This invention relates to liquid storage tanks, and more particularly to a roof for use in conjunction with a floating roof tank.

In the storage of volatile liquids, it has been found that evaporation losses can be reduced by the use of a tank in which the top closure is a roof adapted to float upon the surface of the liquid stored within the tank.

According to this invention, the floating roof comprises a deck, an outer annular pontoon and an intermediate annular pontoon positioned between the outer pontoon and the center of the deck. Radial rafters extend between a ring girder at the center of the deck and the inner pontoon. Additional radial rafters extend between the inner pontoon and the outer pontoon. The substantially circular sheet metal deck is positioned above and secured to the pontoons and rafters and a drain is provided at the center of the deck. The rafters carry the deck loads to the pontoons and serve to stiffen the deck in a manner to make it substantially inflexible. As will be hereafter more fully set forth, the rafters do not extend through the pontoons, but only to the edges thereof. The deck is braced by each pontoon only in the areas immediately above the pontoon, and, therefore, some degree of flexibility is given the roof so that it may adapt itself to unequal loading or unequal buoyancy of the pontoons. The construction of the roof is such, however, that for all practical purposes it may be considered substantially inflexible, such as shown in the patent to W. H. Wiggins issued May 12, 1942 as Number 2,285,772.

The principle of insuring an inflexible deck by the provision of radial rafters may be incorporated in a floating roof having a single annular pontoon with the rafters bridging the entire single deck portion of the roof. It may also be incorporated in a roof having an annular pontoon and a central pontoon with the rafters again bridging the entire single deck portion of the roof. In the instance, the rafters would extend across the deck either as continuous rafters or joined by a ring girder or other structural support at the center, while in the second case, the rafters would extend from the annular pontoon to the central pontoon. The invention will be hereinafter described, however, as embodied in a floating roof having two annular pontoons.

In the preferred embodiment shown, the volume of the pontoons is so adjusted as to maintain the portion of the deck just touching the surface of the liquid under normal conditions. However, the roof may be designed so that the central portion of the deck is somewhat above or below the liquid level, if so desired. A heavy load, whether of rain or snow, will, of course, tend to sink the deck somewhat lower in the liquid. The stiffness of the deck, of course, provides buoyancy for it. By virtue of the construction and arrangement of this roof I find that I can provide a steep slope to the deck from its outer edge to the center of the deck which forms a sump. For example, in a 120 foot diameter roof, I provide a downward pitch to the deck of 24 inches from its outer edge to the central sump. The effect of this comparatively steep pitch is to insure speedy and adequate drainage of the roof through drainage means all located at the sump.

For purposes of disclosure, my invention will be described in conjunction with the accompanying drawings in which:

Fig. 1 is a plan view of a portion of the floating roof;

Fig. 2 is a sectional view taken on line 2—2 of Fig. 1;

Fig. 3 is an enlarged detailed view of a portion of the pontoons with the roof removed; and

Fig. 4 is an enlarged sectional view through the pontoons similar to Fig. 2.

Referring now to the drawings, 10 indicates a liquid storage tank having a floating roof 11 floating upon the surface of a liquid 12 stored within the tank. The floating roof includes an outer annular pontoon 13 positioned beneath the outer edge of the deck 14, as shown, and a central sump 15. An inner annular pontoon 16 is positioned intermediate the sump and the outer pontoon. The central sump includes a drain pipe 17 for draining liquid from the surface of the deck. A ring girder 18 surrounds the central sump to which are attached the inner ends of a first plurality of radial rafters 19 radiating from the ring girder to the inner pontoon. In the embodiment shown, the rafters are channel members and are welded to the deck along their entire length. As shown in the drawings, the rafters 19 are attached to, but do not extend through, the inner pontoon. A second plurality of radial rafters 20 are attached to and extend from the outer edge of the inner pontoon to the outer edge of the outer pontoon, as shown. The deck 14 comprises a plurality of sheet metal plates secured together to form a substantially circular deck, and is secured to the upper sides of the pontoons and to the rafters in such a manner as to prevent sagging.
of that portion of the deck immediately above each pontoon. The deck braces are welded to the deck and to the sides of the pontoon, but it will be seen from the drawings that the braces have ends beveled to a point 22, and those points only are welded to the pontoons. This arrangement provides an adequate brace for the roof while permitting some degree of flexibility to that portion of the roof above each pontoon. The pontoons are open topped except for the deck which closes them.

Sealing means of usual construction will, of course, be employed to seal the space between the roof and the side walls of the tank.

In a typical construction, a floating roof embodying the invention having a diameter of 120 feet is provided with deck plates which weigh approximately 2 pounds to the square foot. The entire roof has an average weight of 16 pounds per square foot. If the deck plates were not attached to the radial rafters, it is clear that the plates would flex upwardly with a gas pressure in the space beneath the deck in excess of 8 pounds per square foot. Accordingly, I weld the plate under side of the deck to all, or substantially all, of the radial rafters to prevent flexure of the roof and to maintain the same substantially inflexible, as previously described.

In the event the gas pressure beneath the roof in the space defined by the inner pontoon and in the space between the two pontoons exceeds a predetermined amount, emergency venting means is provided. The predetermined pressure at which the emergency vents will come into operation will, of course, be somewhat less than 16 pounds per square foot in excess of atmospheric, but more than 8 pounds per square foot. A vent pipe 23 connects the gas space around the center of the roof with the gas space between the pontoons to equalize the pressure beneath the roof. An emergency vent pipe 24 is provided in the outer pontoon to permit gases to escape to the atmosphere from beneath the deck when the pressure has increased to the extent necessary to lift the roof sufficiently to raise the inner end of that pipe out of the liquid. Inasmuch as gas pressure under the roof would cause the level of the liquid above the roof to be lower than the liquid level outside of the roof and adjacent the side walls of the tank, the vent pipe 24 is inclined upwardly and outwardly to guard against a liquid leak in the vent. Under gas pressures less than the predetermined maximum, the pipe 24 will, of course, be immersed in the liquid and no venting will take place.

An added feature of my invention is the simplicity and economy with which the roof may be erected. It has been customary in the past, in the construction of floating roof tanks, first to fabricate a tank and then construct the roof within the tank. In the usual construction, temporary erection framing is employed within the tank and the floating roof laid out and assembled upon such temporary framing. After the roof has been completed, the framing is removed and very often is unusable in other construction and is discarded. In the construction of the roof shown herein, the need for temporary erection framing is eliminated. The pontoons and the ring girder may be laid in place while resting upon the bottom of the tank and tied together by means of the radial rafters. The deck plates are then assembled upon the upper surfaces of the pontoons and rafters and welded or otherwise secured in position. During the entire construction, the radial rafters take the place of the temporary erection framing, but unlike such framing, are incorporated into the permanent and final structure, hence eliminating all waste of material.

While I have shown and described my invention in its preferred embodiment, it is to be understood that it may be modified in 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.

1. In a liquid storage tank, a floating roof comprising, a substantially circular deck, an outer annular pontoon positioned beneath the outer edge of the deck, a central sump in the deck and an inner annular pontoon beneath the deck between the outer pontoon and the sump, said pontoons being closed on their upper sides only by said deck, a first plurality of radial rafters beneath the deck and extending from the sump to the inner pontoon, a second plurality of radial rafters beneath the deck and extending from the inner pontoon, said rafters being respectively secured at their ends to the sides of the sump and pontoons along only a portion of the depth of the sump and pontoons, said deck and rafters comprising the only structural connection between said pontoons and said sump, said deck being secured to at least the entire length of some of the rafters to render the deck over the rafters substantially inflexible, the side portions of the pontoons at the rafter end connections being structurally supported only by the deck, and means of the pontoons to permit flexing of said portions to provide for positive vertical stress-avoiding movement of the pontoons and inflexible deck portions under influence of non-uniform loads in the roof and unequal buoyancies of the pontoons, and said deck having a substantially uniform slope from its outer edge to the sump.

2. The floating roof of claim 1 in which said sump includes a ring girder and the inner edges of said first plurality of radial rafters are attached to the girder.

3. In a liquid storage tank, a floating roof comprising, a substantially circular deck, an outer annular pontoon positioned beneath the outer edge of the deck, a central sump in the deck and an inner annular pontoon beneath the deck between the outer pontoon and the sump, a ring girder around the sump beneath the deck, said pontoons being closed on their upper sides only by said deck, a first plurality of radial rafters having their inner edges secured to the girder and having their outer edges secured to the inner side of the inner pontoon, a second plurality of radial rafters having their inner edges secured to the outer side of the inner pontoon and having their outer edges secured to the inner side of the outer pontoon, said rafters being respectively secured to the sides of the pontoons, said deck and rafters comprising the only structural connection between said pontoons and said ring girder, said deck being secured to at least the entire length of some of the rafters to render the deck over the rafters substantially inflexible, and means permitting relative vertical stress-avoiding movement of the pontoons and inflexible deck portions under influence of non-uniform loads in the roof and unequal buoyancies of the pontoons including side portions of said pontoons at the rafter end con-
sections thereto structurally supported only by said deck and the bottom of the pontoon to permit flexing of said portions, and said deck having a substantially uniform slope from its outer edge to the sump.

4. The floating roof of claim 3 including a deck brace beneath a portion of the deck and within a pontoon, said brace being secured to the pontoon in a manner permitting some flexure of said portions of the deck.

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