Feb. 12, 1935. J. H. WIGGINS 1,990,627

FLOATING ROOF FOR LIQUID STORAGE TANKS

Filed May 27, 1931

Fig. 1.

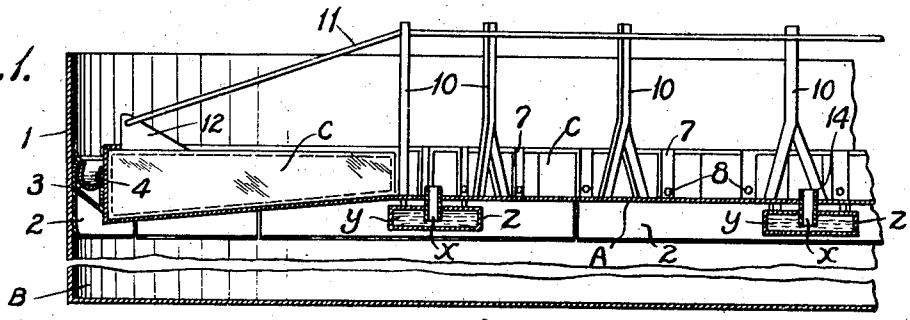


Fig. 2.

Fig. 6.

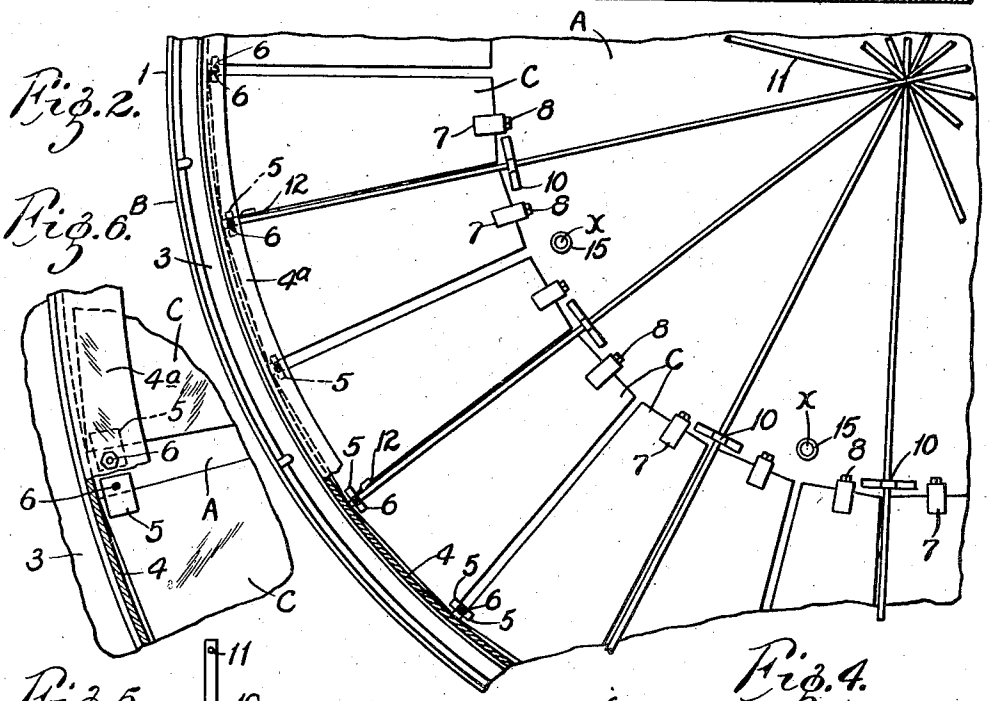


Fig. 5.

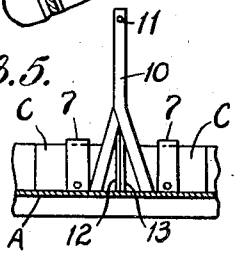


Fig. 4.

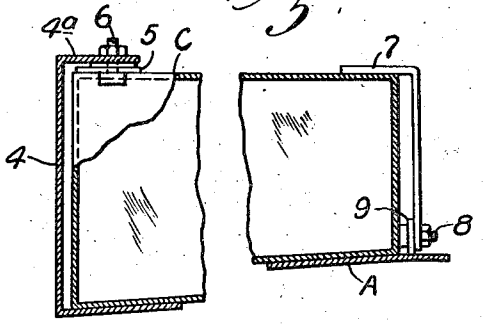
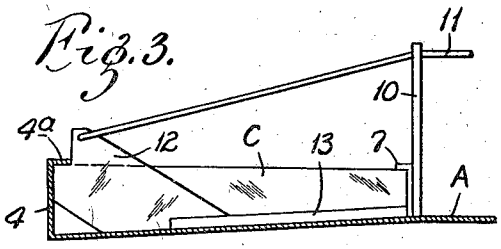


Fig. 3.



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FLOATING ROOF FOR LIQUID STORAGE TANKS

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11 Claims. (Cl. 220—26)

This invention relates to floating roofs for liquid storage tanks.

One object of my invention is to provide a floating roof, which, in addition to being capable of flexing or "breathing" so as to vary the volume of the gas space on the underside of the roof, is of such construction or design that it will not be thrown out of balance by an excessive load of rain water or a similar load imposed upon the top side of the roof, or by the accumulation of an excessive quantity of gases on the underside of the roof.

Another object is to provide a roof of the combined floater and breather type, that is equipped with a truss of novel construction which reinforces the peripheral portion of the roof without interfering with the breathing action of the central portion of the roof.

And still another object of my invention is to provide a design or form of construction for floating roofs for liquid storage tanks, which makes it possible to convert a pan type roof into a roof of the combined floater and breather type without the necessity of taking the tank out of service and without resorting to a welding or riveting operation during conversion. 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 my improved floating roof.

Figure 2 is a fragmentary top plan view of said roof.

Figure 3 is a detail transverse sectional view, illustrating the truss for the circumferential portion of the roof.

Figure 4 is an enlarged detail view, partly in section, illustrating the means that is used to hold the pontoons in operative position on the top side of the roof.

Figure 5 is a detail view, taken at right angles to Figure 3, looking outwardly towards the rim of the roof; and

Figure 6 is an enlarged detail view, illustrating how the pontoons are bolted to the rim.

In the accompanying drawing which illustrates the preferred form of my invention, A designates a limber sheet or flexible diaphragm that floats upon and covers the major portion of the surface of a body of liquid confined in a tank B, said limber sheet A being constructed from metal plates joined together by gas and liquid-tight joints, so as to produce a substantially imperforate diaphragm having an imperforate peripheral portion, and a central portion that is capable of flexing or "breathing". At the peripheral edge of the roof is a structure commonly referred to as a "seal" that is used to close the space between the roof and the side wall 1 of the tank B. Said seal may be of any preferred type or kind and is herein illustrated as being composed of shoes or segmental members 2 movably mounted on the roof and arranged in sliding engagement with the side wall 1 of the tank, and a flexible element 3 attached to said shoes and to a rim 4 that projects upwardly from the peripheral edge of the roof.

Instead of providing the peripheral edge of the roof with a depending flange for confining the major portion of the gases and vapors on the underside of the roof, as is the usual practice in floating roofs of the pan type, the roof is so constructed that the imperforate peripheral portion of same will sag or deflect downwardly sufficiently to normally maintain the outer edge of said peripheral portion in a lower horizontal plane than the central portion of the roof, as shown in Figure 1, thereby causing gases which collect between the underside of the roof and the surface of the liquid on which the roof floats, to naturally flow to the central portion of the roof, or, in other words, to be practically confined to the central portion of the roof which floats in a plane higher than the outer edge or peripheral edge of the roof. This sagging or deflection of the imperforate peripheral portion of the roof can be attained in various ways, as, for example, by joining the roof plates together in such a way, during the process of building the roof, that the peripheral portion of the roof will be disposed at a slight downward angle relatively to the central portion of the roof, or by imposing a sufficient load on the peripheral portion of the roof, to cause it to sag or normally occupy a downwardly deflected position. Obviously, the roof might be constructed so that the peripheral portion of same is inclined downwardly slightly and the normal or required deflection obtained by loading the peripheral portion of the roof. In the roof herein shown the downward deflection of the peripheral portion is attained by the weight of the rim 4, and the seal between the roof and the side wall of the tank, plus the weight of a plurality of pontoons C mounted on the top side of the peripheral portion of the roof and joined to the roof in any suitable way that will cause said pontoons to impart sufficient buoyancy to the roof to make it practically unsinkable. The pontoons C will usually be constructed of metal plates connected together by gas and liquid-tight joints in such a way as to form hollow boxes or members which are so

proportioned and arranged that they will cover a large area of the top side of the roof and form in effect an annular float or buoyant device on the top surface of the roof which also functions as a means to confine a load of rain water or snow to the central portion of the top surface of the roof, thereby effectively preventing a rain load or similar load from shifting to or accumulating at such a point on the top surface of the roof as to throw the roof out of balance. If the roof is provided with a polygonal shaped rim 4, as herein illustrated, the pontoons C will consist of sector shaped metal boxes whose outer ends terminate at or adjacent the inner side of said rim, as shown in Figure 4, it being preferable to provide the pontoons with inclined bottom walls disposed at substantially the angle of deflection of the circumferential portion of the roof.

It is immaterial what means is employed to hold the pontoons C in position or attach them to the roof. I prefer, however, to detachably connect the outer end portions of the pontoons C to the rim 4 and secure the inner ends of the pontoons in such a way that they are capable of a slight vertical movement relatively to the roof, whereby the pontoons will be prevented from binding when the roof "breathes". As shown in Figures 4 and 6, the pontoons C may have plates 5 welded to the outer ends of same so as to receive fastening devices 6, such as bolts, which project through flanges or inwardly-projecting portions 4^a on the rim 4. The inner ends of the pontoons C are overlapped by substantially inverted L-shaped retaining devices 7 whose vertical legs are attached to the roof by fastening devices 8, which pass through lugs 9 that are welded to the top side of the roof. Such a method of combining the pontoons C with the roof is desirable, in that it is inexpensive, efficient, it eliminates damage or injury to the pontoons produced by "breathing of the roof, and it enables a conventional pan type roof to be converted quickly and at a low cost into a combined breather and floater roof, without taking the tank out of service and without using any fire or welding or riveting during the conversion.

The roof is preferably provided with a truss that prevents the peripheral portion of same from deflecting, or sagging abnormally, in the event an abnormal foreign load is imposed on said circumferential portion. Said truss must be of such design that it will not interfere with the breathing or flexing of the central portion of the roof, and while various types or kinds of trusses may be used, I prefer to equip the roof with a truss made up of vertically-disposed struts 10 arranged between the center and the peripheral edge of the roof, usually at or near the inner edge of the annular row of pontoons, and tension members 11 arranged transversely of the roof and attached at their outer ends to anchoring devices 12 that project upwardly above the top edge of the rim 4. Each of the tension members 11 extends diametrically across the roof, and the outer ends of said tension member are attached to a pair of anchoring devices 12 which are arranged diametrically opposite each other. Preferably, the anchoring devices 12 are formed by gusset plates that re-enforce and strengthen the rim 4, and which are attached to the inner side of said rim and to the top surface of the roof, as shown in Figure 3. The anchoring devices or gusset plates 12 are arranged between adjacent pontoons, and if desired, the lower ends of said gusset plates may be attached to radially-disposed stiffening members 13 fastened to the top side of the roof.

As is the usual practice in floating roofs, some kind of a drainage system is provided for carrying off water that falls on or collects on the top side of the roof. Any suitable type or kind of drainage system may be used, but I prefer to equip the roof with a drainage system which is of such capacity that even an abnormal rain load will be carried off rapidly enough to prevent water from submerging the pontoons C and overflowing onto the seal at the peripheral edge of the roof. I have herein shown a drainage system that comprises a center drain 14 and a plurality of additional drains or intermediate drains 15 arranged between the center drain and the circumferential portion of the roof covered by the pontoons C. Each of said drains may comprise a vertically-disposed drain pipe x of relatively large cross-sectional area, whose upper end terminates at a point above the top side of the central portion of the roof, and whose lower end is normally submerged in a body of water y contained in a cup z fastened to the lower end of the drain pipe x.

A roof of the construction above described has the desirable characteristics of a floating roof and also the desirable characteristics of a "breather" type roof, as its central portion is capable of "breathing", i. e., flexing upwardly and downwardly and thus varying the volume of the vapor space or gas space on the underside of the roof. When the liquid in the tank B boils the central portion of the roof will rise or flex upwardly before the circumferential portion of the roof starts to rise, due, of course, to the fact that the central portion of the roof is lighter than the peripheral portion on which the pontoons C rest. It will thus be seen that the volume of the gas space on the underside of the roof will be increased automatically to meet existing conditions, by the upward flexing of the central portion of the roof and by the bodily upward movement of the roof as an entirety. Due to the fact that the peripheral portion of the roof is deflected downwardly, the gases on the underside of the roof have a natural tendency to flow to the central portion of the roof and to be confined to that zone or portion of the roof which is intended to breathe or flex. This is of considerable advantage, in that it effectively prevents the roof from being thrown out of balance by the accumulation of an excessive quantity of gases near the periphery, on the underside of the roof, as might be apt to occur if the roof were not constructed in such a way as to confine the gases to the central portion of the roof. Nor is there any liability of the roof being thrown out of balance by a rain load or similar load collecting at a low point on the peripheral portion of the roof, due to the fact that the annular float or buoyant device, produced by the pontoons C, covers a sufficient area of the top side of the roof, to confine a rain load or similar load to the central portion of the roof. In addition to the desirable features above pointed out, my invention makes it possible to easily convert a pan type roof into a combined breather and floater at a low cost, as a conventional pan type roof can be changed or modified to embody my invention, simply by mounting pontoons or similar buoyant devices on the top side of the peripheral portion of the roof, and by loosening or slightly modifying any existing trussing on said roof.

Having thus described my invention, what I

claim as new and desire to secure by Letters Patent, is:

1. A floating roof, consisting of a limber sheet or diaphragm having an imperforate peripheral portion provided at its outer edge with an upwardly-projecting rim, a plurality of substantially sector-shaped pontoons, mounted on the top side of said imperforate peripheral portion, and radially-disposed reinforcing devices for said rim attached to same and positioned between adjacent pontoons.

2. A floating roof for liquid storage tanks, consisting of a limber sheet or diaphragm having an imperforate peripheral portion and a central portion that flexes or "breathes", pontoons mounted on the top side of said peripheral portion, and a retaining means for said pontoons having provision for permitting the pontoons to move relatively to the roof, upon flexing of the roof.

3. A floating roof for liquid storage tanks, consisting of a limber sheet or diaphragm provided with a central portion that is adapted to flex or "breathe" and an imperforate peripheral portion, an upwardly-projecting rim at the outer edge of said peripheral portion, removable pontoons mounted on the top side of said peripheral portion, means for attaching the outer ends of said pontoons to the rim, and a holding means for the inner ends of said pontoons that permits the inner ends of the pontoons to have a slight upward movement or vertical movement relatively to the roof.

4. A floating roof for liquid storage tanks, consisting of a limber sheet or diaphragm having an imperforate peripheral portion provided at its outer edge with an upwardly-projecting rim, a plurality of pontoons mounted on the top side of said imperforate portion and attached at their outer ends to said rim, and pontoon retaining devices attached to the roof and combined with the pontoons so as to permit movement of the pontoons upon flexing of the roof.

5. A floating roof for liquid storage tanks, consisting of a limber sheet or diaphragm having an imperforate peripheral portion which is inclined downwardly relatively to the central portion of the roof, and a separate substantially annular buoyant means mounted on the top side of said peripheral portion and composed of substantially sector-shaped pontoons whose bottom sides are shaped to conform approximately to the angle of deflection of the imperforate peripheral portion of the roof.

6. A floating roof for liquid storage tanks, consisting of a limber sheet or diaphragm having a central portion designed to "breathe" and a peripheral portion that is imperforate and inclined downwardly, a substantially annular buoyant means located wholly above the top side of the peripheral portion of the roof and sustained by same, a center drain leading from the top side of the roof, and additional drains between said center drain and said annular buoyant means.

7. A floating roof for liquid storage tanks, consisting of a limber sheet or diaphragm having an imperforate peripheral portion that is inclined downwardly relatively to the central portion of the roof, said central portion being adapted to "breathe", a substantially annular buoyant means mounted on the top side of said peripheral portion, struts projecting upwardly from the roof at the inner edge of said buoyant means, and tension members extending diametrically across the roof in engagement with said struts and having their outer ends attached to anchoring devices located at the peripheral edge of the roof.

8. A floating roof for liquid storage tanks having an imperforate peripheral portion whose outer edge normally lies in a lower horizontal plane than the central portion of the roof, said central portion being capable of flexing to vary the volume of the gas space on the underside of the roof, removable pontoons mounted on the top side of said imperforate peripheral portion of the roof, and means for detachably combining said pontoons with said peripheral portion.

9. A floating roof for liquid storage tanks, consisting of a limber sheet or diaphragm whose central portion is capable of flexing so as to permit the roof to "breathe", said diaphragm having an imperforate peripheral portion provided at its outer edge with an upwardly-projecting rim, pontoons mounted on the top side of the peripheral portion of the roof, and a truss that reinforces said peripheral portion, said truss comprising tension members anchored at their outer ends to said rim at a point higher than the top edge of said rim.

10. A floating roof for liquid storage tanks, consisting of a limber sheet or diaphragm whose central portion is capable of flexing so as to permit the roof to "breathe", said diaphragm having an imperforate peripheral portion provided at its outer edge with an upwardly-projecting rim, pontoons mounted on the top side of the peripheral portion of the roof, devices attached to the roof and to the inner side of said rim to reinforce and strengthen said rim, and a truss that reinforces said peripheral portion, said truss comprising struts located some distance inwardly from said rim, and tension members engaging said truss and attached to said reinforcing devices at a point higher than the top edge of said rim.

11. A floating roof for liquid storage tanks having an imperforate peripheral portion whose outer edge normally lies in a lower horizontal plane than the central portion of the roof, said central portion being capable of flexing to vary the volume of the gas space on the underside of the roof, and pontoons carried by the peripheral portion of the roof and located wholly above the top side of said peripheral portion, whereby said pontoons may be applied to the roof while the roof is floating on the liquid in the tank.

JOHN H. WIGGINS.