Jan. 25, 1944. D. E. LARSON 2,339,997

LIFTER ROOF

Filed Nov. 24, 1941 2 Sheets-Sheet 1

Fig. 1.

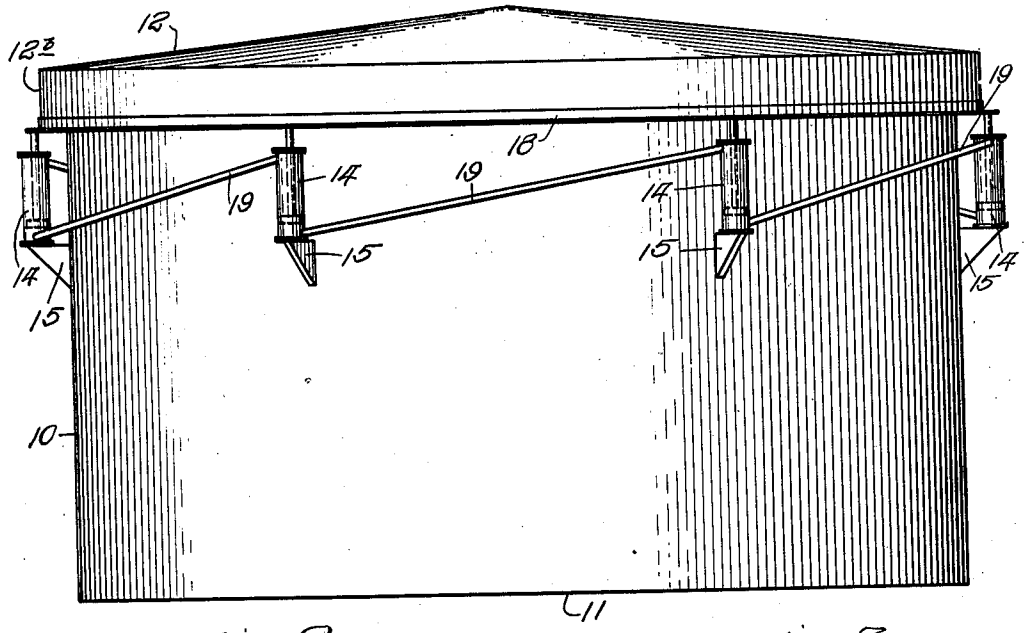


Fig. 2.

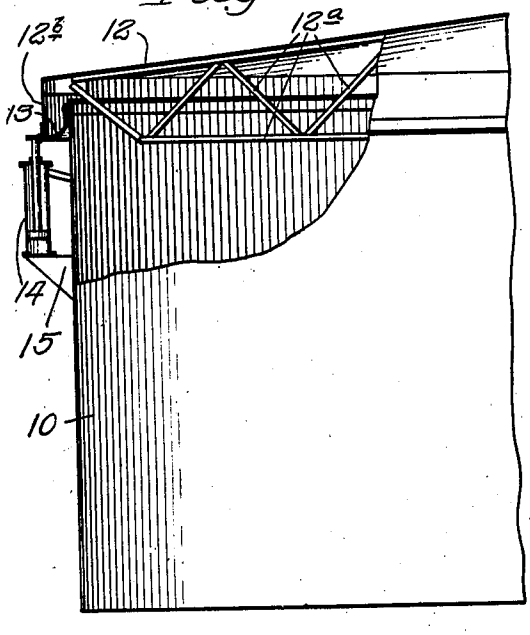
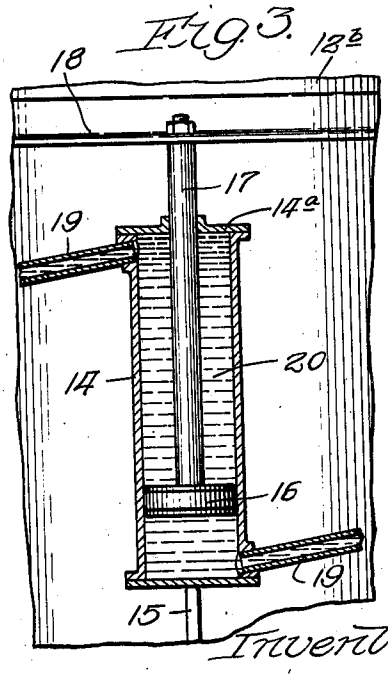


Fig. 3.



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Fig. 4.

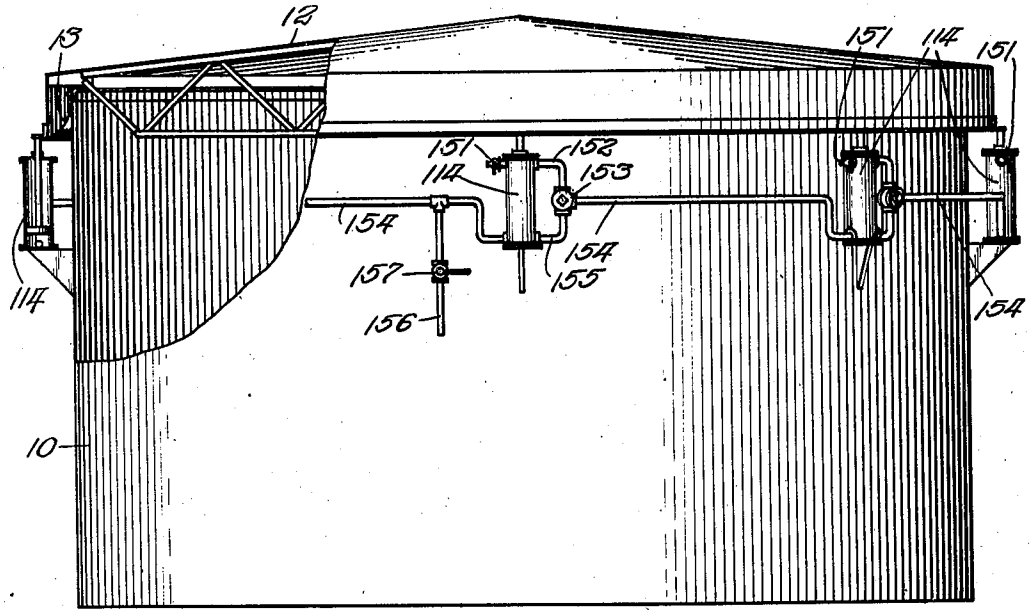


Fig. 5.

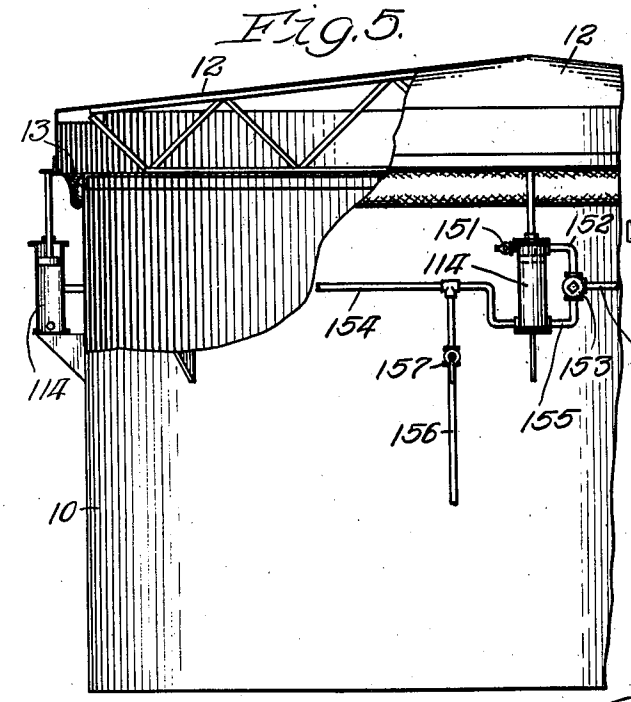
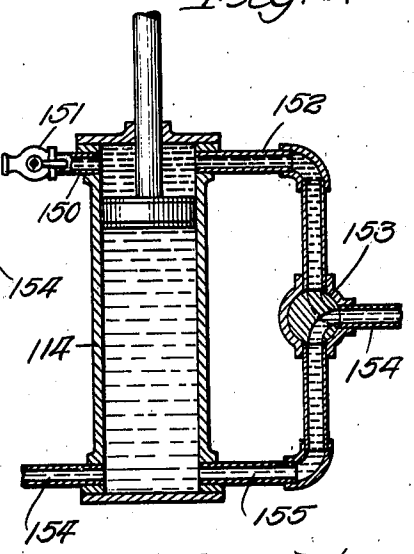


Fig. 6.



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2,339,997

UNITED STATES PATENT OFFICE

2,339,997

LIFTER ROOF

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Application November 24, 1941, Serial No. 420,291

1 Claim. (Cl. 48—176)

This invention relates to improvements in lifter roofs and more especially such a device in connection with a tank, shell or container adapted for the storage of gases, or volatile liquids.

Among the features of my invention is the provision of stabilizing means for the roof to prevent it from tipping or tilting. The guiding means insures that the roof remains horizontal in its vertical movements.

My invention may be described in general as a hydraulic stabilizing system as it comprises a plurality of cylinders attached to the tank with a plurality of pistons therein attached to the roof. The bottom of each cylinder is connected to the top of the adjacent cylinder on one side so that as the pistons rise, fluid will be transferred from the top of one cylinder to the bottom of the adjacent cylinder and vice versa.

Another feature of my invention is the provision of an hydraulic stabilizing system as above described so that the cylinders and pistons can be used as hydraulic jacks to lift the roof. This is of especial value in connection with a lifter roof having a curtain seal as it furnishes means for making the seal readily accessible from the outside for replacement or repairs. This can be done easily if the roof can be raised by some other means (such as the hydraulic jacks) than the application of pressure in the vapor space.

My improved hydraulic stabilizing system is preferably located on the outside of the tank where it is easily accessible for inspection.

Other features and advantages of my invention will appear more fully as I proceed with my specification.

In those forms of device embodying the features of my invention shown in the accompanying drawings, Fig. 1 is a view in side elevation; Fig. 2 is a vertical sectional view of the seal, also showing one of the cylinders; Fig. 3 is a vertical sectional view on an enlarged scale of one of the hydraulic cylinders; Fig. 4 is a view similar to Fig. 1, partly in section, showing a modified form; Fig. 5 is a view similar to Fig. 4 showing the parts in an altered position; and Fig. 6 is a vertical sectional view on an enlarged scale of one of the cylinders of the device of Figs. 4 and 5.

As shown in the drawings, 10 indicates a cylindrical shell or tank and 11 the bottom thereof.

12 indicates a vertically movable roof with the stiffening girders 12*a*. The outer edge of the roof is preferably provided with a depending flange or apron 12*b*.

13 indicates a flexible fabric seal connecting the lower edge of the apron 12*b* to the upper edge of the tank wall 10. This seal permits vertical movements of the roof, at the same time sealing the tank against loss of vapor.

14, 14 indicate a plurality of vertical cylinders on the outside of the tank supported on the brackets 15 attached to the outside of the wall 10. As here shown, there are six of these cylinders equally spaced about the tank. In each cylinder there is a piston 16 with a vertical piston rod 17 having its upper end attached to the angle-iron 18 mounted on the outside of the apron 12*a* at the lower edge thereof. The upper ends of the cylinders 14 have heads 14*a* through which the piston rods 17 extend, it being understood that there is a fluid-tight joint between the piston and the head or suitable backing (not shown).

The lower end of each cylinder 14 is connected by the pipe 19 to the upper end of the next cylinder to the right, and so on entirely around the tank. The entire system is filled with suitable liquid 20 such as, for example, water, oil, brine or the like.

It will be seen that in the operation of the device the roof 12 will rise and fall with changes in pressure of the gas under the roof inside of the tank. As the piston in any one cylinder descends, liquid under the piston flows from the bottom of that cylinder into the top of the next cylinder to the right. Accordingly, all the pistons must descend in unison. Likewise, when any one piston rises the liquid flows back from the top of the cylinder to the right into the bottom of that cylinder and consequently all the pistons must rise in unison. Because all the pistons must move upwardly and downwardly in unison, tilting and tipping of the roof are prevented in its vertical movements.

In the device of Figs. 4 and 5 I have shown how the cylinders can be used as hydraulic jacks to lift the roof. As here shown, each cylinder 114 is provided with two pipes at the top, namely vent pipe 150 controlled by the valve 151 and a pipe 152 leading to the two-way valve 153. The pipe 154 leads from the valve 153 to the bottom of the next cylinders to the right. The valve 153 can be operated to connect the pipe 154 either to the top of the adjacent cylinder (to the left) by means of the pipe 152 or to the bottom thereof by the pipe 155. It is shown in the latter position in solid lines in Fig. 6. The other position is indicated by the broken lines in Fig. 6. When the valve 153 is turned to connect the pipe 154 to the pipe 155, the vent 151 is opened and liquid may then be pumped into the bottoms of all the cylinders by means of the pipe 156, the valve 157

being opened for this purpose. The pipes 154 and 155 therefore connect the bottoms only of all cylinders and since the valves 151 are all open the tops of all the cylinders are vented and consequently the cylinders and pistons all act as hydraulic jacks to lift the roof. If the vents 151 are closed and the valves 153 all turned to connect the pipes 154 to the pipes 152 so that the top of each cylinder will be connected to the bottom of the next adjacent cylinder to the right and the entire system filled with liquid and the valve 157 closed, it will be seen that the operation of the roof will be the same as described above with respect to the device of Figs. 1–3.

Although I have shown flexible fabric for sealing the space between the tank and the roof it is obvious that other forms of seal may be used. For example, there would be a liquid seal comprising a trough with liquid in it at the upper edge of the tank and a depending apron or rim on the roof with its lower edge immersed in the liquid. Such a seal also would remain effective during the vertical movement of the roof. Such a seal, whether liquid or fabric, may in general be referred to as a flexible seal.

It will be seen that the equalizing or guiding arrangement of the hydraulic cylinder with pistons therein that I have used may be described and claimed broadly enough to cover some arrangements not employing hydraulic cylinders and pistons. In the construction shown the pistons are attached to the roof and the cylinders with the connecting pipes and liquid therein comprise flexible connections between the pistons whereby all the pistons must move upwardly and downwardly in unison. For example, as one piston moves downwardly it forces the liquid below it into the top of an adjacent cylinder forcing that piston downwardly at the same rate, and so on entirely around the tank. There could, of course, be other mechanical connections between the pistons, or equivalent members, than the liquid, which would accomplish the same purpose.

While I have shown and described certain embodiments of my invention, it is to be understood that it is capable of 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, in which it is my intention to claim all novelty inherent in my invention as broadly as permissible, in view of the prior art.

What I claim as new, and desire to secure by Letters Patent, is:

A storage tank, comprising: a substantially cylindrical shell member; a vertically movable roof member; a plurality of hydraulic cylinders each containing a double-acting piston connected in a closed circuit, the one with the others by pipes connecting the upper part of one cylinder with the bottom part of the next; piston rods connected to one of the first mentioned members; and means connecting the cylinders to the other of the first mentioned members, wherby vertical motion of the roof is equalized on all sides of the same.

DONALD E. LARSON.