

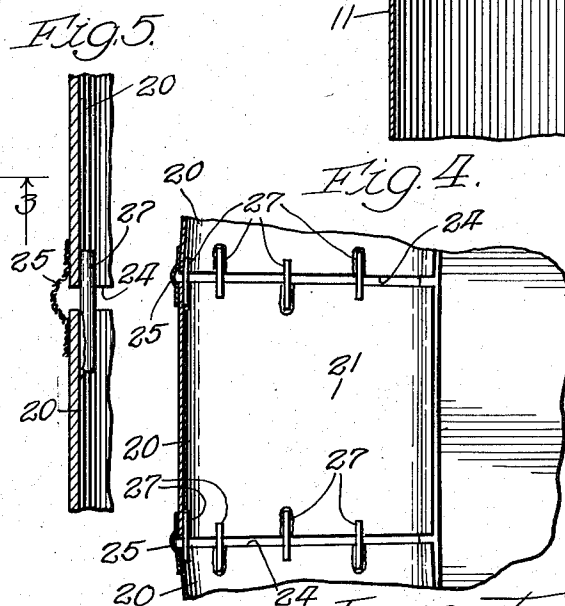
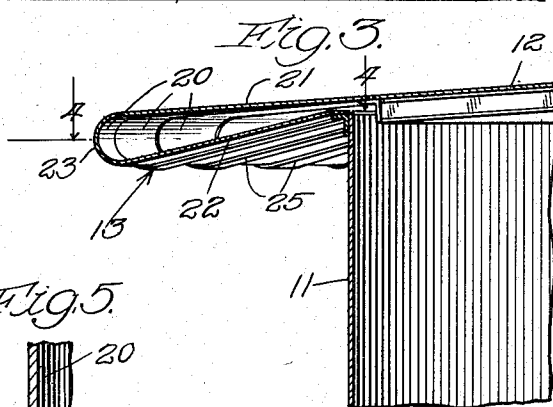
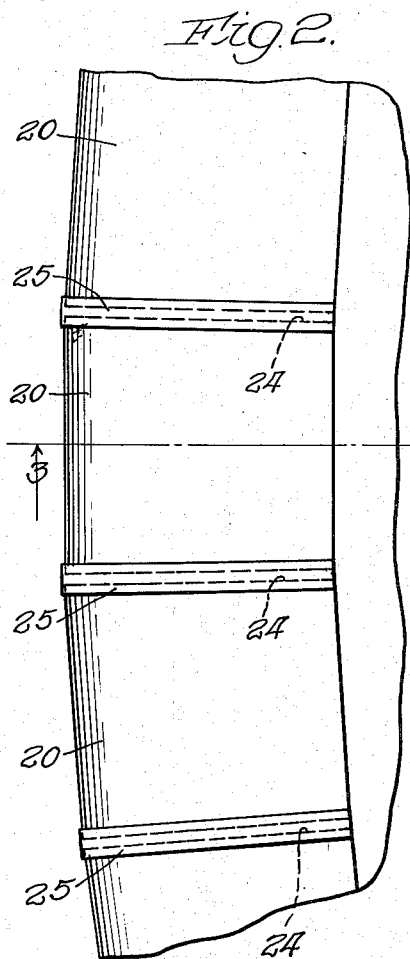
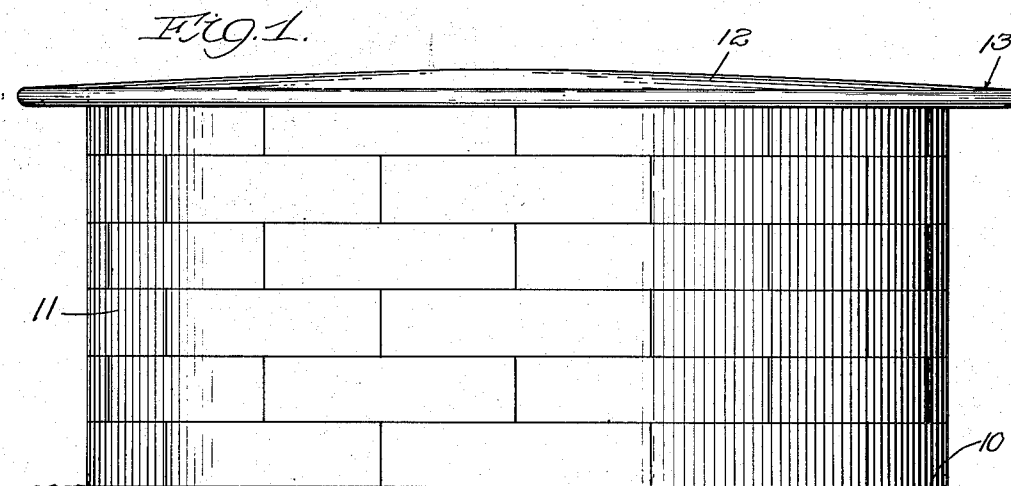
Oct. 20, 1953

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2,656,263

CONNECTOR FOR LIQUID STORAGE TANKS

Filed Aug. 15, 1950



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## UNITED STATES PATENT OFFICE

2,656,263

## CONNECTOR FOR LIQUID STORAGE TANKS

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Application August 15, 1950, Serial No. 179,551

6 Claims. (Cl. 48-178)

1

2

This invention relates to a volatile-liquid storage vessel and more particularly to a bendable connector for use in connecting the side walls and roof of such a vessel.

Storage vessels used for holding volatile liquids, such as crude oil or gasoline, generally have a volume of vapor-air mixture above the liquid level which increases and decreases according to the atmospheric conditions present. One general type of vessel which may be used to diminish the loss of valuable vapors during expansion of the vapors, comprises those vessels having fixed sidewalls with a plate roof which flexes upwardly and downwardly with corresponding increase and decrease of the air-vapor pressure within the vessel. In the past, a continuous plate connection has been used between the roof plates and the sidewalls, which has been subjected to secondary stresses causing cracks in the bendable portions. This invention provides a means for connecting the roof and sidewalls which eliminates the difficulties heretofore encountered.

The invention is illustrated in a particular embodiment shown in the accompanying drawings, in which:

Fig. 1 is an elevational view of a balloon type roof storage vessel for volatile liquid with the roof in partially raised position; Fig. 2 is an enlarged broken plan of a portion of the connector member; Fig. 3 is a broken vertical sectional view taken as indicated by line 3-3 in Fig. 2; Fig. 4 is a broken horizontal section taken as indicated by line 4-4 in Fig. 3; Fig. 5 is an enlarged fragmentary view of two adjacent plates forming a portion of the connector and illustrating the aligning and sealing means extending between the two plates.

The balloon type roof vessel illustrated in Fig. 1 has a bottom 10 resting on grade or a prepared foundation and a cylindrical sidewall 11 made up of individual plates welded together. A plate roof 12 is connected to the upper edge of the sidewalls 11 by an overhanging connector 13. As an example of a particular balloon roof vessel, the vessel illustrated is one approximately 96 feet in diameter and 42 feet high with the overhang 13 extending 6 feet beyond the periphery of the vessel wall, giving the roof a diameter of approximately 12 feet more than the sidewall 11.

In operation, a volatile liquid is stored in the vessel and the space between the surface of the liquid and the roof 12 constitutes a vapor-air space. As the sun heats the contents, more of the liquid goes into the vapor state and in-

creases the pressure above the surface of the liquid. To accommodate this expansion, the roof 12 flexes upwardly to increase the vapor space within the vessel. Also since the roof plates are connected by the overhanging plates 13 of the connector, to the sidewalls, secondary bending stresses are set up in the connector 13. As the roof returns to a lower position of rest on a framework within the vessel, different secondary stresses may occur in the connector.

The particular connector with which this invention is concerned comprises a plurality of individual plates 20 arranged in side by side alignment around the upper portion of the vessel to form the overhanging portion of the roof 12. Each of the plates 20 is bent upon itself forming two legs or opposed flat portions 21 and 22 joined by an arcuate portion 23. The upper leg 21 of each plate is connected to the roof plates and the lower leg 22 is connected to the upper portion of the sidewall 11 of the vessel. As the roof 12 rises or falls, most of the bending in the overhang 13 occurs in the arcuate portion 23.

To render the vessel gas-tight, and yet provide for only simple bending stresses in the plates 20, the plates are so positioned that a space 24 exists between each adjacent pair of plates in all positions of the roof relative to the sidewall of the vessel. A fabric seal 25 is cemented or otherwise fastened to each adjacent pair of plates to cover the space 24 between the plates. The fabric used is impregnated with a rubber-like material, such as neoprene to increase its wearing qualities, and also to render it gas-tight. Thus, with the space 24 always present between adjacent plates 20 forming the connector 13, only simple bending stresses are set up in each of the plates 20 as the roof flexes in response to the necessities of air vapor space within the tank, since the plates may move relative to each other circumferentially of the vessel.

Means are provided for keeping adjacent plates 20 aligned generally in a horizontal direction. This means comprises a plurality of bars 27 each attached to one plate so as to bridge the space 24. A row of bars 27 are used between each adjacent pair of plates and alternate ones of the bars are welded to opposite plates of each adjacent pair. As best seen in Fig. 5, the bar 27 is welded to the lower of the plates 20 illustrated and is in sliding contact with the upper plate 20. The bars thus act somewhat like spaced interfitting teeth in maintaining adjacent plates aligned horizontally.

While the use of the articulated connector above described has been illustrated only with

3

respect to a balloon type roof vessel, it may also be used for connecting the roof to the sidewall of a breather roof vessel. Cracks in the roof of such vessels will be eliminated by using the articulated connector of this invention.

The foregoing detailed description is given for clearness of understanding only and no unnecessary limitations should be understood therefrom as some changes will be obvious to those skilled in the art. The spirit and scope of the invention will be pointed out in the appended claims.

**I claim:**

1. A fluid storage vessel comprising a stationary lower portion having a bottom and sidewalls, a roof movable vertically relative to the lower portion to provide a variable volume gas space within the vessel and an articulated connector between the side walls and roof, said connector being formed of a plurality of separate plates placed in side-by-side relation about the upper portion of the sidewalls, each plate being bent upon itself to form a pair of opposed flat portions joined by a curved portion, each plate being continuous from sidewall to roof with said flat portions being joined respectively to the roof and sidewalls so that movement of the roof causes bending in said plates and fabric sealing means between each adjacent pair of plates making the connector gas-tight.

2. An articulated member for use in connecting the sidewall of a fluid storage vessel to a roof movable vertically relative to the sidewall comprising, a plurality of separate plates each folded upon itself to form opposed flat portions joined by a curved portion, said plates being positioned in spaced side by side relation about the juncture of the roof and sidewalls, each plate being continuous between the roof and sidewalls with portions on opposite sides of the curved portion being joined respectively to the roof and the sidewall and flexible sealing members covering

4

the space between each adjacent pair of plates making the member gas-tight.

3. An articulated member as set forth in claim 2 in which, the plates forming the member are flexed in said curved portion upon vertical movement of the roof and adjacent plates are provided with means aligning them in a generally horizontal direction.

4. In a fluid storage vessel having sidewalls and a vertically movable roof of the balloon type, means connecting the roof and sidewalls comprising, a vertically expansible connector member conforming in plan to the peripheral plan of the vessel, said member being formed of a plurality of separate plates each folded upon itself and having a generally U-shaped cross-section, said plates each being continuous with one of the free legs of each plate being joined to the roof and the other leg being joined to the upper edge of the sidewall, said plates being placed in side by side relation about the periphery of the vessel, means aligning said plates in generally horizontal direction and sealing means between each adjacent pair of plates.

5. Apparatus of the character described in claim 4, in which each plate is spaced from the adjacent plates in all positions of the connector member assumed in response to movement of the roof relative to the sidewalls of the vessel.

6. Apparatus of the character described in claim 5, in which the aligning means comprise a row of spaced rods bridging the space between each adjacent pair of plates, each rod being secured only to one of said plates and adjacent rods in each row being secured to different plates.

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