Sept. 30, 1958 H. H. LEE 2,854,223

FLOATING ROOF TANKS

Filed April 25, 1956 2 Sheets-Sheet 1

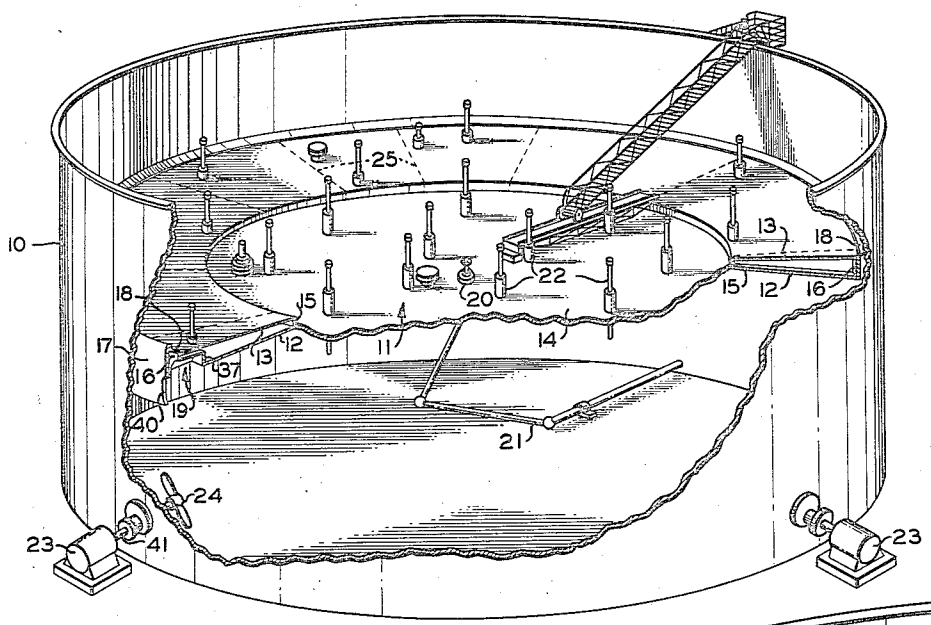


FIG. 1.

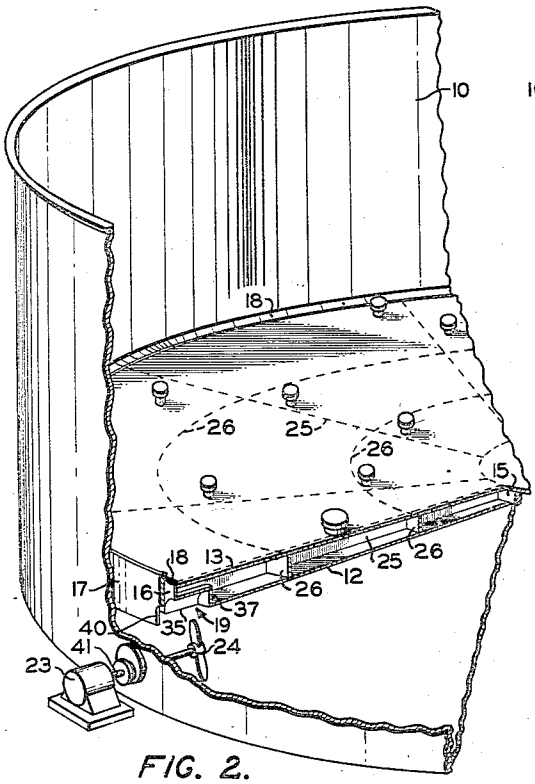


FIG. 2.

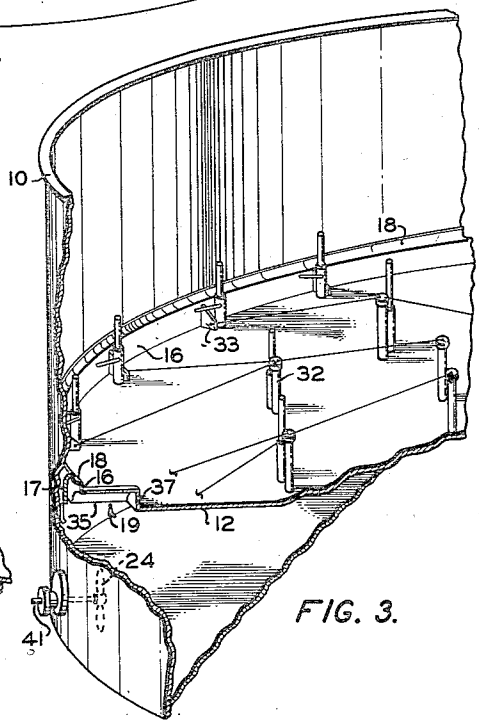


FIG. 3.

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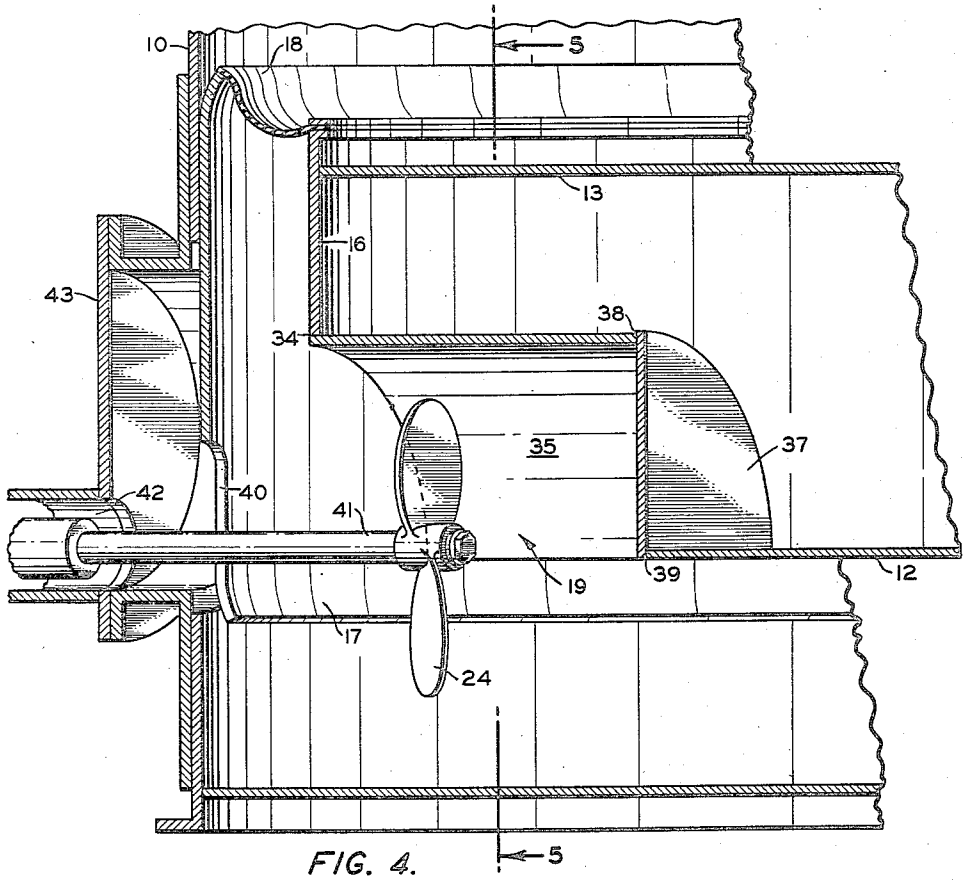


FIG. 4.

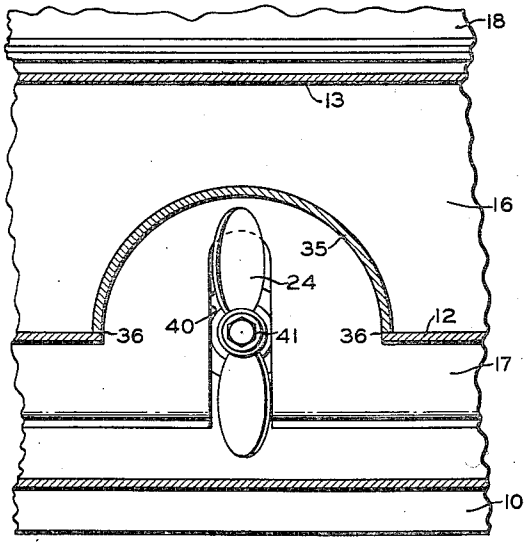


FIG. 5.

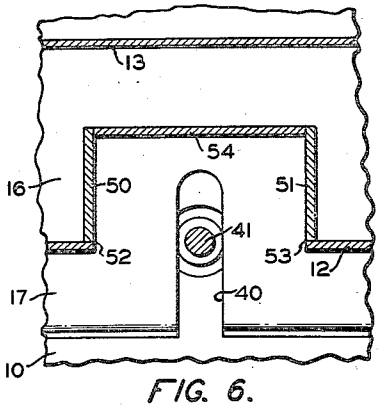


FIG. 6.

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2,854,223

FLOATING ROOF TANKS

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Application April 25, 1956, Serial No. 580,480

7 Claims. (Cl. 259—109)

This invention relates to floating roof tanks. In one aspect this invention relates to an improved floating roof for a floating roof tank. In another aspect this invention relates to an improved floating roof adapted to be employed in a tank equipped with mixing means.

Floating roof tanks are widely employed in the petroleum industry for the storage of volatile liquids. In such tanks, the roof normally floats on top of the stored liquid and is raised or lowered as the liquid is pumped into or removed from the tank. Floating roof tanks are very efficient in reducing evaporation losses and in reducing fire hazards. In general, floating roof tanks can be divided into three types, i e., (*a*) pan type, (*b*) double deck type, and (*c*) annular pontoon type. A pan type floating roof comprises a single circular deck or plate having a vertical rim at the periphery thereof. A double deck floating roof comprises a circular like pontoon made up of two spaced apart decks or plates joined at their outer peripheries. In such a roof two decks cover the entire surface of the stored liquid. The annular pontoon type of floating roof comprises an annular pontoon ring having spaced apart upper and lower decks or plates and a center section of a single deck or plate. The annular pontoon ring is positioned on the outer portion of the floating roof.

Floating roof tanks, while very efficient and widely employed, are relatively expensive to construct and maintain. Therefore, it is desirable to employ each tank to its maximum storage capacity. In the operation of such tanks, it is not desirable to empty the tank to the point where the roof no longer floats, i. e., it is resting on the roof supports, because to do so exposes the surface of the stored liquid and the advantages of the tank are, to a large extent, lost. It is common practice to employ floating roof tanks for blending as well as for storage. When this is done some type of mechanical mixing means, such as a rotating propeller mounted on a shaft extending through the shell of the tank, is frequently employed, in combination with the tank. This practice reduces the effective storage capacity of such tanks because obviously, the roof cannot be lowered to a point where it comes in contact with said mixing means because of possible damage to the bottom of the roof or to said mixing means. This problem is particularly important in connection with the double deck and annular pontoon types of tanks because of their widespread use for such practice.

I have found that by providing an upwardly and inwardly extending recess in the outer peripheral portion of the floating roof that the useful capacity of the tank can be appreciably increased. By providing said recess the bottom of the floating roof can be lowered to a point at least even with or below the level of the mixing means. Thus, broadly speaking my invention comprises a floating roof having at least one such recess in the outer peripheral portion thereof.

An object of this invention is to provide increased useful storage capacity in a floating roof tank. Another

object of this invention is to provide an improved floating roof tank. Still another object of this invention is to provide an improved floating roof having a recess in the outer peripheral portion of said roof. Still another object of this invention is to provide an improved floating roof tank equipped with mixing means and equipped with an improved floating roof adapted to be cooperatively positioned with respect to said mixing means so as to increase the effective storage capacity of said tank. Still other aspects, objects and advantages of the invention will be apparent to those skilled in the art upon reading this disclosure.

Thus according to the invention, there is provided a floating roof for a liquid storage tank which comprises a substantially circular-like plate having a vertical rim or wall at its outer periphery, normally resting on top of the stored liquid, and having at least one recess in the outer peripheral portion thereof.

Still further according to the invention, there is provided a blending and storage tank for liquids comprising: a substantially cylindrical outer shell; mixing means extending through said shell into the lower portion of said tank; and a floating roof comprising substantially circular-like plate having at least one recess in the outer peripheral portion thereof, said recess being adapted to receive and surround said mixing means when said roof is lowered into the lower portion of said tank.

The advantages of my improved floating roof will be readily apparent to those skilled in the art in view of this disclosure. For example, when employing my improved floating roof, it is possible to increase the useful storage capacity of the tank, as mentioned above, without sacrificing the advantages of the floating roof. In normal operations of a tank not equipped with my improved floating roof, the contents of the tank cannot be pumped out to a level below about 3 to 6 feet, depending upon the size and type of mixing apparatus employed. When using my improved floating roof, it is possible to pump out the contents of the tank to a level of about 1.5 feet or less. Another advantage of the invention is the increased flexibility in the choice of mixing means. Formerly it was necessary to equip tanks with the smallest possible mixing means and frequently mixing efficiency has been decreased for this reason.

Figure 1 is a perspective view of an annular ring pontoon type floating roof tank equipped with my improved floating roof.

Figure 2 is a perspective view of a double deck pontoon type floating roof tank equipped with my improved floating roof.

Figure 3 is a perspective view of a pan type floating roof tank equipped with my improved floating roof.

Figure 4 is an elevation, partly in cross section, of the lower portion of a floating roof tank illustrating an application of the invention to a pontoon type roof, and the cooperation between the roof and the mixing means of the tank.

Figure 5 is a cross section along the line 5—5 of Figure 4.

Figure 6 is a cross section looking generally in the same direction as in Figure 5 but showing a modification of the invention.

Referring now to the drawings, the invention will be more fully explained. Like reference numerals are employed in all of the drawings where possible to denote like elements. In Figure 1, there is shown a storage tank having a substantially cylindrical shell **10** and a floating roof **11** within said shell. The roof here illustrated is of the annular ring pontoon type. Said roof comprises an annular pontoon having a lower deck or plate **12**, an upper deck or plate **13**, and a center section **14**. Said center section can be an extension of lower

deck or plate **12**. A vertical inner wall **15**, in sealed engagement with said lower plate **12** and said upper plate **13**, is provided at the inner periphery of the annular pontoon. A vertical outer wall **16**, in sealed engagement with said lower plate **12** and said upper plate **13**, is provided at the outer periphery of said annular pontoon ring. Thus, the annular pontoon is defined by plates **12** and **13**, inner wall **15**, and outer wall **16**. Any type of suitable sealing means can be employed to seal the space between the outer periphery of said pontoon and the inner wall of shell **10**. Said sealing means usually comprises a curved shoe **17** adapted to bear against the inner wall of shell **10** and suitably supported from the edge of the pontoon by means, not shown, and a gastight flexible material **18**, such as a treated fabric, connecting the top of said shoe and said pontoon. Various types of sealing means will be well known to those skilled in the art. A recess **19** is provided in the outer peripheral portion of the annular pontoon. Said recess is adapted to receive and surround propeller **24** when the roof is lowered into the lower portion of the tank. Recess **19** will be further described hereinbelow in connection with Figure 4. A drain **20** is provided at the center of said center section **14** and is connected to a hinged drain pipe **21** which extends through shell **10**. Any suitable type of drain mechanism can be employed in this tank or in any of the tanks illustrated herein. Adjustable roof supports **22** of a type well known to those skilled in the art are provided for supporting the roof when it is lowered into its lowermost position. A floating roof is never allowed to come to rest on the tank bottom as this interferes with operation of the inlet and outlet connections and would cause damage to the sealing means such as shoe **17**. The roof supports here illustrated comprise a sleeve attached to the roof and an inner pipe or rod slidably mounted in said sleeve. When liquid is pumped from the tank, the lower end of said rod or pipe comes into contact with the tank bottom and holds the roof above said tank bottom at a desired predetermined distance. Said inner rod can be adjusted to hold said roof at a desired distance above the bottom of the tank by means of pins (not shown) which extend through said sleeve and engage said rod or pipe. Mixing means comprising a motor **23**, shaft **41**, and propeller **24** are provided in the lower portion of the tank. It will be understood that any suitable number of said mixing means can be employed. The actual number will depend upon the size of the tank. Obviously, the number of recesses **19** provided will depend upon the number of mixing means employed.

Figure 2 illustrates an application of the invention to a double deck pontoon type floating roof. The roof here illustrated is of the type employed in large diameter tanks and in addition to the elements described in connection with Figure 1, there are shown circular bulkheads **26** which are employed to increase the stability of the structure. Radial bulkheads **25** are like those in Figure 1 except that they extend from the outer periphery of the pontoon to the center of the pontoon. In smaller tanks, only one or possibly no circular bulkheads **26** would be employed. Likewise, the number of radial bulkheads **25** would be decreased. Said radial and circular bulkheads are employed primarily to stiffen and strengthen the pontoon; however, they also serve to divide said pontoon into a plurality of pontoon compartments. A plurality of pontoon compartments is advantageous in the event of a leak because all buoyancy is not lost as a result of one leak. The roof will continue to float with several compartments flooded. Regardless of the number of compartments, it will be noted that the pontoon as a whole, in either Figure 1 or Figure 2, is defined by inner vertical wall **15**, outer vertical wall **16**, lower plate **12**, and upper plate **13**. While said pontoon has been described as having its inner periphery defined by vertical wall **15**, it will be understood

that the portion within the circumference of inner vertical wall **15** can also be of double deck structure. Usually, however, most of this area is taken up by a manway, not shown.

In Figure 3, the floating roof illustrated is of the pan type and comprises a single substantially circular deck or plate **12** having a vertical rim or wall **16** in sealed engagement with said deck or plate **12** at the outer periphery thereof. Said deck or plate **12** is usually coned slightly downward toward the center and is held to this shape by means of light trusses **32**. Suitable supports **33** are provided at the periphery of said deck **12** to support rim **16**. Any suitable sealing means, such as that previously described, can be employed to seal the space between rim **16** and shell **10**.

In the modification of the invention illustrated in Figures 4 and 5, recess **19** is comprised of an arcuate opening provided in the lower portion of outer wall **16** and an adjoining rectangular opening provided in the outer peripheral portion of lower plate **12**. An arcuate wall member **35** is sealingly engaged to the edge of said arcuate opening at **34** and the horizontal inwardly extending edges of the rectangular opening in lower plate **12** at **36**. End wall member **37**, having an upper arcuate edge in sealed engagement at **38** with the inner edge of said arcuate wall member **35** and a lower straight edge in sealed engagement at **39** with the transversely extending edge of rectangular opening in plate **12**, is provided as the back closure for said recess **19**. Seal shoe **17** is provided with an upwardly extending notch **40** adapted to receive shaft **41** of the mixing means when the floating roof is lowered into its lowermost position as here illustrated. Said shaft **41** supports propeller **24** and extends through opening **42** in manway cover **43** to motor **23**. Any suitable sort of packing material (not shown) can be employed in opening **42**.

Figure 6 illustrates another embodiment of the invention wherein said recess **19** is in rectangular form. In this embodiment, said recess comprises a rectangular opening provided in outer wall **16** and an adjoining rectangular opening provided in the outer peripheral portion of lower plate **12**. Said recess is defined by a first vertical wall member **50** and a second vertical wall member **51**, each sealed to and extending inwardly toward the center of the pontoon from a vertical edge of the rectangular opening in said outer wall **16**. Said wall members **50** and **51** are also in sealed engagement with the inwardly extending horizontal edges of the rectangular opening in plate **12** at **52** and **53**, respectively. A horizontal wall member **54** is in sealed engagement with the top edge of each of said vertical wall members **50** and **51** and the top edge of said opening in said outer wall. A third vertical wall member (not shown) similar to the previously described end member **37** (except that it is rectangular in shape) and having the same function as said member **37** is in sealed engagement with the inner edges of said first and second vertical wall members and the inner edge of said horizontal wall member so as to complete the forming of recess **19**.

While recess **19** has been defined in terms of a wall member, or members, and an end wall member it is within the scope of the invention for the wall member, or members, and the end wall member to be fabricated as one unit or wall member adapted to be sealingly engaged to the provided openings in the wall **16** and plate **12**. For example, referring to Figure 4, arcuate wall member **35** and end wall member **37** could be fabricated as one unit, in which case the joint at **38** would be eliminated.

Ordinary materials of construction can be employed. Usually plate steel is employed, the type depending upon the liquid to be stored. Any suitable method can be employed for sealingly engaging the recess housing to the provided openings in the outer wall **16** and the plate **12**; welding is usually preferred.

While the invention has been described in connection

with floating roofs of the double deck pontoon type, the annular ring pontoon type, and the pan type, it is within the scope of the invention to modify other types of floating roofs so as to provide a recess of the type herein described. These and various other modifications of the invention will be apparent to those skilled in the art in view of the above disclosure.

I claim:

1. A blending and storage tank for liquids comprising: a substantially cylindrical vertical outer shell; mixing means extending through said shell into the lower portion of said tank; and a floating roof within said shell, said roof comprising a substantially circular-like plate having a vertical wall at its outer periphery and having at least one recess in the outer peripheral portion thereof, said recess in said roof being adapted to receive and surround said mixing means when said roof is lowered into the lower portion of said tank.

2. A blending and storage tank for liquids comprising: a substantially cylindrical vertical outer shell; mixing means comprising a shaft extending through said shell into the lower portion of said tank and a propeller mounted on said shaft; a floating roof within said shell, said roof comprising a substantially circular-like plate having a vertical wall at its outer periphery and having at least one recess in the outer peripheral portion thereof, said recess in said roof being adapted to receive and surround said mixing means when said roof is lowered into the lower portion of said tank; and sealing means comprising a shoe attached to said vertical wall and adapted to bear against the inner wall of said shell, said shoe having a vertically extending notch therein adapted to receive said shaft when said roof is lowered into the lower portion of said tank.

3. A floating roof for a liquid storage tank, which comprises: a substantially circular-like plate having a vertical wall at its outer periphery; at least one recess in the outer peripheral portion of said plate, said recess comprising an arcuate opening provided in the lower portion of said wall and a rectangular opening provided in the outer peripheral portion of said plate and being defined by: an arcuate wall member in sealed engagement with the edge of said arcuate opening in said wall and the inwardly extending edges of said rectangular opening in said plate; and an end wall member having an upper arcuate edge in sealed engagement with the inner edge of said arcuate wall member and a lower straight edge in sealed engagement with the inner transversely extending edge of said opening in said plate.

4. A floating roof for a liquid storage tank, which comprises: a substantially circular like plate having a vertical wall at its outer periphery; at least one recess in the outer peripheral portion of said plate, said recess comprising a rectangular opening provided in the lower portion of said wall and a rectangular opening provided in the outer peripheral portion of said plate and being defined by: a first and a second vertical wall member each in sealed engagement with, a first and a second vertical edge respectively of said opening in said wall, a first and a second edge of said opening in said plate, and extending inwardly from said wall toward the center of said plate; a horizontal wall member in sealed engagement with, the top edge of each of said vertical wall members, the top horizontal edge of said opening in said wall, and extending inwardly from said top edge; and a third vertical wall member in sealed engagement with the inner edges of said first and second vertical wall members, said horizontal wall member, and the transversely extending inner edge of said opening in said plate.

5. A floating roof for a liquid storage tank which comprises: a substantially circular air-tight pontoon comprised of spaced apart upper and lower circular-like plates, a vertical outer wall in sealed engagement with said plates at the outer periphery thereof, and a vertical inner wall in sealed engagement with said plates at the inner periphery thereof; at least one recess in the lower outer peripheral portion of said pontoon, said recess comprising an arcuate opening provided in the lower portion of said outer wall and a rectangular opening provided in the outer peripheral portion of said lower plate and being defined by: an arcuate wall member in sealed engagement with the edge of said arcuate opening in said outer wall and the inwardly extending edges of said rectangular opening in said lower plate; and an end wall member having an upper arcuate edge in sealed engagement with the inner edge of said arcuate wall member and a lower straight edge in sealed engagement with the inner transversely extending edge of said opening in said lower plate.

6. A floating roof for a liquid storage tank which comprises: a substantially circular air-tight pontoon comprised of spaced apart upper and lower circular-like plates, a vertical outer wall in sealed engagement with said plates at the outer periphery thereof, and a vertical inner wall in sealed engagement with said plates at the inner periphery thereof; at least one recess in the lower outer peripheral portion of said pontoon, said recess comprising a rectangular opening provided in the lower portion of said outer wall and a rectangular opening provided in the outer peripheral portion of said lower plate and being defined by: a first and a second vertical wall member each in sealed engagement with, a first and a second vertical edge respectively of said opening in said outer wall, a first and a second edge of said opening in said lower plate, and extending inwardly from said wall toward the center of said lower plate; a horizontal wall member in sealed engagement with, the top edge of each of said vertical wall members, the top horizontal edge of said opening in said outer wall, and extending inwardly from said top edge; and a third vertical wall member in sealed engagement with the inner edges of said first and second vertical wall members, said horizontal wall member, and the transversely extending inner edge of said opening in said lower plate.

7. A blending and storage tank for liquids comprising: a substantially cylindrical vertical outer shell; mixing means extending through said shell into the lower portion of said tank; and a floating roof within said shell, said roof comprising a substantially circular-like plate having a vertical wall at its outer periphery and having at least one recess in the outer peripheral portion thereof adapted to receive and surround said mixing means when said roof is lowered into the lower portion of said tank, said recess comprising an arcuate opening provided in the lower portion of said wall and a rectangular opening provided in the outer peripheral portion of said plate and being defined by: an arcuate wall member in sealed engagement with the edge of said arcuate opening in said wall and the inwardly extending edges of said rectangular opening in said plate; and an end wall member having an upper arcuate edge in sealed engagement with the inner edge of said arcuate wall member and a lower straight edge in sealed engagement with the inner transversely extending edge of said opening in said plate.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,854,223 September 30, 1958

Henry H. Lee

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

In the grant, line 1, and in the heading to the printed specification, line 3, name of inventor, for "Henry S. Lee" read -- Henry H. Lee --; column 2, line 23, after "comprising" insert -- a --.

Signed and sealed this 2nd day of June 1959.

(SEAL)
Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents