

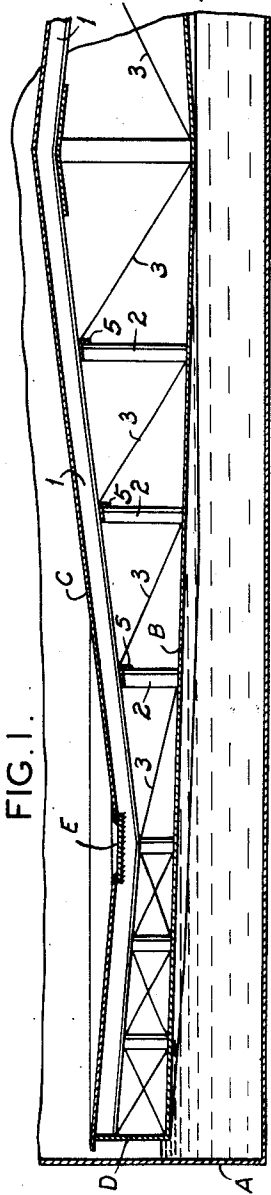
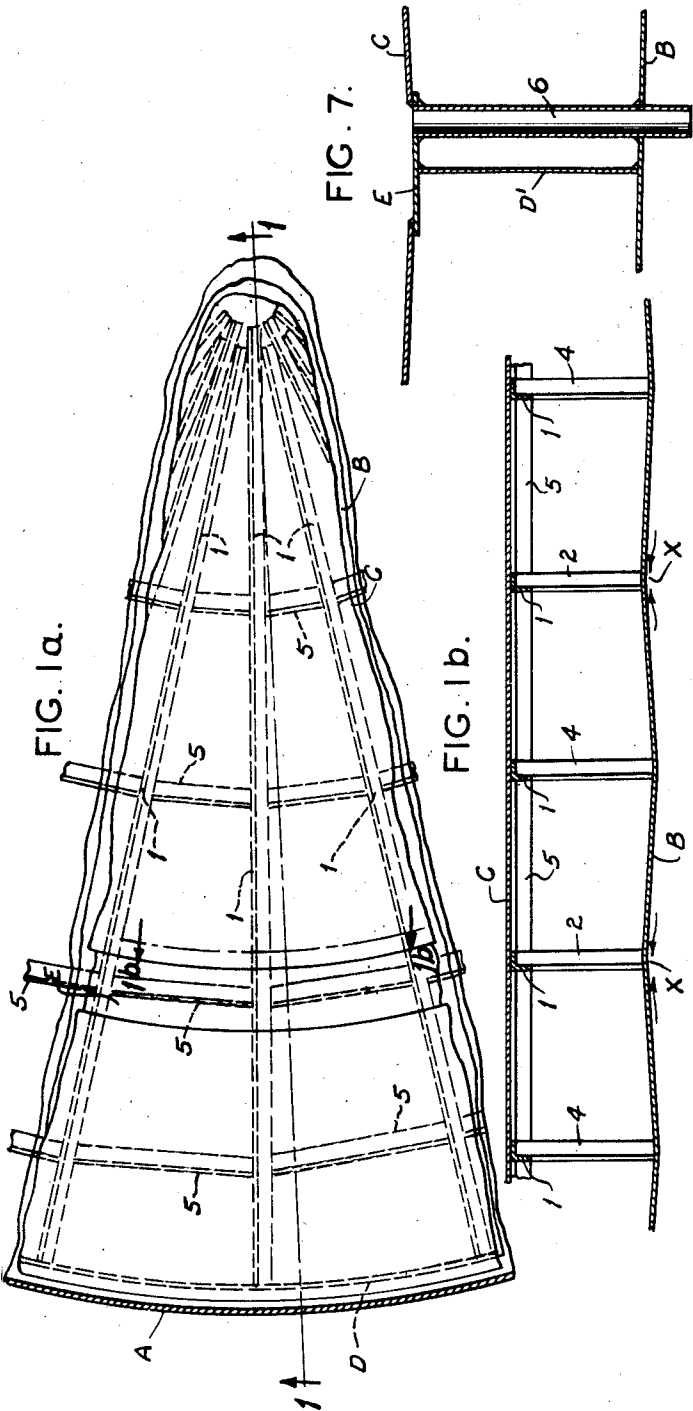
Aug. 12, 1952

J. H. WIGGINS
FLOATING TANK ROOF

2,606,684

Filed Dec. 6, 1948

3 Sheets-Sheet 1



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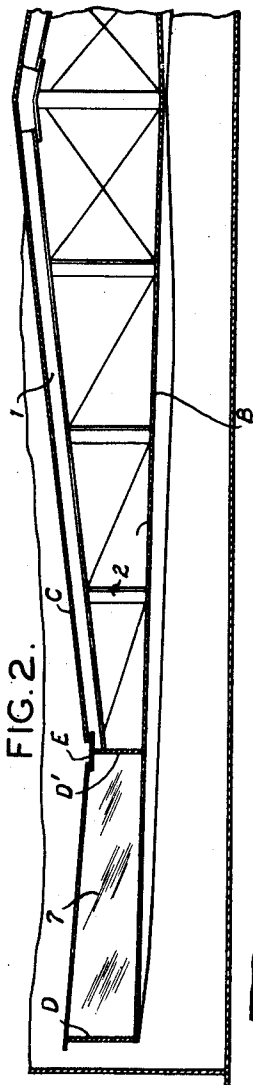


FIG. 5.

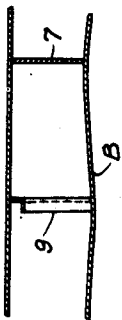


FIG. 6.

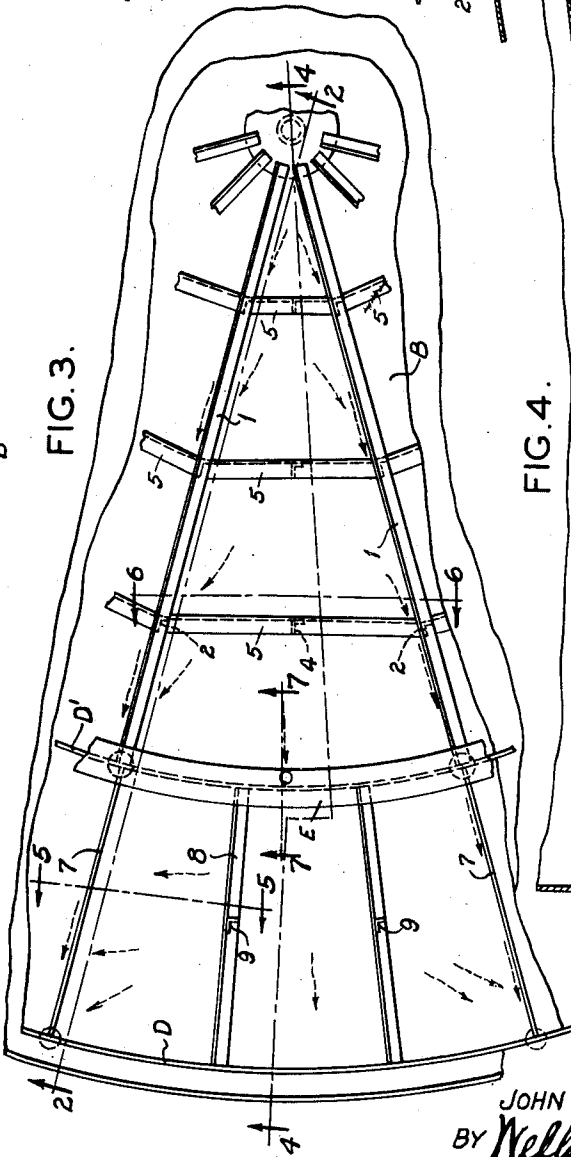
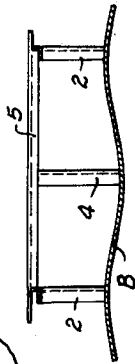
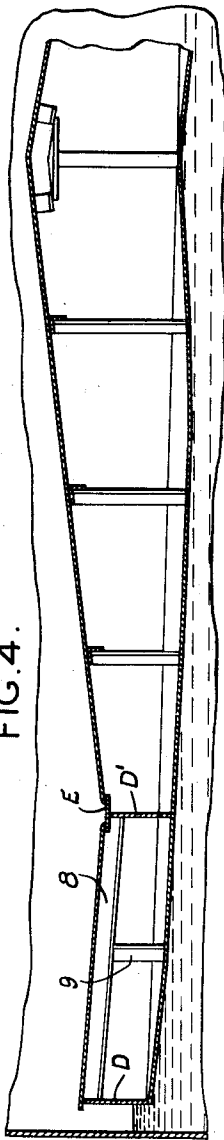


FIG. 4.



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FIG. 8.

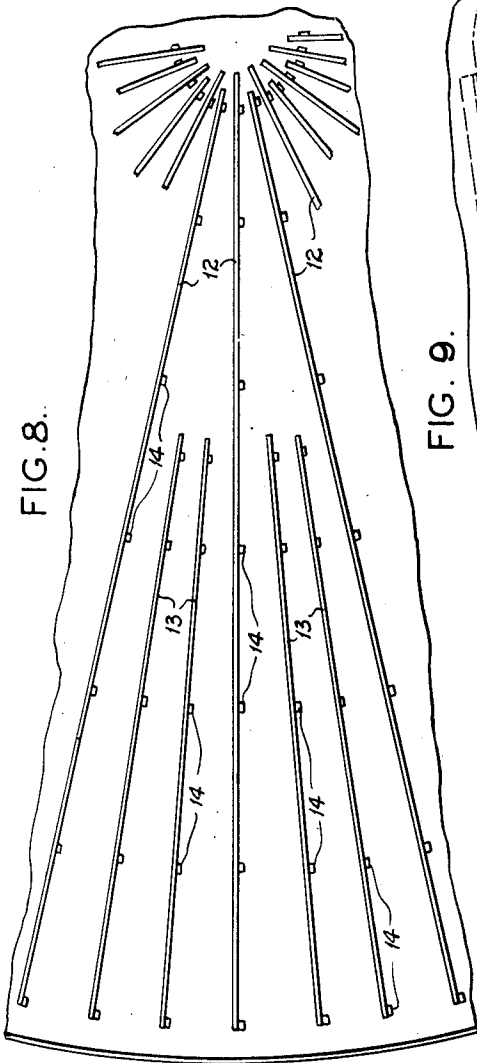


FIG. 9.

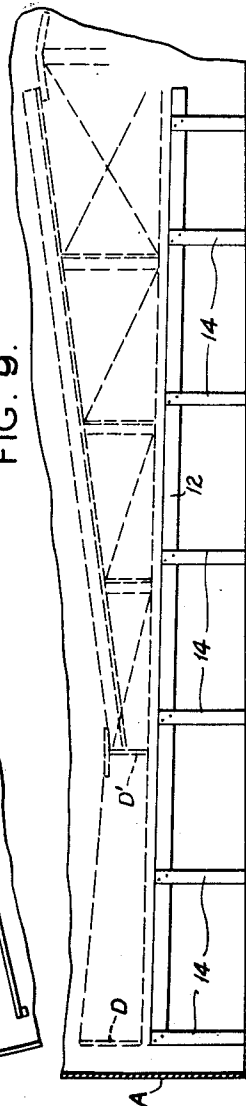
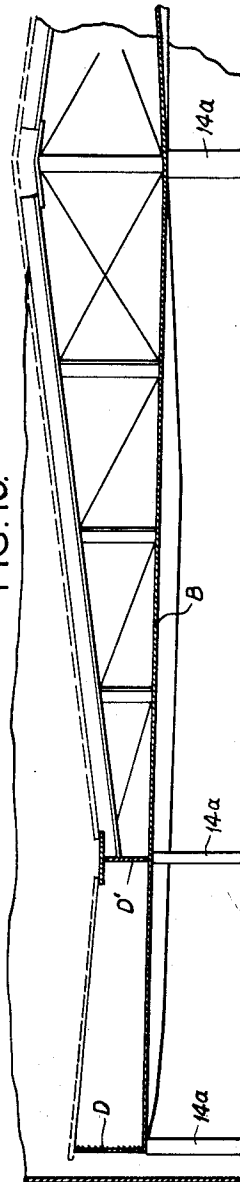


FIG. 10.



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FLOATING TANK ROOF

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3 Claims. (Cl. 220-26)

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This invention relates to floating tank roofs, and has for its main object to provide a floating roof, which is of such design or construction that large quantities of air cannot become trapped between the underside of the roof and the liquid on which the roof floats, and thus cause rapid and destructive corrosion of the metal plates of which the liquid contacting portion of the roof is constructed in instances where the stored liquid consists of "sour" or highly corrosive crude oil.

Another object is to attain the result above referred to, without increasing the quantity of metal used in the roof, or increasing the cost of building the roof.

To this end I have devised a floating tank roof, which, briefly described, consists of the following elements, to wit: (a) a bottom portion constructed from a limber metal diaphragm having radially-disposed, downwardly-sagged portions that constitute air circulating passageways on the underside of the bottom of the roof extending radially from the center of same, which provide for the escape of air that collects at the surface of the liquid on which the roof floats, thereby eliminating the possibility of air becoming trapped on the underside of the roof; (b) a top portion formed by a metal diaphragm that is arranged in superimposed, spaced relation with said bottom diaphragm so as to serve as a rain and snow shield for same; and (c) a means interposed between and engaged with said top and bottom diaphragm for stiffening the roof and for causing the top diaphragm to act as a weight or load which exerts a downward thrust or force on the downwardly-sagged portions of the bottom diaphragm, and thus prevents said portions from flexing upwardly when the roof is floating on the liquid in the tank.

Figure 1 of the drawings is a fragmentary radial sectional view of a floating tank roof constructed in accordance with my invention, and composed of a top diaphragm and a bottom diaphragm arranged in spaced, superimposed relationship, and attached at their peripheral edges to an annular member which constitutes the peripheral wall of a large circular pontoon, said view being taken on the line 1-1 of Figure 1^a.

Figure 1^a is a fragmentary top plan view of the roof shown in Figure 1.

Figure 1^b is a vertical segmental sectional view of the roof shown in Figure 1, taken on the line 1^b-1^b of Figure 1^a.

Figure 2 is a fragmentary vertical sectional view of a roof embodying my invention and composed of a circular center pontoon and an outer

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annular pontoon which surrounds said center pontoon, said view being taken on the section line 2-2 of Figure 3.

Figure 3 is a fragmentary top plan view of the roof illustrated in Figure 2, with the top diaphragm of the roof broken away, so as to show the structure between the top and bottom diaphragms of the roof that is relied upon to impart strength and stiffness to the roof and to maintain the radially fluted form of the bottom diaphragm of the roof.

Figure 4 is a fragmentary radial sectional view, taken on approximately line 4-4 of Figure 3.

Figures 5 and 6 are vertical sectional views, taken on the lines 5-5 and 6-6, respectively, of Figure 3.

Figure 7 is an enlarged sectional view, taken on the line 7-7 of Figure 3.

Figure 8 is a fragmentary top plan view of the erection framing on which the bottom diaphragm of the roof is fabricated.

Figure 9 is a fragmentary radial sectional view of said erection framing, with the roof shown in broken lines; and

Figure 10 is a fragmentary radial sectional view, showing the roof partially completed and supported at key points by posts or uprights after the erection framing has been dismantled or torn down.

In the drawings which illustrate the preferred form of my invention, A designates a tank that is adapted to hold liquid which is protected from the air by a roof that floats on said liquid, B designates the bottom portion or bottom diaphragm of my improved floating tank roof, C designates the top portion or top diaphragm of the roof, which is in spaced relation with said bottom portion, and D designates an annular member, preferably of girder construction, attached to the peripheral edges of the top and bottom portions of the roof, so as to form a rim that projects upwardly around the edge of the bottom portion B; any preferred type of sealing structure may be used to close the annular space between the side wall of the tank and the rim D of the roof.

My improved roof is distinguished from floating tank roofs of conventional construction in two principal respects, as follows:

(1) The diaphragm which constitutes the bottom portion or liquid contacting portion B of the roof is fabricated in such a way that it comprises radially-disposed flutes or corrugations on the underside of same which effectively prevent air from becoming trapped between the underside of

the roof and the liquid when the roof is floating; and

(2) A structure is interposed between the two diaphragms constituting the top and bottom portions C and B, respectively, of the roof, so as to impart stiffness to the roof and also to hold the bottom diaphragm against flexing and maintain it in a radially-fluted or corrugated condition. So far as my broad idea is concerned, any preferred procedure or method may be used in fabricating or combining the co-acting parts of the roof and producing the radially-disposed flutes or corrugations on the underside of the bottom diaphragm, and any suitable type or kind of structure may be used between the top and bottom diaphragms of the roof to stiffen the roof and to prevent the fluted bottom portion of the roof from flexing out of shape when the roof is floating. The bottom portion of the roof consists of a circular diaphragm B, made up of metal plates that are preferably fabricated or connected together in such a way as to produce a continuous limber diaphragm that has a slight downward pitch from its peripheral edge towards its center. Said diaphragm may form the bottom of a large circular pontoon of only slightly less diameter than the tank in which the roof is used, or it may form the bottom of a circular center pontoon and one or more annular pontoons arranged in concentric relation with said center pontoon. The top portion C of the roof may be of any preferred construction, so long as it is of considerable weight and is of such shape or form that it will insure rapid and efficient drainage of rain or snow that falls on the roof.

I have herein illustrated said top portion C as consisting of a diaphragm that comprises an annular-shaped, peripheral portion which slopes downwardly and inwardly from the rim D to a collection trough E on the top surface of the roof, and a cone-shaped central portion that slopes outwardly and downwardly towards said collection trough E. The structure that is used to stiffen the roof and also to maintain the fluted shape or form of the bottom diaphragm of the roof, consists of radially-disposed trusses and vertical hold-down struts, arranged between the top and bottom diaphragm C and B of the roof, and rigidly attached to said bottom diaphragm. Usually, said trusses and hold-down struts will be held in engagement with the top diaphragm of the roof, due to the friction produced by the weight or load of said top diaphragm, but if desired, the top diaphragm of the roof can be welded or attached in any other preferred manner to said trusses and hold-down struts. Preferably, the procedure of building the roof involves fabricating the bottom diaphragm B from metal plates that are joined together in any preferred manner so as to produce a continuous, limber sheet then causing radially-disposed portions of said diaphragm to sag downwardly, subsequently, combining the previously mentioned radial trusses with said bottom diaphragm, so that said trusses hold certain radii of the bottom diaphragm in a straight line and stiffen the parts of said diaphragm lying between the downwardly-sagged portions of the diaphragm, then fabricating the top diaphragm C of the roof while the metal plates constituting said diaphragm are resting upon or supported by the above mentioned radial trusses, and thereafter interposing the previously mentioned hold-down struts between the top diaphragm C and bottom

diaphragm B in such a way that said hold-down struts acting in conjunction with the top diaphragm C, exert a downward thrust on the downwardly-sagged portions of the diaphragm B and prevent them from flexing upwardly when the roof is floating. In other words, the preferred method of constructing the roof is to attach the radially-disposed trusses to the top sides of the ridges of the flutes formed by the downwardly-sagged portions of the bottom diaphragm B, and attach the hold-down struts to the top sides of the valley-like portions formed by the downwardly-sagged portions of said diaphragm.

The roof shown in Figures 1, 1^a and 1^b is constructed in the form of a large circular pontoon of only slightly less diameter than the tank A. As shown in Figure 1^a, the bottom portion of said pontoon is formed by a diaphragm B, which is provided with radially-disposed flutes or corrugations that form air circulating passageways on the underside of the bottom of the roof, when the roof is floating. As previously stated, and as shown in Figure 1, the diaphragm B is pitched downwardly slightly from its peripheral edge towards the center of the diaphragm, and consequently, the radially-disposed flutes in the diaphragm B have a slight upward pitch from the center towards the peripheral edge of the roof, thereby increasing the tendency of the air to flow outwardly towards the rim or outer edge portion of the roof. A trussing structure that is arranged on the interior of the roof, in engagement with the top and bottom diaphragms of same, imparts sufficient stiffness to the roof to enable the roof to successfully carry an abnormal rain or snow load. I have herein illustrated said trussing structure as comprising or being composed of top cord members 1 engaged with the underside of the top diaphragm C, and extending radially from the center of the roof to the rim D, as shown in broken lines in Figure 1^a, vertical truss members 2 attached to said radial top cords 1 and to the top side of the bottom diaphragm B, and inclined braces 3 attached to said above mentioned parts, as shown in Figure 1. By building the roof in this manner, I reduce the cost and weight of the roof and simplify the construction of same, due to the fact that the bottom diaphragm B serves as the bottom cords of radially-disposed trusses which are relied upon to stiffen the roof and hold certain radii of the bottom diaphragm of the roof in a straight line. Preferably, as shown in Figure 1^b, the above mentioned radially-disposed trusses are arranged in longitudinal alignment with the ridges *x* of the flutes in the bottom diaphragm B that form air circulating passageways on the underside of the roof, when the roof is floating. The fluted or corrugated shape or condition of the bottom diaphragm B is maintained by a means or structure interposed between the top and bottom portions of the roof and illustrated herein as being composed of or comprising vertical hold-down struts 4 interposed between the top diaphragm C and bottom diaphragm B, and arranged in spaced relation along the valley-like portions in the top face of the bottom diaphragm B formed by the downwardly-sagged portions of said bottom diaphragm. Usually, circumferentially-disposed supporting members 5 for the top diaphragm C of the roof will be attached to the top cord members 1, so as to bridge the spaces between said top cord members, and the upper ends of the hold-down struts 4 will be attached

to said supporting members 5, as shown in Figure 1^b. In a roof of the construction above described, the internal structure interposed between and engaged with the top diaphragm C and bottom diaphragm B, effectively trusses the roof from one side to the other and holds the bottom diaphragm of the roof in such shape or form that certain radii of said bottom diaphragm are held rigid in a straight line, and downwardly-sagged portions of the bottom diaphragm lying between said radii are prevented from flexing upwardly when the roof is floating. In such a roof the downwardly-sagged portions of the bottom diaphragm form flute-like air circulating passageways on the underside of the roof which gradually increase in width from the center towards the peripheral edge of the roof, the ridges of said flute-like air circulating passageways being held in a rigid condition by the radially-disposed trusses attached to the top side of the bottom diaphragm. The previously mentioned annular water collection trough in the top surface of the roof is herein illustrated as being formed by an annular member positioned between the oppositely-inclined drainage surface on the top side of the roof and welded or permanently attached in any other way, to the metal plates, which form the cone-shaped central top side of the roof and the downwardly-pitched, peripheral part at the periphery of the top diaphragm C of the roof. As is obvious, suitable outlet drains 6 are provided for the annular collection trough E, and the top portion C of the roof will be equipped with numerous manholes (not shown) that provide access to the interior of the roof during the building of same, and when the roof is in use.

In Figure 2 of the drawings I have illustrated a roof that embodies the novel characteristics and features of the roof shown in Figure 1, but which is distinguished from same, in that instead of being constructed in the form of a single large pontoon, it is composed of a circular center pontoon that constitutes a large portion of the area of the roof, and an annular peripheral pontoon that surrounds and is attached to said center pontoon, the bottom portion B of the roof being formed by a circular, radially-fluted diaphragm of the kind previously described, which constitutes the bottom of both of the above mentioned pontoons. In the roof shown in Figure 2, a second annular member D', preferably of girder construction, set inwardly some distance from the rim D of the roof in concentric relation with same, is interposed between and attached to the top and bottom portions C and B of the roof, so as to separate the central portion of the interior of the roof from the peripheral portion of the interior. As shown in the drawings, the annular member which constitutes the bottom of the drainage trough E is attached to the web of said second annular member D', so as to form, in effect, the top flange of an annular girder. The top cord members 1 in the center pontoon terminate at the girder D', but the bottom diaphragm B of the roof extends outwardly to the peripheral girder that constitutes the rim D of the roof. The interior of the peripheral pontoon, formed by the two annular girders D and D' and the peripheral parts of the top and bottom portions of the roof attached to said girders, is divided into a plurality of compartments by radially-disposed bulkheads 7, arranged preferably in longitudinal alignment with the cord members 1. The compartments of the peripheral annular

pontoon located between the bulkheads 7 are provided with radially-disposed rafters 8 that support the top walls of said compartments, and hold-down struts 9 are arranged between said rafters 8 and the downwardly-sagged portions of the bottom diaphragm that constitute the air circulating passageways in the underside of the bottom diaphragm, so as to prevent upward flexing or deformation of the bottom diaphragm B adjacent the rim of the roof.

The co-acting parts of the roof may be assembled or connected together by any preferred procedure or method. One simple method that I have devised involves the following procedure, to wit: Forming the bottom portion B of the roof from metal plates that are joined together so as to produce a substantially dish-shaped or inverted cone-shaped diaphragm, causing or permitting radially-disposed portions of said diaphragm to sag downwardly so as to impart a radially-fluted shape or form to the diaphragm, attaching radially-disposed trusses or truss members to the top side of the diaphragm at points between the downwardly-sagged portions of the diaphragm so as to stiffen and hold certain radii of the diaphragm in a straight line, such, for example, as the top cords 1 and vertical truss members 2, previously referred to, fabricating the top portion C of the roof from metal plates supported by and engaged with the top cord members on the underside of the top portion of the roof, and attaching the top and bottom portions C of the roof to an annular member that constitutes the peripheral rim of the roof, as shown in Figure 1, or attaching the top and bottom portions of the roof to an annular rim, and to a second annular member set some distance inwardly from the rim, as in the roof shown in Figure 2. In Figures 8, 9 and 10 of the drawings I have illustrated in detail the preferred procedure of construction the roof shown in Figure 2. Preparatory to starting the fabrication of the bottom diaphragm B, I build an erection framing in the tank A on the bottom of the tank, said framing being composed of two groups of radially-disposed rafters 12 and 13 supported by uprights or legs 14, as shown in Figures 8 and 9, the rafters 12 and 13 being pitched downwardly slightly from the tank side wall to the center of the tank, as shown in Figure 9. Metal plates are then laid on said erection framing and joined together, so as to produce a continuous limber diaphragm, whose central portion is pitched downwardly slightly from its peripheral edge. Certain of said radially-disposed rafters are then removed, such, for example, as the rafters 13, shown in Figure 8, with the result that radially-disposed portions of the diaphragm which lie between the rafters 12 will sag downwardly. Subsequently, in any preferred sequence, the members that constitute the outer and inner girders D and D' are attached to the diaphragm B that rests on the erection framing formed by the rafters 12 and the previously-described radial trusses, bulkheads and hold-down struts are attached by welding or in any other suitable manner to the top face of said diaphragm B, thus producing a supporting structure on which the plates constituting the top portion C of the roof can be laid while said plates are being joined together. If desired, prior to fabricating the top portion C of the roof, while it is supported by the previously described trusses, bulkheads and hold-down struts, the erection framing on which the bottom diaphragm of the roof was fabricated can be dismantled or removed progressively and re-

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placed by legs or vertical uprights 14, shown in Figure 10, that support the partially completed roof at key points, as, for example, at the peripheral edge of the roof, at the center of the roof, and at the inner circular girder D'.

In Figure 1^b and Figure 3 of the drawings, the arrows indicate the direction of flow of the air or gases which collect on the underside of the roof, the arrows in Figure 3 being in broken lines.

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

1. A floating tank roof, comprising a metal diaphragm that constitutes the bottom portion of the roof, a top diaphragm arranged in spaced relation with said bottom diaphragm, said bottom diaphragm having radially-disposed flutes or corrugations that form air circulating passageways on the underside of the roof when the roof is floating, radial trusses arranged in spaced relation between said diaphragms and attached to the top sides of the ridges of the flutes in the bottom diaphragm to stiffen the same, and hold-down struts on the interior of the roof interposed between said top and bottom diaphragms for causing part of the weight or load of the top diaphragm to exert a downward force on the portions of the bottom diaphragm intermediate said trusses so as to prevent upward flexing of said intermediate portions.

2. A floating tank roof, comprising an annular metal diaphragm that constitutes the bottom of the roof, a roof or top portion arranged in spaced relation with said bottom diaphragm, an annular rim of circular construction attached to the bottom diaphragm and to the top part of the roof at the peripheral edges of same, the bottom diaphragm being provided with downwardly-sagged portions that form flutes or corrugations on the underside of said bottom diaphragm which extend radially from the center of said diaphragm towards the periphery of same, trussing members on the interior of the roof attached to the top

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side of the bottom diaphragm and engaged with the top part of the roof in alignment with the ridges of the flutes in the bottom diaphragm, and hold-down struts on the interior of the roof arranged between the top part of the roof and the downwardly-sagged portions of the bottom diaphragm that constitute the above-mentioned flutes so as to cause the top part of the roof to act as a load or downward force that is applied to the downwardly-sagged portions of the bottom diaphragm.

3. A floating tank roof, comprising a top portion and a bottom portion arranged in spaced superimposed relation, an annular rim attached to the peripheral edges of said top and bottom portions, stiff radial trusses between the top and bottom portions of the roof attached to certain radii of the bottom portion located between downwardly-sagged parts of said bottom portion, and members on the interior of the roof interposed between and engaged with the top portion of the roof and the downwardly-sagged parts of the bottom portion for causing the top portion of the roof to function as a weight or load that exerts a downward thrust on the sagged portions and thus prevent said sagged portions from flexing upwardly, the bottom portion of the roof being pitched downwardly slightly from its peripheral edge towards its center.

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