April 20, 1948. H. C. BOARDMAN 2,439,792

FLOATING ROOF STORAGE TANK

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Fig. 1.

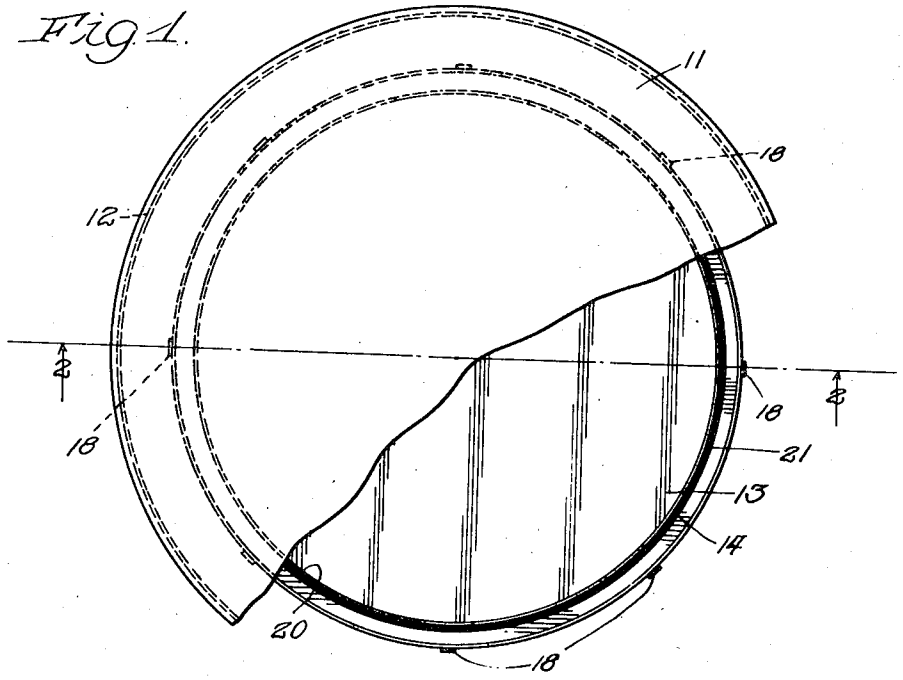
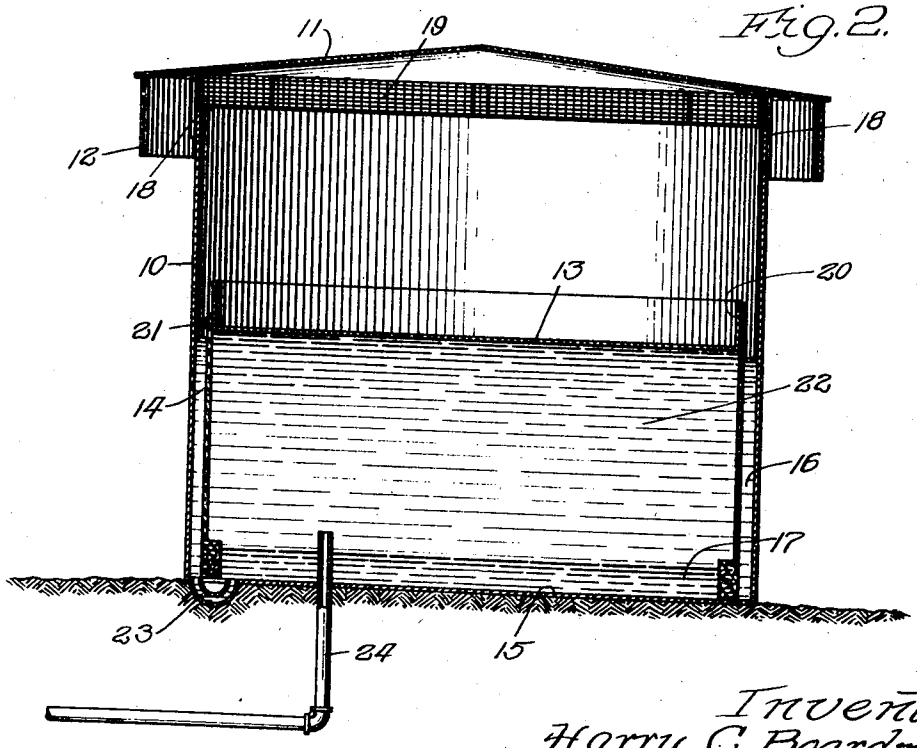


Fig. 2.



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FLOATING ROOF STORAGE TANK

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6 Claims. (Cl. 220—26)

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This invention relates to a storage tank and particularly to a tank used for storing fluids such as volatile liquids.

When volatile liquids are to be stored there is always danger of losses due to evaporation of the liquid. There are also explosion and fire hazards if the vapors are of an explosive type. Among the types of tanks used for storing volatile liquids is the floating roof tank wherein the roof floats on top of the liquid and within the confines of a shell. In tanks of this type the roof is constructed with pontoons so as to give the roof added buoyancy, and the roof is also provided with a seal to close off the area between the edge of the floating roof and the side of the shell. These tanks are somewhat bulky and expensive to build. Often the stored liquid volatilizes and the vapors gather under the roof, tending to get it out of balance. In floating roof tanks there is also danger that the vapors will escape around the edge of the roof, especially if the seal becomes worn.

I have invented a new type storage tank for storing volatile liquids wherein the losses on filling, emptying, and standing storage are substantially eliminated. The new tank permits the use of a fixed weather roof without danger of any explosive mixture being formed beneath the weather roof. The new tank comprises a substantially cylindrical shell, a weather roof fixed to the top of the shell, a flat floating roof within the shell, a flexible impervious sealing member connecting the floating roof to the bottom of the tank to define a storage space under the floating roof, a portion of sealing liquid between the sealing member and the shell, a portion of sealing liquid in the bottom of the storage space, and means connecting the two portions of sealing liquid together. The sealing liquid has a specific gravity greater than that of the liquid to be stored. Filling and emptying means are provided in communication with the storage space at a point above the greatest height of the sealing liquid in the bottom of the storage space.

The new tank will have no evaporation losses either on standing storage or on filling and emptying the tank. No water, snow, or the like can gather on the floating roof, as it is protected by a fixed weather roof. There is no seal between the floating roof and the shell other than the sealing liquid between the sealing member and the shell. Because the roof does not depend upon its own buoyancy to float there is no necessity for pontoons, reinforcing trusses or drains, all of which are needed on the ordinary floating

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roof. There is no vapor mixed with air under the floating roof or the fixed weather roof to create fire and explosion hazards. As there is no abrasion of the inside of the shell this surface may be kept painted so that rust will not form and drop to the bottom to clog the pumps, as sometimes happens with ordinary floating roofs.

The invention will be described as related to the embodiment shown in the accompanying drawings. Of the drawings Fig. 1 is a plan view of a storage tank embodying the invention with portions broken away for clarity of illustration; and Fig. 2 is a vertical section taken along line 2—2 of Fig. 1.

The storage tank shown in the accompanying drawings comprises a substantially cylindrical shell 10, a fixed weather roof 11 thereover, having a depending skirt 12 beyond the shell, a flat floating roof 13 therein, a substantially cylindrical, flexible sealing member 14, attached to the edge of the floating roof 13 and to the bottom 15 of the tank, a portion 16 of sealing liquid between the sealing member 14 and the shell 10, and a second portion 17 of sealing liquid over the bottom 15 and within the sealing member 14.

The weather roof 11 is supported on the shell 10 by means of a plurality of spaced posts 18 attached to the top of the shell and supporting the weather roof. The space between the top of the shell and the weather roof is covered by a screen 19. Any other type of opening besides the screen may be provided to permit flow of air around the top of the shell 10. The depending skirt 12 serves as a shield to prevent snow, rain, dirt, and the like from blowing in through the screen 19.

The floating roof 13 has a flat bottom and is provided with an upstanding edge flange 20. The flexible sealing member 14, which may be a fabric impregnated with a flexible impervious material, is attached to the edge of the floating roof as by bolting the top edge of the sealing member to the bottom of the flange 20 by means of bolts 21. The flexible sealing member is substantially cylindrical in shape and has a diameter slightly greater than the diameter of the floating roof 13, but smaller than the diameter of the shell 10. The sealing member is substantially as long as the maximum storage space desired, and has its bottom end attached in sealing contact with the bottom 15 of the tank.

The portion 16 of sealing liquid between the sealing member 14 and the shell 10 is preferably the same liquid as that portion 17 at the bottom of the storage space 22. The sealing liquid is of greater specific gravity than the liquid

to be stored within the storage space. Means are provided connecting the two portions 16 and 17 of sealing liquid, and this means may be a bypass pipe 23 in communication with both portions of sealing liquid. Other means may also be used, such as holes provided in the bottom of the sealing member 14.

Filling and emptying means are provided communicating with the storage space 22 at a point above the highest possible level of the portion 17 of sealing liquid at the bottom of the space. This means may be an inlet and outlet pipe 24.

The level of the two portions of the sealing liquid will depend upon the weight of the floating roof 13, the weight of the sealing member 14, the difference between specific gravities of the sealing liquid and the stored liquid, and the amount of stored liquid within the storage space. The system may be so designed that the level of sealing liquid between the sealing member 14 and the shell 10 is always substantially at or just below the bottom of the floating roof 13. As liquid to be stored is pumped into the storage space 22 the floating roof 13 rises within the shell 10, and the quantity of sealing liquid at the bottom of the storage space is decreased, while the quantity of liquid outside the sealing member 14 is increased. When stored liquid is withdrawn the floating roof will fall and the conditions will be just the opposite. When substantially all stored liquid has been withdrawn the floating roof will be near the bottom of the tank and most of the sealing liquid will be in the bottom of the storage space. It is necessary that the pipe 24 extend above the maximum height of the sealing liquid in the bottom of the storage space in order that no sealing liquid will be withdrawn with the stored liquid.

As can be seen from the above description, any vapor formed from the stored liquid will collect beneath the floating roof 13 and will be held by the sealing member 14. In this respect the storage tank constitutes both a liquid and gas container. The same principles as used in constructing a storage tank for volatile liquids may also be used in constructing a similar tank for the storage of gases.

Having described my invention as related to one embodiment of the same it is my intention that the invention be not limited by any of the details of description unless otherwise specified, but rather be construed broadly within its spirit and scope as set out in the accompanying claims.

I claim:

1. A storage tank comprising an outer shell, a bottom therefor, a floating roof smaller than the shell and located within the shell, a flexible sealing member connecting the floating roof to said bottom to define a storage space under said floating roof, a portion of sealing liquid between the sealing member and the shell, a portion of sealing liquid in the bottom of the storage space, said portions of sealing liquid having specific gravities greater than that of the stored liquid, means connecting that portion of sealing liquid outside the sealing member with that portion at the bottom of the storage space, and filling and emptying means communicating with the storage space at a point above the greatest height of the sealing liquid in the bottom of the storage space.

2. The storage tank of claim 1 wherein the sealing liquid in both portions is the same.

3. The storage tank of claim 1 wherein the filling and emptying means extend through the bottom of the tank.

4. A storage tank for liquids comprising an outer shell, a bottom therefor, a floating roof smaller than the shell and located within the shell, a flexible sealing member connecting the floating roof to said bottom to define a storage space under said floating roof, a portion of sealing liquid between the sealing member and the shell, a second portion of the same sealing liquid in the bottom of the storage space, said sealing liquid having a specific gravity greater than that of the stored liquid, means connecting that portion of sealing liquid outside the sealing member with that portion at the bottom of the storage space, and filling and emptying means extending through the bottom of the tank and communicating with the storage space at a point above the greatest height of the sealing liquid in the bottom of the storage space.

5. The storage tank of claim 4 wherein the floating roof is of circular shape and the flexible sealing member is a cylinder of approximately the diameter of the floating roof.

6. A storage tank for liquids comprising an outer shell, a bottom therefor, a weather roof over the shell, air openings between the weather roof and the shell, a floating roof smaller than the shell and located within the shell, a substantially cylindrical flexible sealing member of approximately the diameter of the floating roof having one end attached to the floating roof at substantially the edge thereof and the other end attached to the bottom of the tank substantially beneath the first end to define a storage space between the floating roof and the bottom of the tank and within the sealing member, a portion of sealing liquid between the sealing member and the shell, a second portion of the same sealing liquid in the bottom of the storage space, said sealing liquid having a specific gravity greater than that of the liquid to be stored, means connecting that portion of sealing liquid outside the sealing member with that portion at the bottom of the storage space, and filling and emptying means extending through the bottom of the tank and communicating with the storage space at a point above the greatest height of the sealing liquid in the bottom of the storage space.

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