

Figure 1 of the drawing is a vertical transverse sectional view of a liquid storage tank equipped with a floating deck or roof embodying my present invention; and

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

In the accompanying drawing which illus-

trates the preferred form of my invention, 1 designates the side wall of a large metal tank of the kind that are used in the oil fields for storing oil, which tanks often have a diameter in excess of 100 ft., and A designates as an entirety a deck or roof that floats upon and is sustained by the liquid x in the tank. The space between the peripheral edge of said roof A and the side wall 1 of the tank can be closed by any suitable means that will permit the roof to move vertically relatively to the side wall of the tank when the level of the liquid in the tank rises and falls, without danger of liquid or gases escaping from the tank through the space between the peripheral edge of the roof and the side wall of the tank. In the tank herein illustrated the space between the peripheral edge of the roof and the side wall of the tank is sealed by an expansible and contractible gas-tight structure carried by the roof and comprising a shoe 2 arranged in sliding engagement with the side wall of the tank, with its lower edge portion submerged in the liquid in the tank, swinging hangers 3 on the peripheral edge of the roof A which carry the segmental-shaped members that constitute the shoe 2, and a piece of gas-tight fabric 4 attached to the upper edge of the shoe and to a part at the peripheral edge of the roof A that projects upwardly above the surface of the liquid. Any other type of sealing means or closure can be used for the space between the floating roof and side wall of the tank without departing from the spirit of my invention.

The roof A is composed of an annular float or pontoon 5 that floats on the liquid in the tank and constitutes the peripheral portion of the roof, and a member or part 6 combined with said pontoon in such a way as to form a downwardly open gas receiving space. The part 6 preferably consists of a flexible diaphragm that constitutes the central portion of the roof, and said diaphragm is constructed from metal plates connected together in such a way as to produce a flexible structure that is capable of moving upwardly and downwardly a limited distance relatively to the horizontal plane in which the top side of the float 5 lies, so as to increase and de-

crease the volume of the vapor space of the tank, as described in my prior U. S. Patent No. 1,645,313, dated October 11, 1927. The float or pontoon 5 is preferably constructed in the form of a box girder that extends around the entire periphery of the roof, and which has sufficient buoyancy and strength to carry the weight of the roof and a considerable overload, even though the overload is concentrated on a surface of relatively small area adjacent the edge of the roof. The diaphragm 6 which constitutes the central portion of the roof is constructed so that it normally occupies a downwardly flexed position, as shown in full lines in Figure 1, with its central portion resting upon the liquid in the tank and its peripheral portion connected to the float 5 at a point above the surface of said liquid, thereby forming an annular gas or vapor space y on the underside of the roof in which gases and vapors can collect.

If the gases or vapors on the underside of the roof expand, due to the heat produced by the sun's rays which strike the top surface of the roof, the diaphragm 6 will flex upwardly when the gases or vapors in the vapor space of the tank exert an upward pressure on said diaphragm in excess of the weight of the diaphragm, thereby automatically increasing the vapor space of the tank sufficiently to prevent the diaphragm from being subjected to injurious strains and also overcoming the tendency of the gases bubbling up around the outer edge of the float 5. If the upward pressure on the underside of the diaphragm 6 continues to increase, after the diaphragm has flexed upwardly into its extreme elevated position, as shown in broken lines in Figure 1, the entire roof will bodily move upwardly slightly relative to the surface of the liquid in the tank, thereby causing the float or pontoon 5 to float higher in the liquid, with the result that the volume of the vapor space of the tank will be increased considerably.

In order to prevent a dangerous pressure from being created in the tank, i. e., a pressure that will lift the float 5 completely out of the liquid, I provide the roof with a volume control pressure relief mechanism that operates automatically to vent the vapor space on the underside of the diaphragm 6 after the float or pontoon 5 has been raised a certain distance or has bodily moved upwardly a certain approximate distance relatively to the surface of the liquid on which it floats, said relief mechanism permitting gases to escape from the underside of the roof until the float 5 has descended or dropped to a safe position. Any suitable type of venting mechanism may be used to vent the vapor space of the tank when a dangerous pressure develops therein, but I prefer to equip the diaphragm 6 with a vapor discharge pipe 7 that projects upwardly through the central portion of the

diaphragm, as shown in Figure 1, the open lower end of said vent pipe 7 projecting downwardly from the underside of the diaphragm 6 a sufficient distance to insure said vent pipe being sealed by the liquid in the tank when the diaphragm 6 flexes upwardly to increase the vapor space of the tank. The depending portion of the vent pipe 7 is also made long enough to insure said vent pipe remaining sealed by the liquid in the tank, even when the float 5 rises slightly relatively to the surface of the liquid in the tank, but when said float rises beyond a certain point, the lower end of the vent pipe 7 will be withdrawn from the liquid in the tank, thereby permitting the gases in the vapor space of the tank to escape through the vent pipe 7, as indicated in broken lines in Figure 1, thus relieving the internal pressure of the tank. If desired, the terminal end or discharge end of the vent pipe 7 can be directed downwardly and arranged in alignment with a return pipe 8 that projects downwardly through the diaphragm 6, so as to cause any globules of liquid that may be entrained in the escaping gases to be removed from or knocked out of said gases and returned to the body of liquid in the tank, through the return pipe 8. Preferably, the vent pipe 7 is provided at its lower end with a funnel-shaped intake portion 7^a, and the return pipe 8 is provided at its upper end with a funnel-shaped intake portion 8^a, so as to direct the escaping gases into the vent pipe and also cause said escaping gases to contact with a baffle or equivalent means that tends to effect the removal of globules of liquid when said escaping gases pass into the atmosphere from the discharge end of the vent pipe.

The hollow member that constitutes the float or pontoon 5 is made as tight as possible, but as there is always liability of some liquid leaking into the float 5, I prefer to equip said float with a means that will automatically effect the removal from said float of any liquid that leaks into the same. As shown in Figure 2, the float 5 is preferably provided with transversely-disposed, vertical partitions 9 that divide the interior of the float into a plurality of compartments. Each of said compartments is equipped with a discharge pipe 10 that projects downwardly through the top wall of the compartment and terminates adjacent the bottom of the compartment, as shown in Figure 1. In the event liquid leaks into the compartment in a sufficient quantity to cover and seal the lower end of the discharge pipe 10, communication will be cut off between the atmosphere and the interior of the compartment. Consequently, the heat that is produced by the sun's rays striking on the top wall of the compartment during the day time, will cause the air in the compartment to expand, thereby creating sufficient pres-

sure in the compartment to cause the liquid in same to be forced upwardly through the discharge pipe 10. This escaping liquid can either be permitted to fall on the top surface of the float 5, or it can be returned to the body of liquid in the tank through a return pipe 11 provided at its upper end with a funnel-shaped intake portion 11^a that is in alignment with the terminal portion of the discharge pipe 10, the return pipe 11 extending vertically through the compartment with which it is associated and being connected by gas-tight joints to the top and bottom walls of said compartment. It will thus be seen that it is impossible for liquid to leak into the float 5 and accumulate therein in a sufficient quantity to materially reduce or destroy the buoyancy of the float, due to the fact that the interior of the float is divided into a number of compartments, each of which is equipped with a means rendered operative by the daily thermal expansion of the air in the compartment to automatically effect the discharge or removal of the liquid that has seeped into the compartment.

From the foregoing it will be seen that a closure for liquid storage tanks of the construction above described virtually consists of a breather type roof that will rise and fall in the tank as the level of the liquid in the tank varies. When the tank is in use the variation in the upward pressure exerted on the under side of the roof by the gases confined in the gas space of the tank act in conjunction with the buoyant means that sustains or supports the roof to cause the flexible metallic portion of the roof to flex or bend in such a way as to automatically vary the volume of the gas space of the tank. In the preferred form of my invention herein illustrated the buoyant supporting means for the roof is of substantially annular form and is arranged at the peripheral edge of the roof, but I wish it to be understood that my broad idea contemplates the use of any suitable buoyant means that floats or rests upon the liquid in the tank and which is combined with the roof in such a way that it will function in the manner above described. It is to be noted that the buoyant means attached to the roof has some weight so that as it is lifted by gas pressure under the roof it exerts an increasing relative downward pull on the roof and its distribution is such that the relative forces will promote the flexing of the roof above described.

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

1. A breather roof having a confined gas space and provided with a flexible sheet metal portion; and buoyant means attached thereto, the buoyant means being so located that, and the relative vertical forces accomplished

through the flexible roof due to gas pressure and by the buoyant means and the relative loads found in the flexible sheet metal portion and the buoyant means being so proportioned with respect to each other that, under varying pressures in the gas space the flexible sheet metal portion will change its shape so as to vary the volume of said gas space.

2. A breather type roof of the kind defined in claim 1 in which the buoyant means consists of a substantially circular float arranged at the peripheral edge of the roof.

3. A breather type roof of the kind defined in claim 1 provided with a means rendered operative by the bodily upward movement of the flexible portion of the roof relative to the surface of the liquid in the tank, for venting the vapor space of the tank.

4. A breather type roof of the kind defined in claim 1 in which the buoyant means consists of a substantially rigid circular float arranged at the peripheral edge of the roof.

5. A floating roof having a flexible sheet metal portion and a depending rim together forming a downwardly open gas receiving space, said flexible sheet metal portion being adapted to flex upwardly by increasing gas pressure to increase the volume of the gas receiving space and to overcome the tendency of the roof to tip, and said depending rim including an annular pontoon.

6. A floating roof having a flexible sheet metal portion and a depending rim together forming a downwardly open gas receiving space, said flexible sheet metal portion having fulness adapting it to flex upwardly by increasing gas pressure to increase the volume of the gas receiving space.

7. A floating roof as claimed in claim 6, in which the depending rim includes an annular pontoon.

8. A floating roof as claimed in claim 6, including pontoon means arranged at the periphery of the structure for imparting buoyancy to said structure.

9. A floating roof having a flexible sheet metal portion and a depending rim together forming a downwardly open gas receiving space, the flexible portion being capable of flexing to permit a large portion of its area to contact with the liquid on which the roof is floating while a smaller portion remains above the liquid, and the depending rim including an annular pontoon.

10. A floating roof having a central sheet metal portion supported by an annular pontoon constituting a gas retaining, depending rim to form a downwardly open, gas-receiving space under said central sheet metal portion.

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