Jan. 6, 1953

A. F. FINO ET AL

2,624,490

OIL TANK

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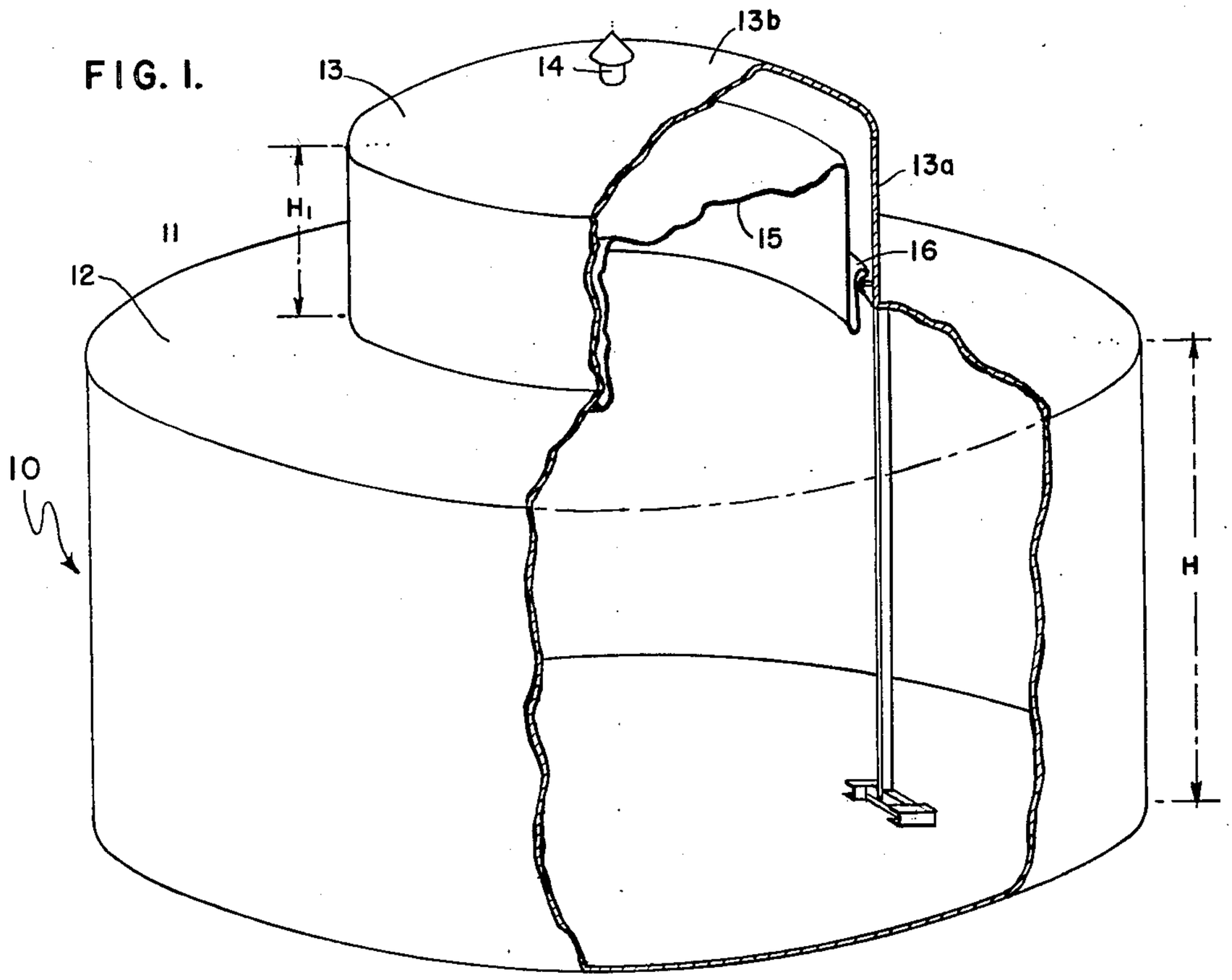
3 Sheets-Sheet 1

FIG. 1.



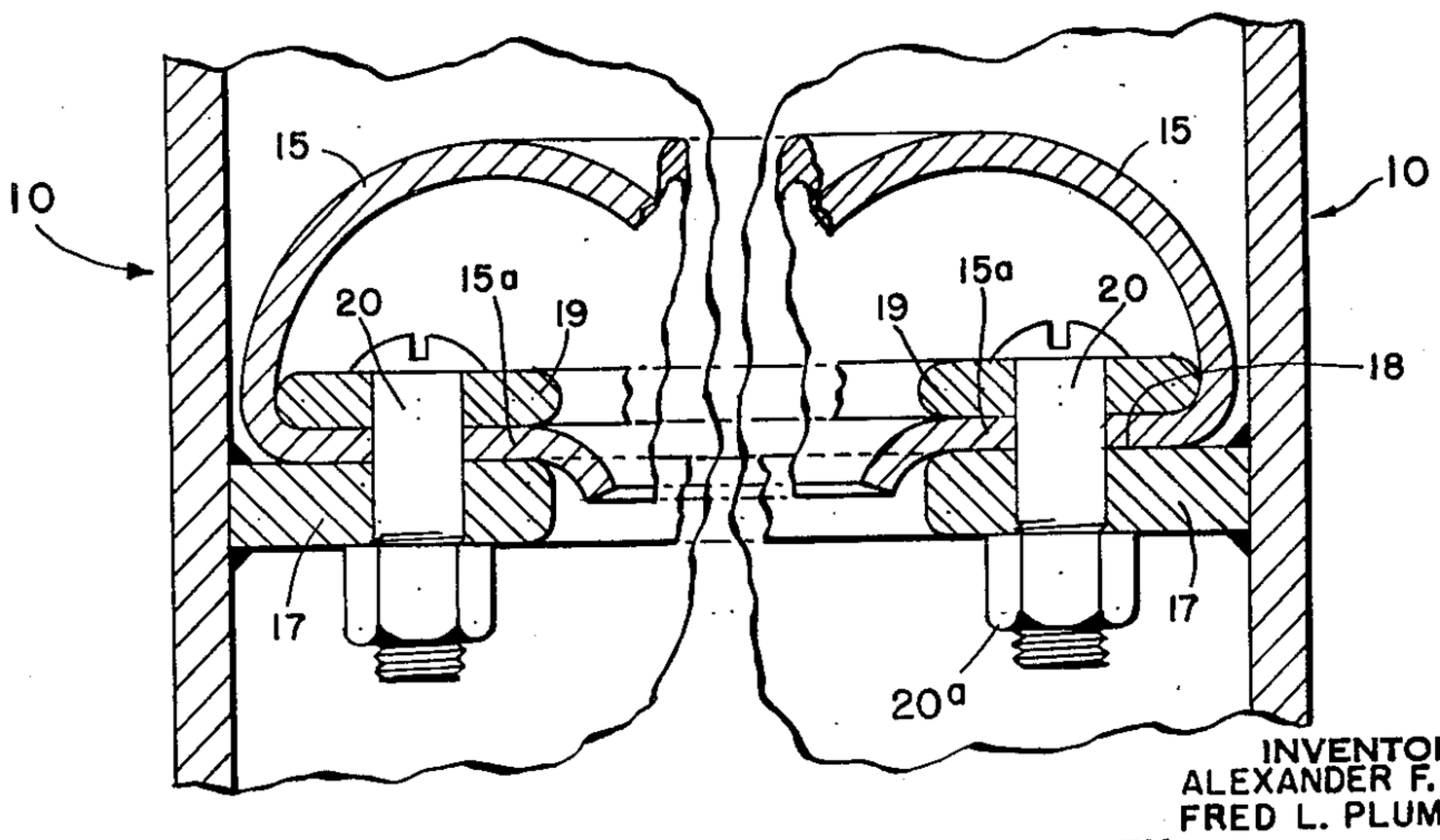


FIG. 2.

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FIG. 3.

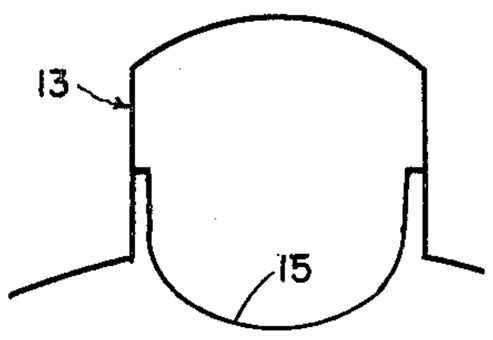


FIG. 4.

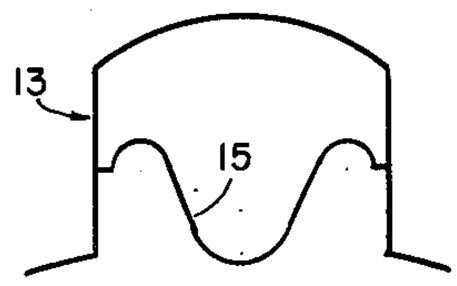


FIG. 5.

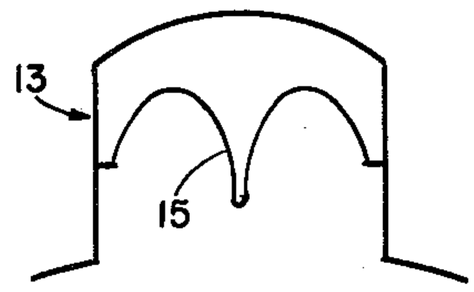
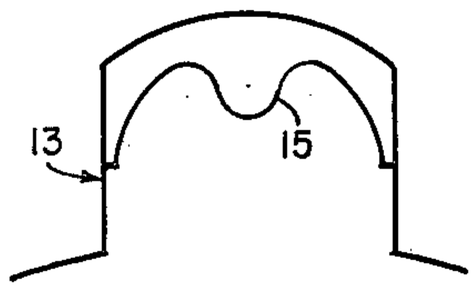


FIG. 6.



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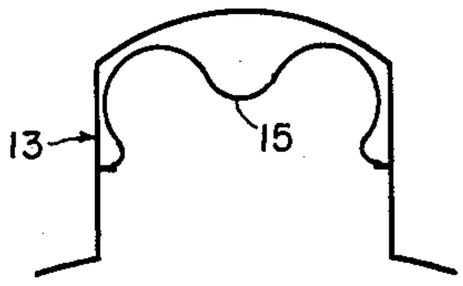

FIG. 8.

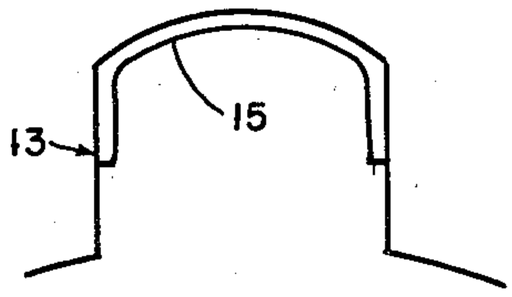

FIG. 9.

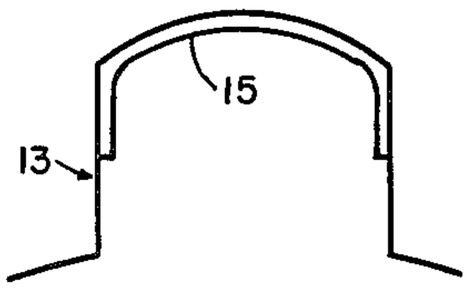

FIG. 10.

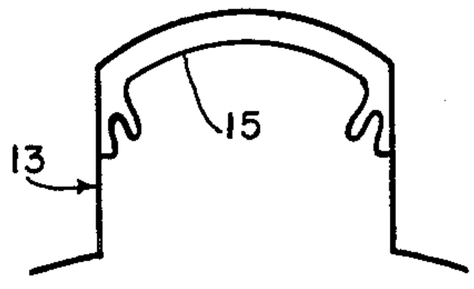

FIG. 11.

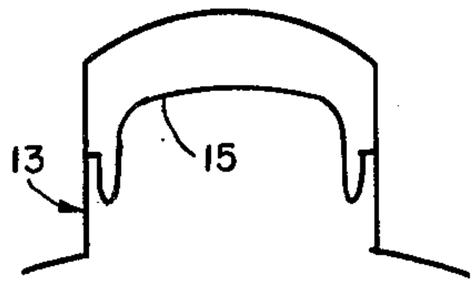

FIG. 12.

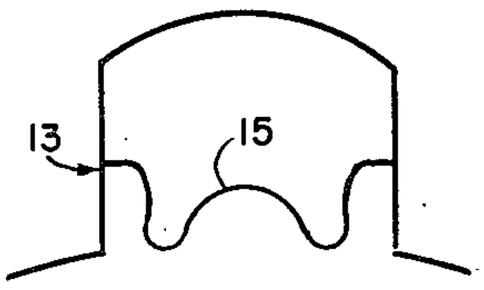

FIG. 13.

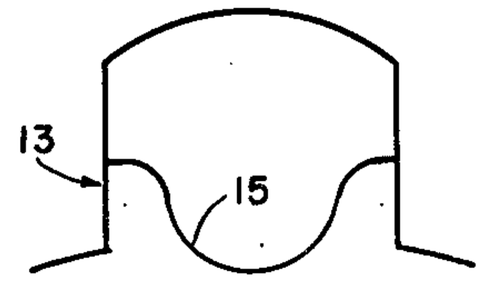

FIG. 14.

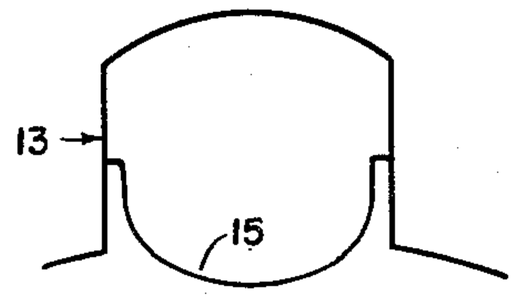

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FIG. 15.

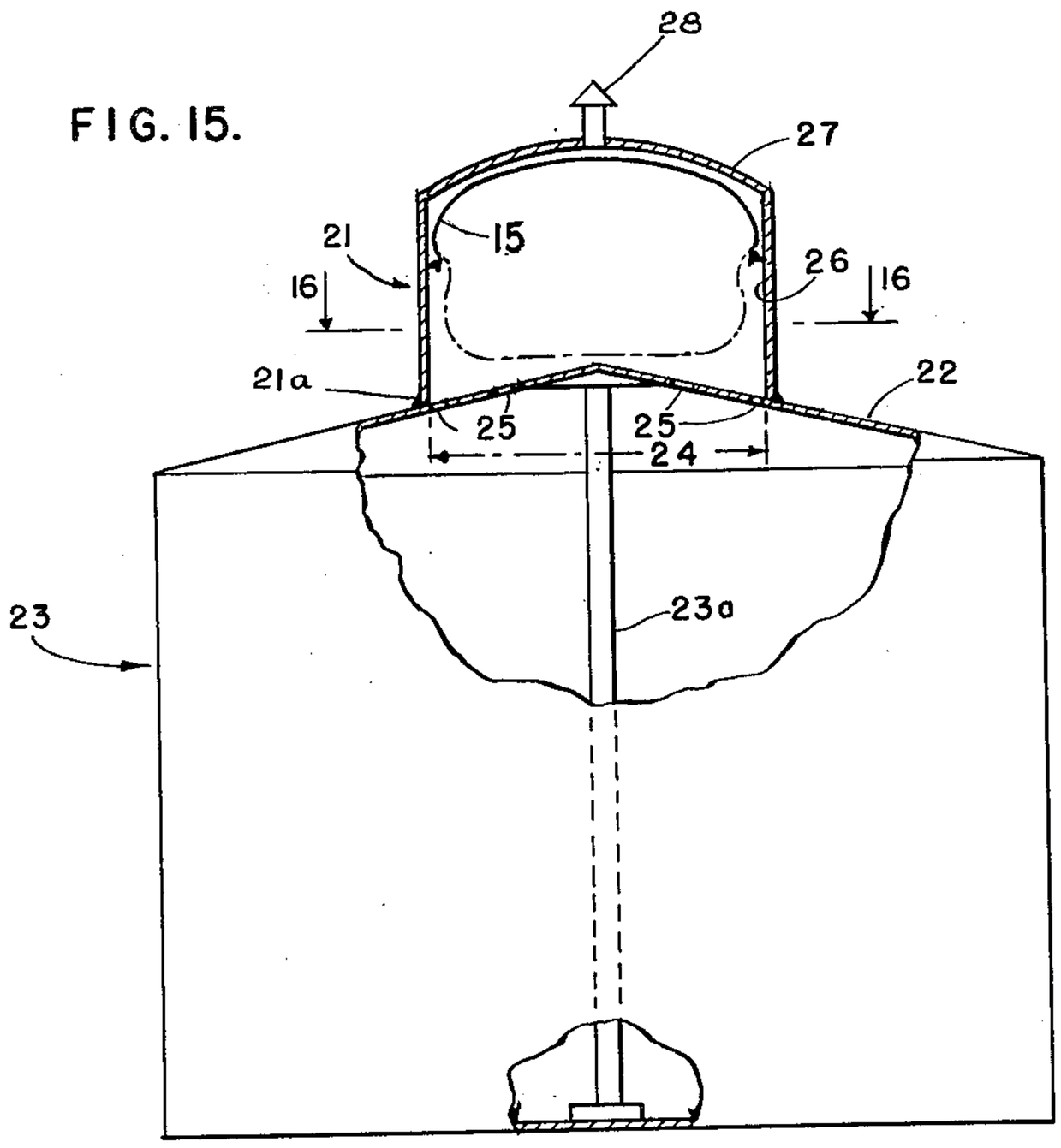


FIG. 15a.

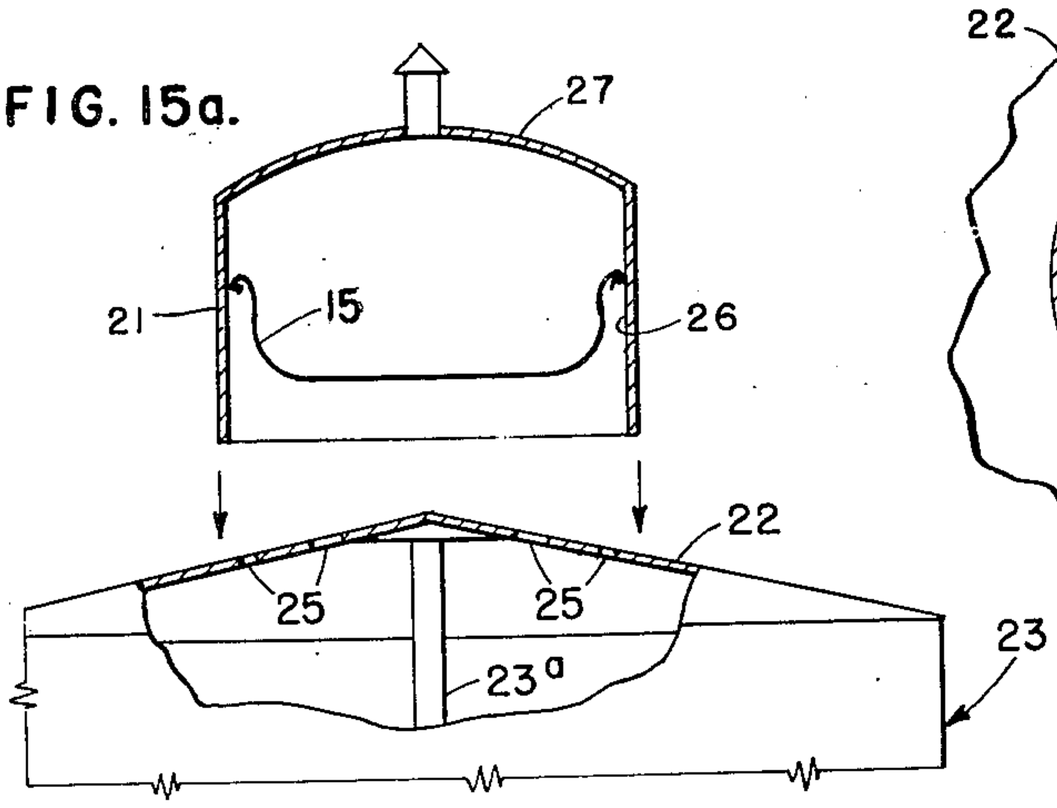
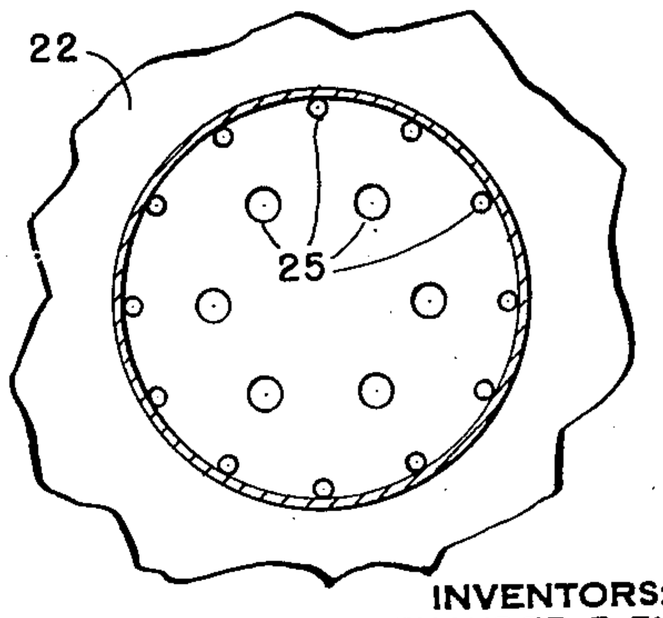


FIG. 16.



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Patented Jan. 6, 1953 2,624,490

UNITED STATES PATENT OFFICE

2,624,490

OIL TANK

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Application March 18, 1950, Serial No. 150,438

1 Claim. (Cl. 220—85)

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This invention relates to closed liquid-storage metallic tanks, adapted for holding a fluctuating amount of volatile liquid, for example high octane gasoline, in such a manner that in spite of the fluctuating outside temperatures with consequent alternate contraction and expansion of the gas or vapor accumulating above the liquid-level, there is rendered unnecessary, except under abnormal conditions, the use of means for venting expanding gas to the atmosphere with the attendant loss of valuable constituents thereof.

There are many existing tanks which cannot now be used for the storage of such gasoline because of such loss through essential vents. So it is an object of this invention to provide ways and means for ready attachment to existing tanks, to render them available for the storage of such gasoline without series vapor losses.

Another object is to make use, in the solving of this problem, of a diaphragm somewhat like that disclosed in copending patent application of Plummer, Serial No. 21,603, filed April 17, 1948, now Patent No. 2,578,090, in which the top face of the stored liquid body in the tank, even though fluctuating, is at all times sealed off against the outer atmosphere by and in contact with a generally bucket-shaped diaphragm or septum of pliable material substantially impervious to gas and liquids, that is at all times in surface contact with the stored liquid, and as a septum separates it from the outer atmosphere. The bucket-shape of such diaphragm comprises a more or less flat bottom portion and a more or less cylindrical wall portion which has its peripheral free edge portion fastened liquid- and gas-tight to the inside of the tank along a horizontal line intermediate the height of the tank wall. A tank of this type may be termed briefly a diaphragm type tank.

According to that copending patent application, when the liquid-level has dropped sufficiently, the diaphragm depending from its wall support assumes its bucket shaped form or contour; but as the level rises the bottom portion of the bucket shape rises therewith with excess material of the diaphragm forming a fold, finally to assume the shape of an inverted bucket. The diameter of the bucket shaped diaphragm is substantially dependent upon and conforms to the basic shape and diameter of the tank, and by necessity requires a round tank to be applied to, and normally it must be made to conform with and fit such a tank especially with respect to the diameter thereof. So it is another object of this invention to re-devise that diaphragm arrangement and its supporting structure so that it can

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be made smaller and then as a unit associated with existing tanks.

It is also among the objects of this invention to provide means or auxiliary structure for making existing tanks into what are in effect diaphragm type tanks, at a minimum of expense yet substantially without reducing the original maximum usable volumetric capacity of the tank.

Another object is to provide means for making tanks into what in effect are diaphragm tanks so that bucket-shaped diaphragms can be utilized whose diameter need not be substantially co-extensive with the diameter of the tank but may be significantly smaller and indeed may be independent of the shape of the main tank.

Still another object is to provide a supplementary structure containing a gas-and-liquid tight bucket-shaped diaphragm, adapted for gas- and liquid-tight attachment to an existing tank for making such tank into what in effect is a diaphragm-type tank.

A further object is to provide improved simple and inexpensive yet effective fastening means for making a liquid- and gas-tight connection between the diaphragm and the tank, that is emplaceable and manipulatable from underneath the diaphragm.

In order to attain some of these objects a diaphragm-containing structure is placed into cooperative relationship with the fixed roof of an existing tank, so that liquid from the tank may communicate with the gas-receiving space in that structure. According to one embodiment, such structure may be fixedly provided upon the tank; according to another embodiment it may be substantially separate from the tank although having communication or transfer connection therewith.

Other objects especially regarding improved fastening means for the diaphragm are attained by providing a horizontal annular ledge along the inner face of what in effect is a vertical tank wall and providing hold-down means for fastening the peripheral edge portion of the diaphragm to the top face of the ledge in such a manner that the edge of the diaphragm points inwardly and away from the wall.

According to one feature this invention provides that a hood or dome be provided upon the top of the roof of an existing tank, and having mounted in it a bucket-shaped flexible diaphragm; or else that a smaller central dome-shaped portion rise vertically from a surounding larger annular roof portion, with a bucket-

shaped flexible diaphragm mounted within the dome-shaped portion.

According to another feature a diaphragm-containing dome is provided upon a fixed roof structure of a closed tank, and the roof portion covered by the dome is provided with fluid passage openings. This arrangement allows for a central supporting column for the fixed roof.

According to still another feature, the means for fastening the peripheral edge portion of the diaphragm to tank wall comprises an annular ledge extending inwardly from the tank wall, a hold-down strip extending along and upon the top face of the ledge for holding down upon the ledge the edge portion of the diaphragm in such a manner that the diaphragm edge extends inwardly away from the tank wall, and screw bolts passing through the assembly of hold-down strip, diaphragm, and ledge for tightening them together, whereby the assembly and connection of parts can be manipulated from underneath the diaphragm.

Other features and advantages will appear as the specification proceeds.

With the above and other objects in view, the invention consists in the construction and novel combination and arrangement of parts hereinafter fully described, illustrated in the accompanying drawings and pointed out in the claim hereto appended, it being understood that various changes in the form, proportions, and minor details of construction, within the scope of the claim or equivalents of its requirements, may be resorted to without departing from the spirit or sacrificing any of the advantages of the invention.

In the drawings:

Fig. 1 is a part-sectional view of an embodiment of a tank equipped with a dome containing a bucket-shaped diaphragm, with the dome constituting a corresponding break or step in the roof of the tank;

Fig. 2 is a greatly enlarged sectional detail view of the improved fastening means for the diaphragm;

Figs. 3 to 8 illustrate diagrammatically stages of progressive deformation of the diaphragm when due to a rising liquid level, starting with the diaphragm in normal bucket-shape and ending with the bucket-shape inverted;

Figs. 9 to 14 illustrate diagrammatically the stages of progressive deformation of the diaphragm when due to a falling liquid level, starting with the diaphragm extended to its inverted bucket-shape and ending with the normal bucket-shape restored;

Fig. 15 is a part-sectional elevational view of an embodiment of a tank in which the roof of the tank itself is substantially unbroken by the dome except for fluid passages provided in that roof portion that is covered by the dome;

Fig. 15*a* is an exploded view, partly in section, of the dome and a fragment of the tank shown in Fig. 15; and

Fig. 16 shows a section taken through the dome on line 16—16 of Fig. 15.

The embodiment in Figure 1 comprises a round tank 10 of a height H, having a fixed roof 11 comprising a substantially horizontal or shallow conical annular portion 12 and a central dome 13 of a height H_1 provided with a top vent 14. The dome comprises a cylindrical vertical wall portion 13[a] and a convexly shallow top portion 13[b], the inner face of the cylindrical portion having fastened thereto a bucket-shaped diaphragm 15 herein also termed a bladder or lung. That

is to say, the diaphragm is peripherally fastened to the inner face of the dome as at 16, the fastening means being more particularly shown in the enlarged detailed Figure 2. The fastening means comprise an annular ledge 17 extending in a horizontal plane and fastened as by welding to the inner face of the dome 13. This ledge presents a horizontal top face 18 upon which is held the peripheral edge portion 15[a] of diaphragm 15 in such a manner that the outer face of that edge portion engages the top face of ledge 17 with the edge portion itself pointing inwardly and away from the inner face of the dome. Hold-down means for maintaining this edge portion 15[a] tightly engaged upon and fastened to the ledge are shown to comprise a flat clamping member 19 and bolts 20 having nuts 20[a] at the lower end and thus accessible from the underside of the diaphragm.

Figures 3 through 8 indicate diagrammatically successive phases or conditions of progressive deformation of the diaphragm 15, namely, from its initial complete upright bucket shape in Figure 3 to its complete inverted bucket shape in Figure 8. Such inversion of the bucket shape takes place due to the expansion of the vapors from the fluid contents of the tank and it compensates for what otherwise would manifest itself as increased vapor pressure which may otherwise require venting of such vapors from the tank.

Figures 9 through 14 illustrate the process in reverse, namely, the condition where the vapor volume shrinks so that the complete inverted bucket shape in Figure 9 reverts to its complete upright bucket shape in Figure 14.

The Figure 15, 15*a*, 16 embodiment shows an auxiliary chamber or dome 21 applied to the fixed shallow conical roof 22 of a tank 23, the roof being supported by a central column 23[a] within the tank. The dome 21 is welded to the tank roof as at 21[a] and houses a bucket-shaped diaphragm D peripherally fastened to the inner face of the dome in a vapor-tight manner substantially similar to that shown in detailed Figure 2. The central portion 24 of the roof that is the portion which is overlain by the dome has communicating openings 25 (see also Figure 16) through which vapor from the liquid stored in the tank may pass to and from the dome 21 in accordance with deformations or movements of the diaphragm D. The dome 21 comprises a cylindrical or vertical portion 26 and a convexly-shaped shallow top portion 27, a vent 28 being provided in the top portion of the dome.

The significance of the Figure 15 embodiment is more clearly illustrated in Figure 15*a* showing the dome 21 inclusive of the diaphragm D detached as a unit from or about to be positioned upon the fixed roof on an existing tank, the roof being unchanged except for the provision of vapor passage openings shown at 25 within the central area 24 of the roof.

What we claim is:

A liquid storage tank for volatile liquids comprising a closed cylindrical wall and a closed bottom attached thereto, a round top attached to the upper part of the wall, a plurality of openings in the top adjacent the center thereof, a cylindrical wall extension affixed to the top adjacent the center thereof and surrounding the openings, the extension being of considerably less diameter than the wall of the tank, an annular ledge affixed to the interior of the extension intermediate the height thereof and extending inwardly therefrom in a horizontal direction, a flexible diaphragm of circular formation com-

pletely housed within the extension at all times and shaped into the form of a bucket with a bottom adapted due to fluctuation in fluid pressure thereon to freely rise and fall past the inner edge of the ledge while unrestricted against fold-forming pressure that foldingly reduces the effective diameter of that bottom as it passes the ledge, the diaphragm having a free edge, a circular ring clamping the free edge of the diaphragm against the ledge, that part of the diaphragm adjacent the clamped portion overlying the ring when the center portion has fallen past the ring and ledge, the openings in the top of the tank providing fluid communicaion between the tank and that part of the extension that is beneath the diaphragm irrespective of the position of its bottom.

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FRED L. PLUMMER.

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