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FLOATING ROOF FOR LIQUID STORAGE TANKS

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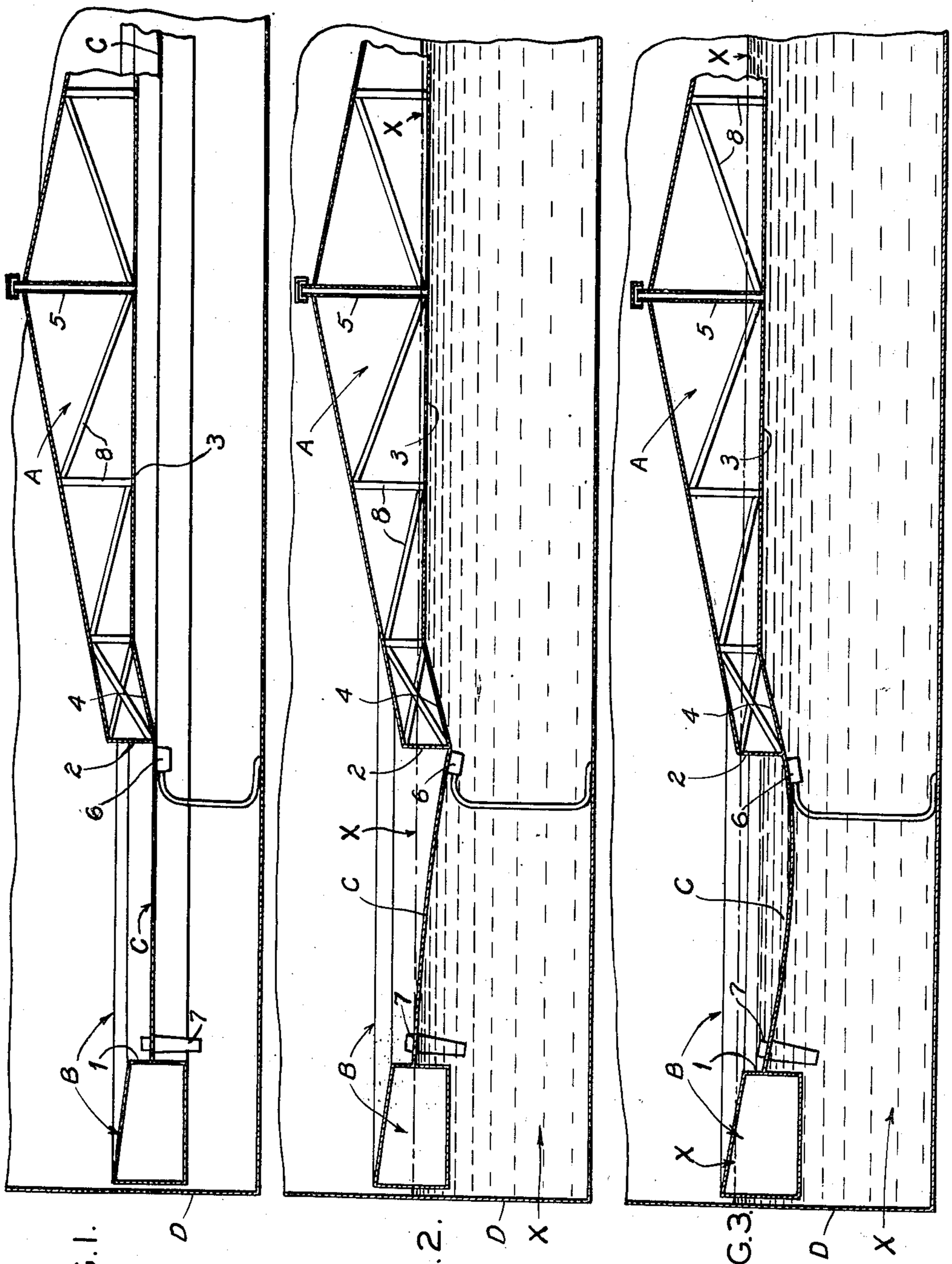

FIG. 1.

FIG. 2.

FIG. 3.

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FLOATING ROOF FOR LIQUID STORAGE TANKS

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5 Claims. (Cl. 220—26)

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This invention relates to a floating tank roof of the general type or kind disclosed in my U. S. Patent No. 2,321,058, dated June 8, 1943, which comprises or is composed of a center pontoon of stiff construction, an annular pontoon of stiff construction located at the peripheral edge of the roof, and a deck portion bridging the space between said center pontoon and peripheral pontoon, and constructed or disposed so that rain water that falls onto said deck portion, or which is discharged onto same from the top sides of said center and peripheral pontoons, will drain to one or more water outlets that lead from the top surface of said deck portion.

One object of my present invention is to provide a floating tank roof of the general type or kind mentioned, whose pontoons and deck portion are of such construction and arrangement, that the entire area of the underside of the roof is effectively maintained in a wetted condition by the liquid on which the roof floats, thereby eliminating rapid or excessive corrosion of the roof resulting from the accumulation of air or vapor between the underside of the roof and the surface of the liquid that supports the roof, when said supporting liquid consists of "sour" or highly corrosive oil.

Another object is to improve or increase the drainage characteristics or qualities of the deck portion of a floating roof of the general type or kind mentioned.

And still another object of my invention is to attain the highly desirable results above referred to, without increasing the cost of the roof, or making it more difficult to fabricate and erect. Other objects and desirable features of my invention will be hereinafter pointed out.

To this end I have devised a floating roof that is distinguished from the roof disclosed in my previously mentioned patent, in the following respects:

1st.—The deck portion of the roof is attached to the peripheral pontoon at a point in close proximity to the lower end of said pontoon, instead of at a point in proximity to the upper end of the peripheral pontoon, thereby eliminating a relatively high or large vapor space on the underside of the roof adjacent the inner rim of the peripheral pontoon, and thus insuring that the underside of the deck portion where it merges into the peripheral pontoon, will be maintained in a wetted condition by contact with the liquid on which the roof floats, or by being constantly washed or splashed by said liquid.

2nd.—The center pontoon is so constructed,

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and is combined with or attached to the deck portion in such a way, that when the roof is floating normally, said center pontoon exerts a load or downward force on the deck portion, that depresses the inner edge of same below the normal level of the liquid on which the roof is floating, and thus holds said deck portion in a downwardly pitched condition, whose angle or grade is sufficiently steep to insure rapid and efficient drainage of any water that falls onto said deck portion. Moreover, as the center pontoon depresses the inner edge of the deck portion below the normal level of the roof supporting liquid, there is no possibility of air or vapor collecting on the underside of the roof at the point where the deck portion merges into the center pontoon, and thus producing corrosion. In the roof described in my patent previously referred to, the inner edge of the deck portion, where it is joined to the center pontoon, is normally maintained in an upwardly inclined position, out of contact with the liquid on which the roof floats; and

3rd.—The center pontoon has a bottom which is of such general shape or form, that the major portion of its area or surface is disposed in a higher horizontal plane than the lower edge of the peripheral rim of the center pontoon. The purpose of constructing the bottom of the center pontoon in this manner is to cause said pontoon to perform the dual function of (*a*) a weight or loading device that depresses the inner edge of the deck portion of the roof below the level of the supporting liquid when the roof is floating normally with no water load or snow load; and (*b*) function as a buoyant device for said deck portion when the roof is carrying a rain or snow load. Preferably, the shape or form of the bottom of the center pontoon is such that any entrapped air on the underside of said pontoon will be directed towards a vent pipe in said pontoon through which the air can escape to the atmosphere.

In the roof disclosed in my previously mentioned patent, the bottom of the center pontoon is given a downward pitch from its periphery towards its center, or, in other words, is made of substantially inverted cone shape, so as to increase the buoyancy or lift of the center pontoon, and said center pontoon exerts an upward force on the deck portion and normally holds the inner edge portion of the deck that is attached to the center pontoon, out of contact with the liquid in the tank, thereby creating a vapor space on the underside of the roof at the zone

where the deck portion merges into the center pontoon.

It is not essential that the bottom of the center pontoon be of the particular cross-sectional shape shown in the drawings. The important thing is that said bottom be so disposed or of such shape or form that, normally, when there is no water or snow load on the roof, the center pontoon will give practically no buoyancy to the deck portion of the roof until the peripheral rim of said pontoon has sunk the inner edge of the deck portion a predetermined amount, but instead, will exert a downward force or load on said deck portion which maintains it in an efficient draining condition, and when a water or snow load comes onto the roof, thus depressing the center pontoon, said center pontoon automatically changes to a buoyant means for the deck portion which assists in carrying the extra load imposed on the roof. The preferable way of constructing the center pontoon is to bend the bottom of said pontoon sharply upward just inside the rim at the peripheral edge of the pontoon, thereby causing the major portion of the bottom to be disposed in a higher horizontal plane than the lower edge of the peripheral rim of the center pontoon. Or the bottom of the center pontoon could be sloped upwardly from the lower edge of the peripheral rim towards the center of the pontoon. When the bottom of the center pontoon is of such shape or form, there will be no dangerous corrosive vapor space between the bottom of the pontoon and the supporting liquid, and normally, the pontoon will give no buoyancy, but as soon as the roof is subjected to any load sufficient to sink the rim portion of the center pontoon, any farther into the liquid, said pontoon instantly imparts its full buoyancy. When the roof is floating normally, with no load, the horizontal portion of the bottom of the center pontoon is slightly submerged in the supporting liquid, say ½". This assures the elimination of any air space here, and also assures that the center pontoon will impart its full buoyancy the instant any water load accumulates adjacent the peripheral rim of the center pontoon.

Figure 1 of the drawings is a fragmentary, vertical, transverse sectional view of a floating tank roof embodying my present invention, showing the roof at the completion of the erecting operation, the roof having a diameter of about 120 ft. and being constructed of $\frac{3}{16}$" steel plate.

Figure 2 is a similar view, showing the normal position of the roof when it is floating on oil, with no water or snow load on the roof; and

Figure 3 shows the roof floating on oil and carrying a water load.

In the drawings, A designates the center pontoon of the roof, B designates the peripheral pontoon, C designates the deck portion, D designates the side wall of the tank, and X designates the liquid in said tank on which the roof floats. The peripheral pontoon, which is of stiff construction, is of annular form and constitutes the peripheral portion of the roof. The center pontoon is also of stiff construction, and is of circular form. The deck portion of the roof is flexible. The top walls or portions of said pontoons are preferably of such shape or form as to shed rain water onto the deck portion C of the roof. As shown in the drawings, the center pontoon is provided with internal trusses of any preferred construction, to which the top and bottom walls of the center pontoon are rigidly attached.

The outer edge of the deck portion C is attached

to the inner rim 1 of the peripheral pontoon B in sufficiently close proximity to the bottom of said pontoon, to cause the underside of the said deck portion, at the point where it is joined to said peripheral pontoon, to be maintained in a wetted condition by the roof supporting liquid X, even when the roof is floating normally, with no water load, as shown in Figure 2. Usually, the deck portion will be attached to the peripheral pontoon B at the level of the supporting liquid X, or about one inch above the liquid surface. The inner edge of the deck portion C is attached to the center pontoon A at the extreme lower edge of the rim 2, which constitutes the peripheral portion of said pontoon. The bottom 3 of the center pontoon is of such shape or form that its central portion is disposed in a higher horizontal plane than the peripheral edge of said bottom, that is attached to the lower edge of the rim 2 of the center pontoon. As previously explained, the cross-sectional shape of the bottom 3 of the center pontoon can be varied, without departing from the spirit of my invention, but usually, said bottom will either slope upwardly from the peripheral edge towards the center of the center pontoon A, or will be bent upwardly sharply at 4, just inside of the rim 2 of said pontoon, and then extend horizontally, or substantially parallel to the surface of the liquid X to the center of the pontoon where a vent pipe 5 rises vertically through the center of the pontoon. One or more primary drains 6 of any preferred type or kind are installed in the deck portion C, preferably in close proximity to the rim 2 of the center pontoon, so as to carry off water from the collection trough formed by the rim 2 and the downwardly pitched deck portion C. A plurality of auxiliary drains or emergency drains 7 of any preferred type or kind are installed in the deck portion C, preferably in close proximity to the inner rim 1 of the peripheral pontoon B. If said emergency drains are of the inverted siphon type, air bleeder pipes (not shown) are preferably installed in the deck portion C adjacent the point where said deck portion is attached to the peripheral pontoon B, so as to provide for the release of any air that may become trapped on the underside of the roof in the zone of the peripheral pontoon. In the drawings, the reference character 8, designates the internal trusses or trussing means of the center pontoon, to which the top wall and bottom wall of said pontoon are rigidly attached.

In the roof shown in the drawings, the top portion of the center pontoon constitutes about 25% of the total area of the surface of the roof, the top portion of the peripheral pontoon constitutes about 25% of the total area, and the deck portion C constitutes about 50% of the total area. The roof is erected inside of the tank D, and during the erecting operation, the center pontoon and peripheral pontoon are sustained by supporting structures of such heights as to cause the deck portion C to assume a level or horizontal position, as shown in Figure 1, when the plates from which said deck portion is formed are welded or connected together. As previously stated, the bottom 3 of the center pontoon is sloped or bent upwardly sufficiently from the rim 2, to the center of said pontoon, to decrease the buoyancy of the pontoon A and concentrate the effective load at the rim 2 of said pontoon, for the purpose of depressing the inner edge of the deck portion C and causing said deck portion to assume such an angular position, when the roof is floating, that it will drain rapidly towards the rim 2 of the

center pontoon A. By laying the deck portion C in a level position when the metal plates constituting the same are being joined together and connected with the pontoons A and B, the rim 2 of the center pontoon A can sag several inches below said level position, without imposing a perceptible load on the peripheral pontoon B, when the roof is floating normally.

At the completion of the operation of erecting the roof, liquid is pumped into the tank C. As the liquid flows into the tank, it first strikes the bottom of the peripheral pontoon B, and as the level of the liquid rises, the pontoon B starts to lift or move upwardly, and all of the air on the underside of the roof is expelled through the vent pipe 5 in the center pontoon A. As the liquid continues to flow into the tank, the peripheral pontoon B rises gradually, but the center pontoon A remains at rest on its supporting structure, until after the peripheral pontoon has risen several inches. This means that the bottom edge of the rim 2 of the center pontoon has submerged several inches below the surface of the roof supporting liquid before the center pontoon starts to float. I have found that in a roof of approximately the dimensions previously mentioned, the peripheral pontoon will rise approximately 8 inches before the center pontoon starts to float, and when the roof is floating normally, as shown in Figure 2, the bottom edge of the rim 2 of the center pontoon will be about 7 inches below the surface of the roof supporting liquid. The load or downward force which the rim of the center pontcon exerts on the inner edge of the deck portion C, deflects said deck portion, to a depth greater than said deck portion would deflect, due to its own weight. Hence, the deflected area of the deck portion does nearly all of the supporting of the center pontoon A. The balance of the center pontoon is supported by the liquid displaced by the bottom of said center pontoon. It is desired that this latter buoyancy be the least possible, but at the same time, have the bottom 3 of the center pontoon submerged in or disposed very close to the roof supporting liquid X. From the foregoing, it will be seen that in my improved roof herein shown, the deck portion C slopes downwardly from the peripheral pontoon B, due to its own weight, during the operation of pumping liquid into the tank to fill the same. As said deck portion submerges in the liquid, progressively towards the center of the roof, it is finally just floating, and from there on, would assume a level position, if it were not for the fact that the center pontoon A is designed so as to concentrate a load on the inner edge of the deck portion C. This concentrated load deflects said deck portion below its normal submergence, in a steeping curve, as shown in Figure 2. The conditions for drainage of said deck portion are good, because the wrinkles in the plates of which it is constructed, are pulled out or removed by the sag or downward pull exerted on the inner edge of said deck portion by the rim 2 of the center pontoon. Also, for about half the distance between the inner rim 1 of the peripheral pontoon B and the rim 2 of the center pontoon A, the liquid X in the tank pushes up against the deck portion C with a force greater than the weight of the plates of which said deck portion is constructed, thereby tending to smooth out any wrinkles in said plates.

The drainage characteristics of my improved roof are exceptionally high, because the roof has a continuous sloping surface which leads rain

water to an annular collection trough equipped with a primary drain. Due to the fact that the underside of the roof is completely submerged in or is so close to the roof supporting liquid as to be always washed or splashed by said liquid, the roof is not liable to corrode rapidly or excessively, if it is used in a tank in which "sour" oil is stored. As the deck portion of the roof constitutes only about half of the entire roof, the water load on the roof builds up deeper than the roof, on the average, submerges. This is advantageous, as it permits the use of shallow, inverted siphons for the auxiliary or emergency drains 7.

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

1. A floating roof, comprising an annular pontoon of stiff construction located at the periphery of the roof, a center pontoon provided with a top and a bottom joined together by a peripheral rim, a deck portion attached to said peripheral pontoon intermediate the top and bottom of said pontoon and attached to said center pontoon at the bottom edge of the rim of said center pontoon, the major area of the bottom of said center pontoon lying in a plane higher than the bottom edge of the rim of said center pontoon and at least in touching contact with the liquid on which the roof floats, and a drainage means for said deck portion.

2. A floating roof of the kind described in claim 1, in which the bottom of the center pontoon slopes upwardly and inwardly away from the bottom edge of the rim of said center pontoon.

3. A floating roof of the kind described in claim 1, in which said drainage means comprises at least one primary drain located adjacent the inner edge of said deck portion, and a plurality of auxiliary or emergency drains or the like adjacent the outer edge of said deck portion.

4. A floating tank roof of the kind described in claim 1, in which the center pontoon is equipped with a venting means through which trapped air can escape from the underside of the roof.

5. A floating tank roof, comprising an annular deck portion floating on the liquid in the tank with substantially the entire area of its underside in contact with the liquid, a stiff, annular pontoon attached to the outer peripheral edge of said deck portion, a stiff center pontoon attached to the inner peripheral edge of said deck portion, said center pontoon being provided with a bottom, the major area of which is disposed in a position higher than the point of attachment of the inner peripheral edge of the deck portion to the center pontoon, and a drain for said deck portion.

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