Aug. 2, 1938. V. A. DE CASTRO 2,125,771

STORAGE TANK FOR VOLATILE LIQUIDS

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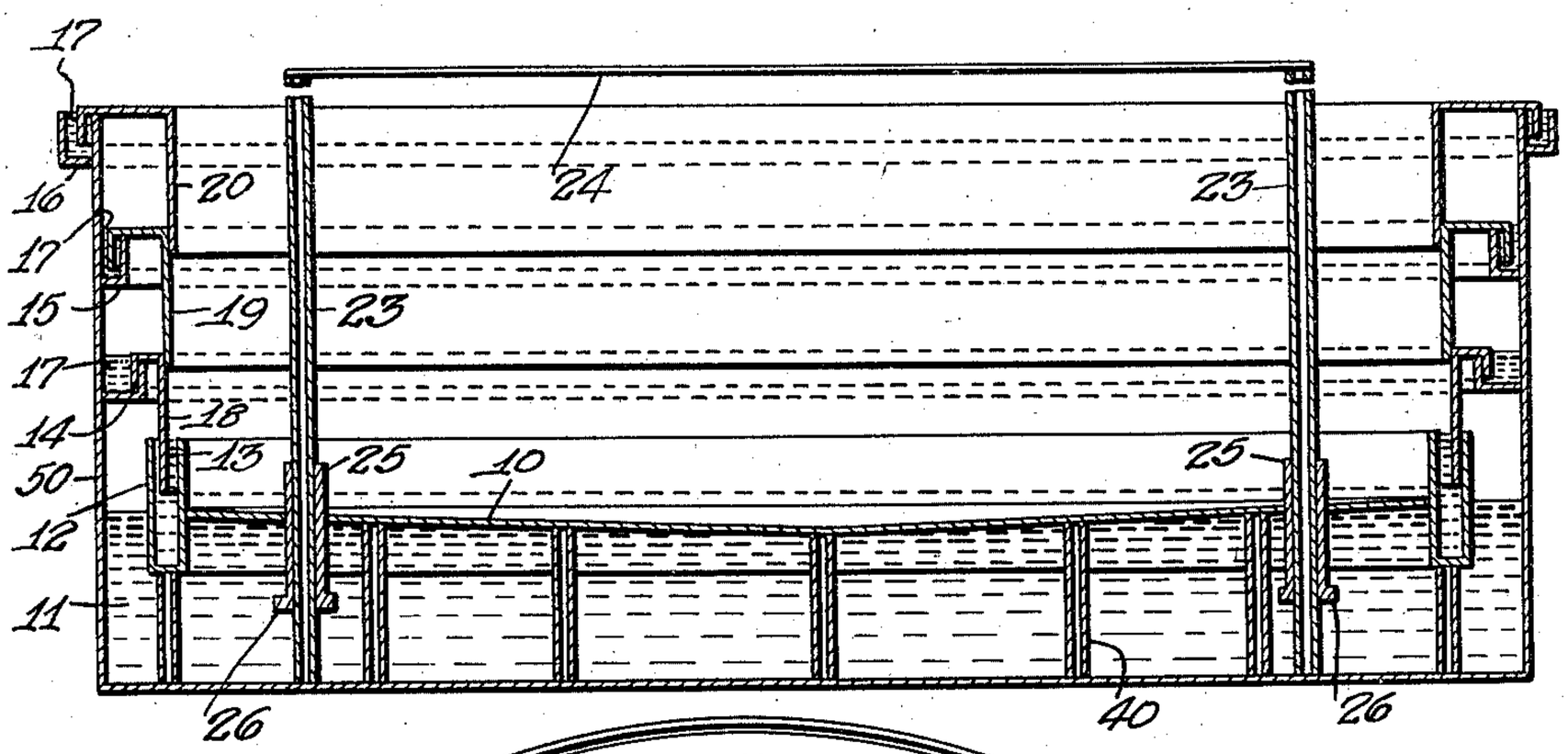

Fig. 1.

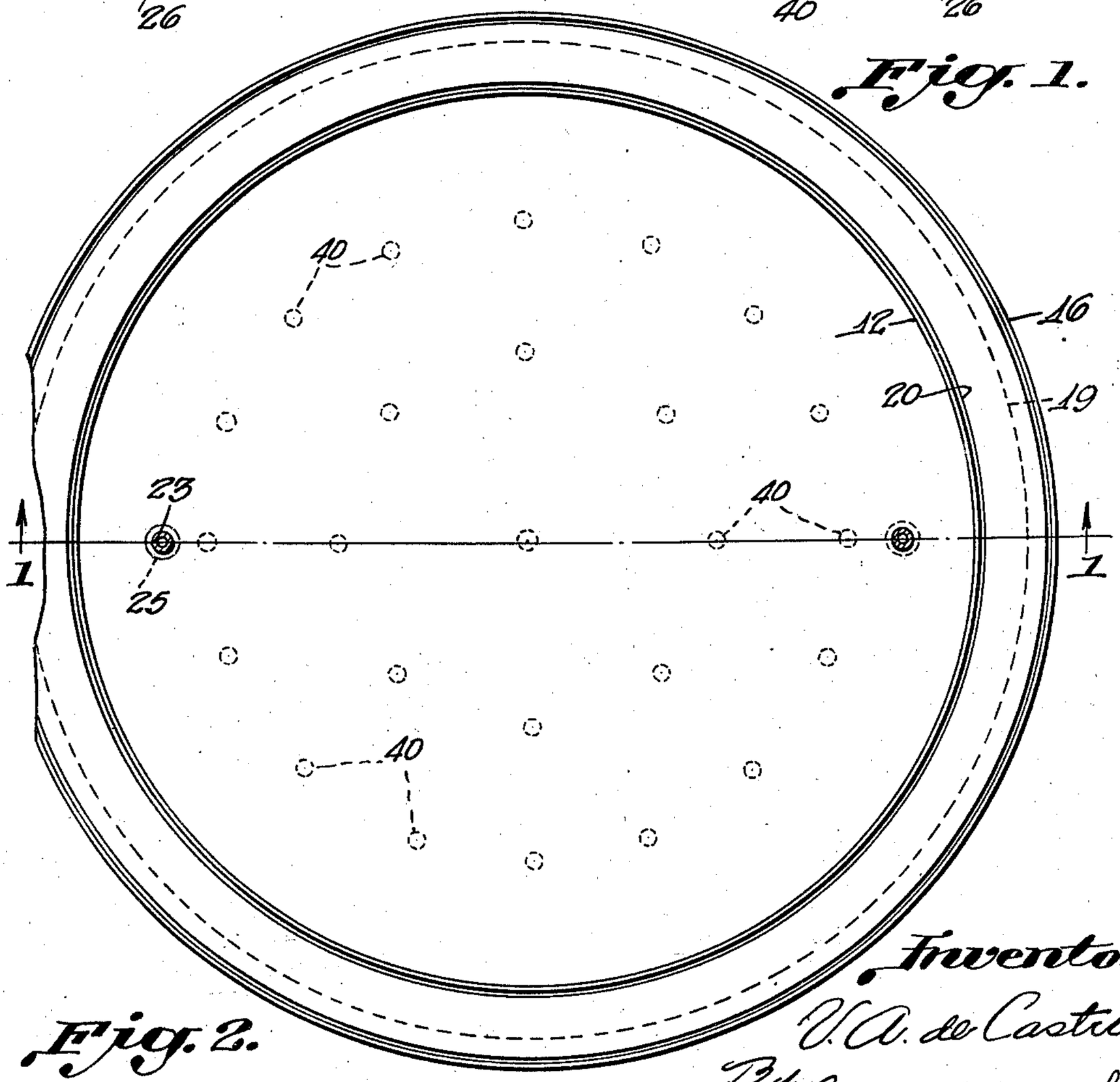

Fig. 2.

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Fig. 3.

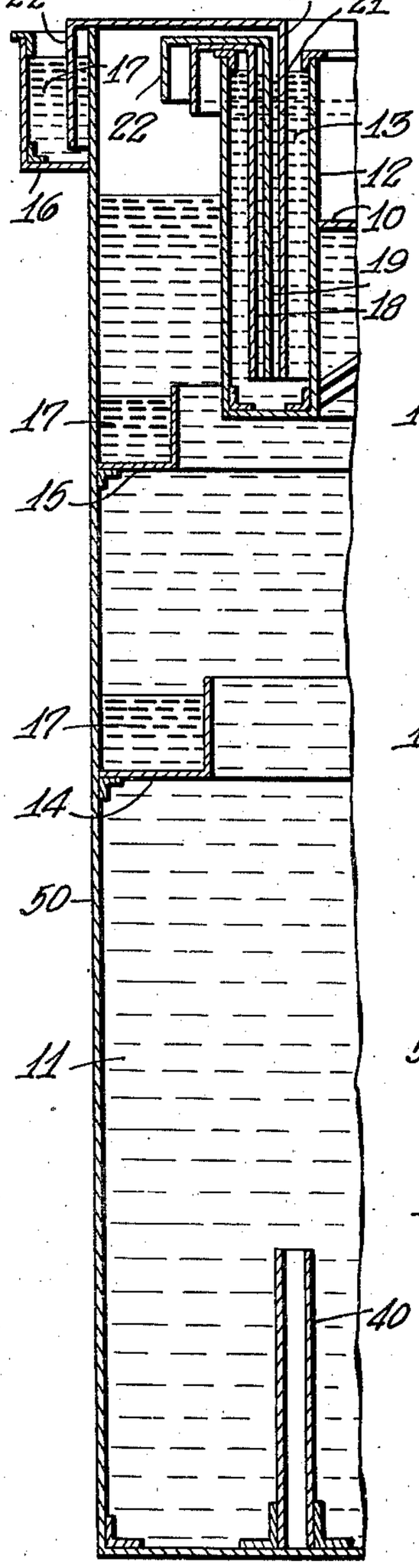

Fig. 4.

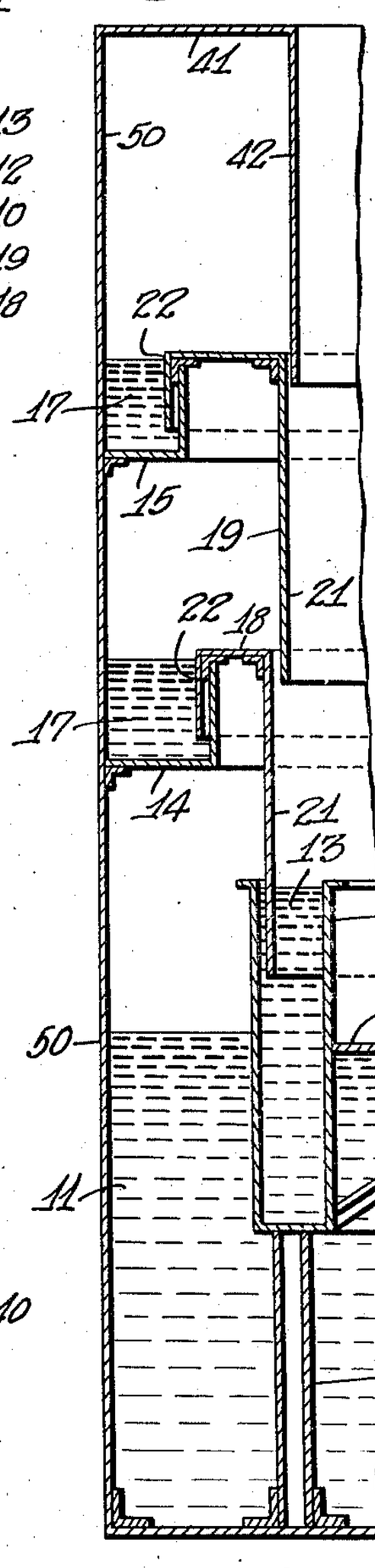

Fig. 9.

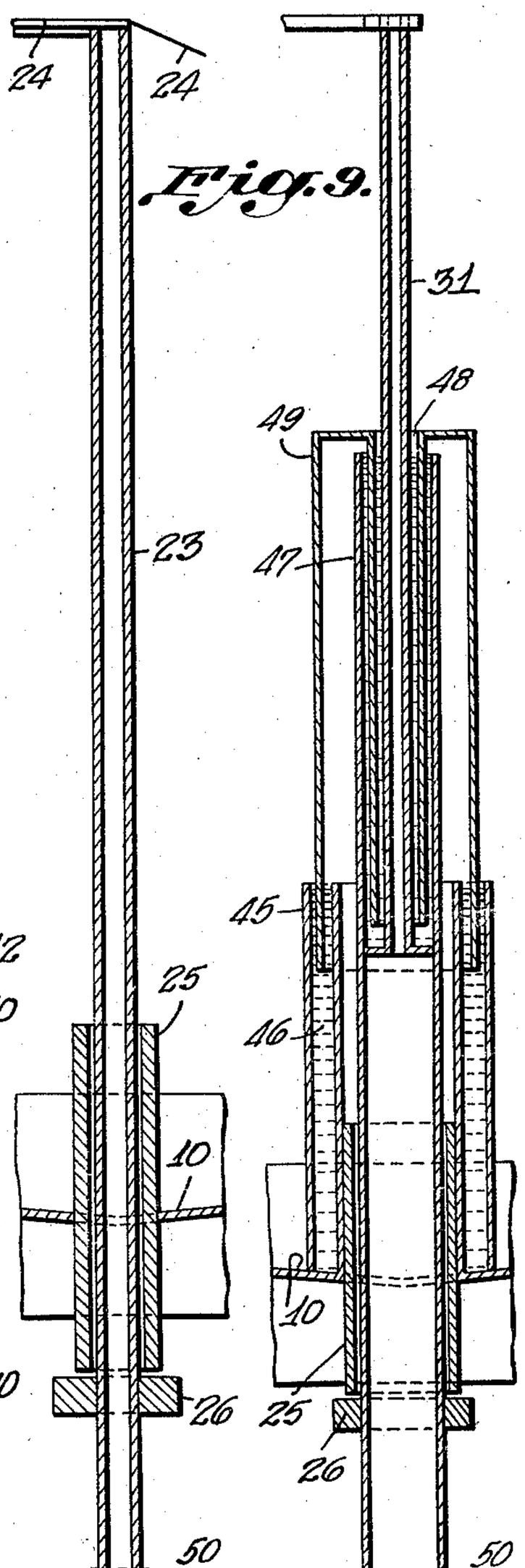

Fig. 8.

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Fig. 5.

Fig. 6.

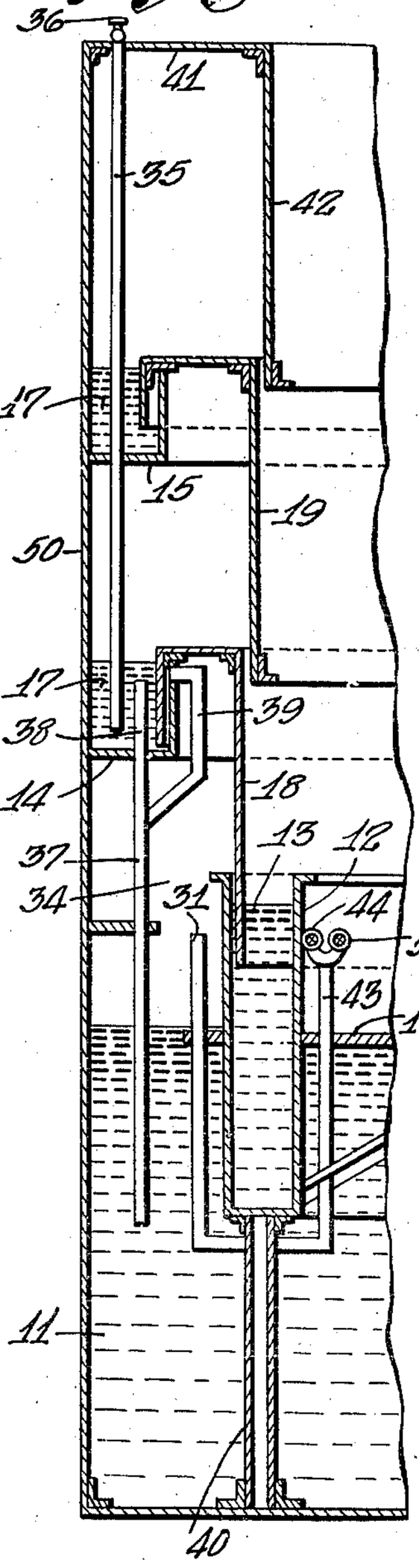
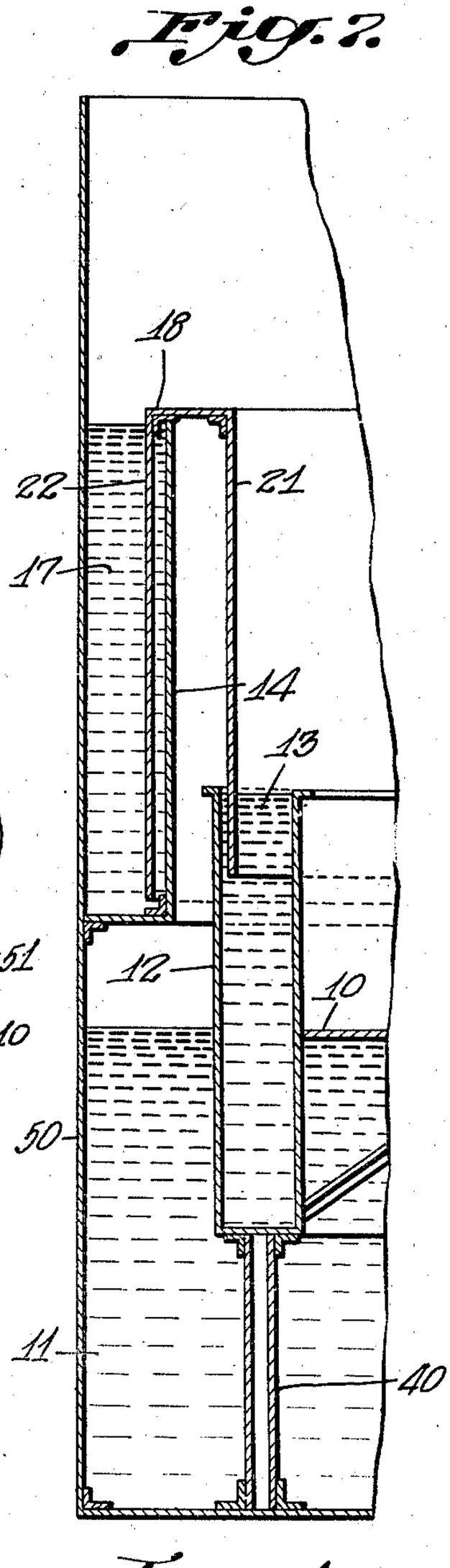


Fig. 7.



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UNITED STATES PATENT OFFICE

2,125,771

STORAGE TANK FOR VOLATILE LIQUIDS

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Application March 7, 1936, Serial No. 67,694

15 Claims. (Cl. 220—26)

This invention relates to certain new and useful improvements in tanks for the storage of volatile liquids such as gasoline and the like, and has special reference to roofs or covers floating directly on the liquids stored within the tanks.

In the past, most of the tanks for the storage of volatile liquids with floating covers have depended mainly for their functioning either on expensive and readily impaired flexible materials, or on a more or less imperfect closure due to the fact that certain sealing members rising and falling with the floating cover would press against the interior of the shell. These means could not possibly attain a vapor-tight condition due to irregularities in the surface of the sides of the tank, and because insufficient pressures were employed as, otherwise, the cover could not descend.

The primary object of my invention is to provide means to prevent or diminish the loss by evaporation of the stored liquid while the latter is being filled into the tank and while such liquid is held in storage, said means consisting primarily of successively formed liquid seals between the floating cover and the sides or shell of the tank; and hence neither a flexible material is required nor a closure by means of a mechanical pressure.

Another object of my invention is to provide means to replenish and to drain the liquid constituting the liquid seal upon the use of which depend the other objects sought.

A still further object of my invention is to prove means whereby the floating cover and sealing media hereinafter described shall be constrained to maintain certain convenient relative positions to each other and to the cylindrical shell of the tank, and that such means shall not impair the condition of hermeticity.

In general, it is the object of my invention to provide, while avoiding the use of flexible material or need for mechanical pressure, a new, improved simple economically-manufactured and economically-operated wholly hermetic tank, with a floating cover, in which tank the evaporation losses and fire hazards are reduced to a minimum. I achieve these objects and such other objects as may hereinafter appear or be pointed out, in the manner illustratively exemplified in the three embodiments shown in the accompanying drawings, wherein:

Figure 1 is a vertical sectional view on line 1—1 of Figure 2, drawn to a relatively small scale, of one embodiment of my improved tank, showing the floating cover at the lowest position in its travel.

Figure 2 is a top plan view of the embodiment depicted in Figure 1.

Figure 3 is a fragmentary vertical section of the embodiment shown in Figure 1, but drawn to a larger scale, and showing the floating cover at the highest position in its travel.

Figures 4, 5 and 6 are fragmentary vertical sections of a second embodiment of my improved tank, all three views showing the cover at its lowest position.

Figure 7 is a fragmentary vertical section of a third embodiment of the tank of my invention.

Figure 8 is a detailed view of one embodiment of a column-guide for the cover.

Figure 9 is a similar view of a second embodiment of a column-guide.

Referring to Figures 1, 2 and 3, I have illustratively shown one embodiment of my tank with a shell 50 of same of substantially cylindrical construction, and provided with a roof or cover 10, which also is substantially rigid and cylindrical and adapted for freely rising and descending as it floats on the stored liquid 11, in accordance with principles well-known in the art.

I provide means whereby the ascending and descending movement of cover 10 can take place without in the least impairing the hermetically-sealed relationship of the cover with reference to the portion of the tank containing the stored liquid, as follows.

As will be noted from the drawings, at the periphery of the floating cover 10, I have provided an upwardly opening annular trough 12, adapted to receive water or other sealing fluid 13, and I have also provided, at suitable varying heights along the shell 50, and forming part thereof, similar upwardly opening annular troughs 14, 15 and 16, having sealing fluid 17 and adapted to receive sealing members 18, 19 and 20, consisting of very thin metal sheets duly reinforced with angles or other means. Each of these members is provided with two vertical depending flanges 21 and 22 respectively, one of these depending flanges being adapted to extend downwardly into the sealing liquid 13 and the other into the sealing liquid 17, thereby constituting a liquid seal between the cylindrical shell 50 and the floating cover 10. Columns 40, affixed to the bottom of the tank, provide a support for the cover when in its lowest position.

The fact that a liquid seal is maintained at

all times, is the keystone of my invention. The condition of continuous hermeticity is attained as follows.

Regardless of whether or not, with variations in the level of the stored liquid, the floating cover rises or descends, there will always be one of the sealing members 18, 19 or 20, with one depending flange 21 immersed in the liquid 13, of the trough 12 and with the other depending flange 22 immersed in the liquid 17, of one of the troughs 14, 15 or 16 of the shell of the tank, thus maintaining a liquid seal and the condition of hermeticity. This occurs since, as the floating cover 10 rises, it picks up each sealing member in turn, and these sealing members will ride up with the cover 10 while the depending flange 21 of one of the sealing members 18, 19 or 20 projects downwardly into the liquid 13 within the trough, and the other depending flange 22 projects downwardly into the liquid 17 of the troughs 14, 15 and 16. On the other hand, as the floating-deck descends it leaves behind one after another of the sealing members, suspended from the vertical wall of its corresponding trough 14, 15 or 16 on the shell of the tank, so that the condition of hermeticity is maintained in a similar manner as described for the upward movement of the cover.

In the tank of my present invention, assuming that the sealing member which is acting to maintain a condition of hermeticity, be seated with its horizontal annular flange resting on the top edge of the vertical wall of a trough on the side of the tank, then a rise in temperature will increase the pressure of the air-vapor mixture contained between the tank wall, the sealing member and the floating cover but only until this pressure reached the amount which just sustains the weight of the said sealing member, at which time the pressure ceases to increase and the volume of the air-vapor mixture increases, gradually lifting the sealing medium as the temperature continues to rise. In the same manner, a drop in temperature will cause a decrease in the volume of the air-vapor mixture and the sealing member, acting at the time to maintain hermeticity will move downwardly in proportion to such drop in temperature until the horizontal ring of the sealing member rests again on the top edge of the annular trough.

The rise or fall of a sealing member automatically compensates for variations in pressure or vacuum but, it being advisable to limit the values of pressure and vacuum to certain predetermined maxima, there are provided pressure-relief safety valve 51, and vacuum-relief safety valve 44, which are accessories well-known in the art. Whenever the pressure within the air-vapor space 34, reaches a predetermined value, valve 51 automatically opens and sufficient volume of the air-vapor mixture escapes into the air to reduce the pressure to less than a predetermined maximum. Similarly, whenever the partial vacuum in the air-vapor space 34 reaches a predetermined value, valve 44 automatically opens and sufficient volume of the outside air flows into the air-vapor space 34 to reduce the value of the vacuum to less than a predetermined maximum. Although shown only in Figure 6, valves 51 and 44 are equally applicable to the three embodiments of the present invention, and all these valves are connected to the end of the U-tube 43 which lies outside of the tank. U-tube 43 passes through the floating cover in an hermetic joint and the free end, 31, lies within the air-vapor space 34, such end 31 serving as an outlet for the excess air-vapor mixture, and as an inlet for the admittance of outside air, depending on whether valve 51 or valve 44 shall at the time be functioning.

The foregoing and the following description applies equally as well to the second embodiment shown in Figs. 4, 5 and 6, and to third embodiment shown in Figure 7, in all of which figures the same numerals describe the like parts as Figures 1, 2 and 3. The main differences among the three embodiments are that whereas in the first embodiment the top trough 16 and top sealing member 20 serve to maintain a vapor-tight relationship when the cover is at the top of its travel, in the second embodiment this function is assumed by an annular flange 41, affixed to the shell and a cylindrical skirt 42 depending from the flange 41; while in the third embodiment, (Fig. 7) the vapor-tight relationship is maintained within the limits of the available travel of the cover by only one deep trough 14 and one sealing member 18.

In Figure 5 there is shown a means for constraining the sealing member or members to travel along definite paths which means, although applied to the tank of the second embodiment, are equally applicable to that of the first and the third embodiments. I have provided roller guides 27 and 28 on the outer depending flanges of the sealing media, which roller guides 27 and 28 are constrained to follow rail guides 29 and 30, carried by the troughs fixed to the tank wall so as to force the sealing media 18 and 19 to follow definite paths in their travel. These roller guides may be equipped, if necessary, with springs or counter weights (not shown in the drawings) to allow for variations from the vertical of the guides 29 and 30.

Female stops, 32, are placed at intervals along the sealing members like 19, while directly below on the corresponding sealing member like 18 are provided male stops 33. When a sealing member carries along the next sealing member above it, the relative position is maintained by the male stops 33 engaging the female stops 32.

In Figure 6 only, I have shown the means proposed for replenishing the sealing liquid and for draining the gasoline or other liquid left in the troughs upon the descent of the level of the stored liquid 11. For clearness, the means for one trough only have been depicted. It will be understood that the other troughs on the shell are similarly provided as by branches of pipe 35 which hermetically passes through the annular flange 41 of the skirt, and through the annular trough 15 and serves to feed sealing liquid to the trough 14 by opening of a valve 36.

An overflow pipe 37, is provided for each trough 14, 15, etc. and has branches 38 and 39 provided to keep the liquid in the trough at a certain level. Inasmuch as the liquids stored, probably gasoline, will be lighter than the sealing liquid, probably water, and not miscible therewith, it will be evident that this gasoline will float on the water, and the opening of valve 36 will serve to add water to the troughs so that any gasoline left in the troughs will overflow through the branch pipes 38 and 39 and back into the bottom of the tank, thus to avoid any evaporation of gasoline, any excess water also overflowing and passing to the bottom of the tank.

Referring specially to Fig. 8, in order to constrain the floating deck to follow definite paths in its upward and downward movements, I have

provided a column guide 23 upon which bears a pipe-sleeve 25, which is hermetically affixed to the cover 10. The sleeve 25 is made to extend below the level of the stored liquid for the purpose of retaining any vapors which may be found between the cover 10 and the liquid 11. Bracing 24 at top of these columns 23 maintain these more rigid, while 26 is a stop to support roof 10 when at its lowest position.

If desired, these column guides 23 can be wholly dispensed with, the cover being guided in its rise and fall, by the sealing members 18, 19, etc.

In Figure 9 a second embodiment is shown of a column guide 31 to constrain the floating deck to follow definite paths in its upward and downward movements. This embodiment differs from that depicted in Figure 8, in that, at all times, throughout the available height of the tank, and regardless of the relative position between the floating deck 10 and the column guide 31, a liquid seal is maintained between such deck and said column.

This continuous liquid seal being maintained as follows. The floating deck 10 is provided with an upwardly open annular trough 45 affixed to the deck 10, and adapted to receive a sealing liquid 46. Within the vertical column 31 there is provided an upwardly-opening annular trough 47 adapted to receive a sealing liquid 48; a sealing member for these two troughs, 49, consists of a downwardly open annular trough with one cylindrical skirt adapted to immerse in the sealing liquid 46 and with the other adapted to immerse in the sealing liquid 48. It will be evident that no matter whether the cover rises or descends, within the available height of the container a continuous seal will be maintained between the depending skirts just mentioned of the sealing medium and the corresponding sealing liquids 46 and 48; for, upon the rise of the cover to such an extent that the depending skirt of the sealing member 49 touches the bottom of the trough 45, the sealing member 49 will be carried upwards with the deck after which the sealing member will rise with additional movement upward of the deck, the liquid seal then being constituted by the other depending skirt of the medium 49 and liquid 48; upon a downward movement of the deck, the foregoing takes place in a reversed order.

It will be understood that although not shown in the drawings, the tank will be provided with the usual inlet and outlet pipes, manholes, dip-hatches and other accessories well-known to those skilled in the art.

I do not limit myself to the embodiments herein described, as it will be understood that various modifications may be made without departing from the general features of the invention. What I claim and desire to secure by Letters Patent is:

1. A tank and roof construction comprising a shell adapted to contain fluid, a roof adapted to overlie and float upon the fluid so contained, sealing means between the roof and the shell, comprising, an upwardly facing annular trough on the roof, a plurality of upwardly facing troughs spaced vertically and fixed to the inner face of the shell and decreasing in width, from lower to upper, and a sealing means for each shell trough including spaced depending flanges each being telescopically receivable in the one above.

2. A tank and roof construction comprising a shell adapted to contain fluid, a roof adapted to overlie and float upon the fluid so contained, sealing means between the roof and the shell, comprising, an upwardly facing annular trough on the roof, a plurality of upwardly facing troughs spaced vertically and fixed to the inner face of the shell, and a sealing means for each shell trough including spaced depending flanges, one flange of each sealing means overlying the roof trough, and the other overlying its shell trough the sealing means being wholly receivable each in the one above it, as the roof ascends.

3. A tank and roof construction comprising a shell adapted to contain fluid, a roof adapted to overlie and float upon the fluid so contained, sealing means between the roof and the shell, comprising, an upwardly facing annular trough on the roof, a plurality of upwardly facing troughs spaced vertically and fixed to the inner face of the shell, and a sealing means for each shell trough including spaced depending flanges, one flange of each sealing means overlying the roof trough, and the other overlying its shell trough, each shell trough being wider than the one immediately above it.

4. A tank and roof construction comprising a shell adapted to contain fluid, a roof adapted to overlie and float upon the fluid so contained, sealing means between the roof and the shell, comprising, an upwardly facing annular trough on the roof, a plurality of upwardly facing troughs spaced vertically and fixed to the inner face of the shell, and a sealing means for each shell trough including spaced depending flanges, the shell troughs increasing in width, and the spacing of the flanges on the sealing means decreasing in width, from the top to the bottom of the shell.

5. A tank and roof construction comprising a shell adapted to contain fluid, a roof adapted to overlie and float upon the fluid so contained, sealing means between the roof and the shell, comprising, an upwardly facing annular trough on the roof, a plurality of upwardly facing troughs spaced vertically and fixed to the inner face of the shell, and a sealing means for each shell trough including spaced depending flanges, one flange of each sealing means overlying the roof trough, and the other overlying its shell trough, the shell troughs increasing in width, and the spacing of the flanges on the sealing means decreasing in width, from the top to the bottom of the shell.

6. A tank and roof construction comprising a shell adapted to contain fluid, a roof adapted to overlie and float upon the fluid so contained, sealing means between the roof and the shell, comprising, an upwardly facing annular trough on the roof, a plurality of upwardly facing troughs spaced vertically and fixed to the inner face of the shell, and a sealing means for each shell trough including spaced depending flanges, one flange of each sealing means overlying the roof trough, and the other overlying its shell trough, fixed guide means for the roof, and liquid seal means between the guide means and the roof.

7. In a tank for volatile liquids, in combination, a wall, a plurality of annular troughs secured thereto at different levels and adapted to receive sealing liquids, each trough being wider than those above it; a plurality of annular sealing members with inverted U cross-sections, each sealing member being wider than those located beneath it, the sealing members being independently and freely vertically movable; a freely vertically movable, independent, cover adapted to float upon liquid in the tank, an annular trough at the edge of the cover adapted to receive a sealing liquid; one depending flange of the narrowest of the freely movable sealing members en-

gaging freely with the widest trough on the wall, and one depending flange of the widest sealing member engaging freely with the narrowest of such troughs, the depending flanges of other sealing members and troughs co-acting similarly.

8. In a tank for volatile liquids, in combination, a wall, a plurality of annular troughs secured to the wall, interiorly, at different levels and adapted to receive sealing liquid, each of such troughs being wider than those above it; a like plurality of annular sealing members with inverted U cross-section positioned at different levels, each sealing member being wider than those located beneath it, and independent therefrom and from the wall, all sealing members being freely vertically movable; a freely vertically movable, independent, cover having a trough adapted to receive sealing liquid; one depending flange of each sealing member being adapted to engage freely with one of the said troughs on the wall, the narrowest sealing member co-acting with the widest trough on the wall, and the widest sealing member co-acting with the narrowest of such troughs, other sealing members co-acting in a similar proportionate arrangement, the other flange of each sealing member being adapted to freely engage with the roof trough whereby when the cover moves upwardly, it can carry along with it in succession said sealing members during all of which time some of said moving sealing members are acting to constitute a liquid seal.

9. In a tank for volatile liquids, in combination, a wall, a plurality of annular troughs secured thereto at different levels and adapted to receive sealing liquids, each trough being wider than those above it; a plurality of annular sealing members with inverted U cross-sections, each sealing member being wider than those located beneath it, the highest of such sealing members being attached to the wall while the others are independently and freely vertically movable; a freely vertically movable, independent, cover adapted to float upon liquid in the tank, an annular trough at the edge of the cover adapted to receive a sealing liquid; the fixed sealing member acting when the cover is nearing its highest position, and the other sealing members acting below the highest position, one depending flange of the narrowest of the freely movable sealing members engaging freely with the widest trough on the wall, and one depending flange of the widest sealing member engaging freely with the narrowest of such troughs, the depending flanges of other sealing members and troughs co-acting similarly.

10. A tank and roof construction comprising a shell adapted to contain fluid, a roof loosely receivable in said shell and adapted to overlie and float upon fluid contained in said shell; sealing means between the roof and the shell, comprising, an up-turned annular trough on the roof, an annular member, of general L-shape in cross-section, fixed to one side of the shell with its stem spaced from the shell so as to form with such shell an upwardly facing annular trough, and a loosely-mounted annular sealing member having two spaced depending flanges one overlying the trough on the roof and the other overlying the trough on the shell, the roof being of such dimensions as to allow it to freely ascend to a level higher than that of the trough on the shell.

11. A tank and roof construction comprising, a shell adapted to contain fluid, a roof freely receivable in said shell and adapted to overlie, and float upon, fluid contained in said shell, and sealing means between the roof and the shell, comprising, an upwardly facing annular trough on the roof, a plurality of pieces of general L-shape in section, spaced vertically, and each fixed to the shell so as to form with the inner face of the shell an upwardly facing annular trough, said troughs decreasing in width progressively upflange overlying the roof trough, and one relatively short depending flange overlying its shell trough.

12. In a tank for volatile liquids, in combination, a cylindrical shell, an annular member of general L-shape in cross-section, fixed to the shell, and forming with said face, an annular trough adapted to receive a sealing liquid; a separate, freely vertically movable circular cover adapted to float upon liquid contained in the tank and of lesser diameter than that of said annular trough, an annular trough on the cover adapted to receive a sealing liquid; and means for establishing a liquid seal between the trough of the wall and the trough of the cover, which comprises an annular, freely vertically movable, inverted sealing member, U-shaped in cross-section, one leg of which overlies the trough of the wall and the other leg of which overlies the trough on the cover; fixed guide means for the cover, and liquid seal means between the fixed guide means and the cover.

13. A tank and roof construction comprising a shell adapted to contain fluid, a roof adapted to overlie and float upon fluid contained in the shell, sealing means between the roof and the shell, comprising, an upwardly facing annular trough on the roof, a plurality of upwardly facing annular troughs spaced vertically and fixed to the inner face of the shell and decreasing in width progressively upward, and a sealing member for each shell trough each including spaced depending flanges, the spacing of which flanges decreases in width progressively downwardly, each sealing member being telescopically receivable in the one above it.

14. A tank and roof construction comprising, a cylindrical shell adapted to contain fluid, a circular roof adapted to overlie and float upon fluid contained in said shell, sealing means between the roof and the shell, comprising, an upwardly facing annular trough on the roof, a plurality of annular pieces of L-shape in cross-section and fixed to the shell so as to form, with the shell, a plurality of upwardly facing annular troughs, spaced vertically, and decreasing in width progressively upwardly, and an annular sealing piece for each shell trough, including spaced depending flanges, one flange of each sealing piece overlying the roof trough, and the other overlying its shell trough, the roof being of lesser diameter than the inner diameter of any shell trough.

15. A tank and roof construction comprising, a shell adapted to contain fluid, a roof adapted to overlie and float upon the fluid so contained, sealing means between the roof and the shell, comprising an upwardly facing trough on the roof, a plurality of pieces of L-shape in cross-section and fixed to the shell so as to form with such shell a plurality of upwardly facing troughs, spaced vertically, each shell trough being wider than the one immediately above it, and a sealing piece for each shell trough including spaced depending flanges, the spacing of which decreases in width progressively downward.

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