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FLOATING ROOF DRAIN

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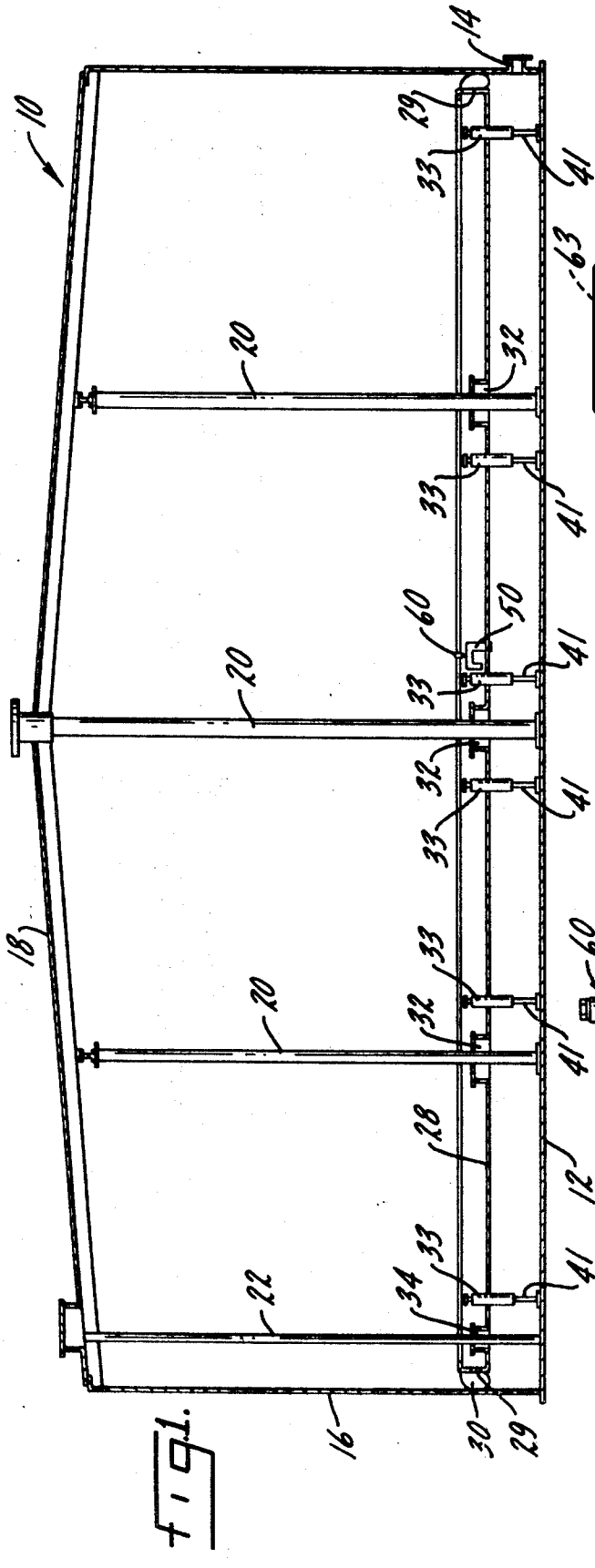


Fig. 1.

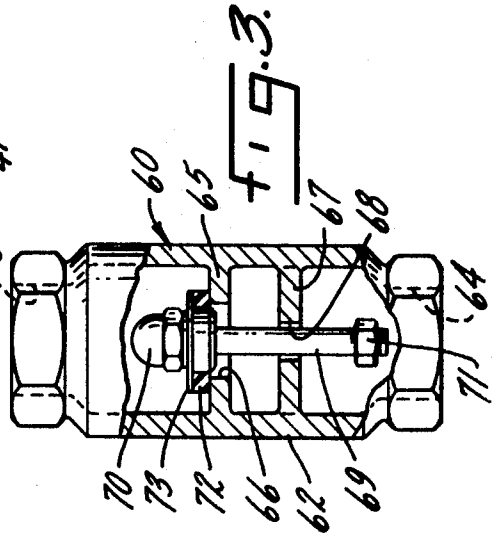


Fig. 3.

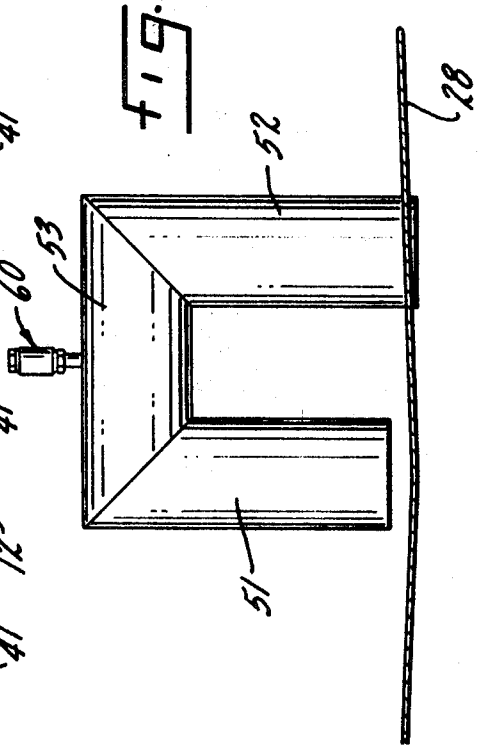


Fig. 2.

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FLOATING ROOF DRAIN

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ABSTRACT OF THE DISCLOSURE

A method and apparatus for removing liquid from a sunken floating roof of a liquid storage tank. The method comprises the steps of: withdrawing liquid from below the sunken floating roof; and siphoning liquid from above the floating roof to below the floating roof when the liquid lever of the tank is below the accumulated liquid above the floating roof. The apparatus includes a generally inverted U-shaped siphon drain having first and second upstanding leg portions connected together at their respective upper ends by a connecting portion; the bottom end of the second portion extends below the roof and the bottom end of the first portion is positioned above the roof. A check valve is attached to the connecting portion to allow trapped air to escape from the pipe only in a vertically upward direction.

BACKGROUND OF THE INVENTION

This invention relates to liquid storage tanks of the type provided with a movable roof or deck which floats upon and is supported by the liquid in the tank. It particularly relates to a method and apparatus which will efficiently and automatically remove liquid from a sunken pan type floating roof without the assistance of personnel entering the tank and without structural damage to the roof.

The roofs in floating roof installations may sink because, for example:

(1) Out-of-roundness of the tank shell due to settlement of the foundation. The pan binds on the shell and tilts as the liquid level changes causing liquid to overflow into the pan.

(2) Improper operation of mixers may throw liquid into the pan.

(3) A rapid insertion of gas-laden liquid under the deck may create tilting due to a gas bubble which binds the pan to the tank shell causing liquid to over-flow the pan.

(4) Rain water may accumulate in the pan. In short, the roof will sink whenever the weight of the roof plus liquid accumulated in the pan is greater than the weight of a volume of liquid equal to the volume displaced by the roof.

The floating roof frequently has support legs to support the roof on the floor of the tank. These legs, especially in covered floating roof tanks, are not designed to support any load except the weight of the pan and a few inches of liquid standing above the pan. Since the rim of the pan is about 15 inches high, it is possible for a 15 inch liquid level to form on the pan when the pan is on its legs on the floor of the tank. This amount of liquid will do no harm as long as it is balanced by a counter pressure of liquid underneath the pan. But, when liquid is withdrawn from the tank to allow workers to repair the tank and the sunken roof, then the liquid underneath the pan must be removed, thus resulting in an unbalanced force of 15 inches of liquid above the pan which cannot normally escape. The economically designed legs cannot support the roof and such liquid and will fail.

In the past, two methods have been used to unload product from the pan of a sunken roof. First, a hot tap may be made into the tank shell through a welded fitting and the product then removed by a suction apparatus. Second, a workman may walk onto the sunken roof with an oxygen mask to manually remove the drain plug, which is located in the center of the roof for this type of emergency use. Both of these methods are hazardous, costly and require experienced personnel. Thus, a simple, safe, economical method and apparatus for removing the liquid product from above the roof is required.

SUMMARY OF THE INVENTION

Therefore, one object of this invention is to provide a method of removing liquid from a sunken pan type floating roof that is simple, safe, and economical.

Another object is to provide a method of removing liquid from a sunken pan type floating roof without causing structural damage to the floating roof.

A further object is to provide an apparatus which will efficiently and automatically remove liquid from a sunken pan type floating roof without the assistance of personnel entering the tank and without structural damage to the floating roof.

To attain these and other objectives the present invention provides a novel method and apparatus to remove the accumulated liquid from the roof pan automatically at the same time the liquid is being removed from below the pan. The invention utilizes the theory of an ordinary siphon. A siphon is a pipe or tube bent to form two legs of unequal length, by which a liquid can be transferred to a lower level, over an intermediate elevation, by atmospheric pressure forcing the liquid up the shorter branch of the pipe immersed in it, while the excess of weight of the liquid in the longer branch (when once filled) causes a flow. Trapped air or other gas present within the pipe will prevent flow of liquid unless there is provision for removing the air.

The present method comprises the steps of: withdrawing liquid from below the sunken floating roof; and siphoning liquid from above the floating roof to below the floating roof when the liquid level in the tank is below the accumulated liquid above the floating roof. The rate of liquid flow from below the floating roof should be equal to or less than the rate of liquid flow being siphoned from above the floating roof to below the floating roof.

Apparatus to facilitate the above-mentioned liquid removal method provides a generally inverted U-shaped siphon drain having first and second upstanding leg portions connected together at their respective upper ends by a connecting portion; the bottom end of the second portion extends below the roof and the bottom end of the first portion is positioned above the roof. A check valve is attached to the connecting portion to allow trapped air to escape from the pipe only in a vertically upward direction.

DESCRIPTION OF THE DRAWING

The invention, both as to its organization and method of operation, taken with further objects and advantages thereof, will best be understood by reference to the following description taken in conjunction with the accompanying drawing, in which:

FIG. 1 is a cross-sectional view of a storage tank embodying the features of the present invention, illustrating the floating roof in its sunken position;

FIG. 2 is an enlarged fragmentary cross-sectional view of an embodiment of the storage tank of FIG. 1, illustrating the siphon drain of the instant invention and

FIG. 3 is an enlarged plan view, partially broken away, of the check valve of the instant invention.

DISCLOSURE OF THE INVENTION

Referring now to the drawings, and more particularly to FIG. 1, there is illustrated a closed storage tank of the floating roof type identified generally by reference numeral **10**. The storage tank **10** serves to store liquid, for example, petroleum products, which is fed to and withdrawn from the tank **10** through shell nozzle **14** which communicates with the lower portion of the tank **10**.

The tank **10** includes a circular floor **12** which is located on the ground and a generally cylindrical shell **16** extending upwardly from the periphery of the floor **12**. The shell **16** supports the edge of a fixed roof **18** that has an upwardly extending conical shape. In addition to the shell **16**, vertical support columns **20** extending upwardly from the floor **12** may be employed to internally support the fixed roof **18**.

For purpose of preventing the volatilization of the liquid stored in the tank **10** and, further, for the purpose of maintaining any vapor adjacent to the liquid, a floating roof **28** floats on and extends over substantially the entire surface of the liquid. As is known to those skilled in the art, the floating roof **28** moves vertically within the storage tank **10** as the level of the liquid within the tank **10** changes. To prevent vapor loss, a conventional resilient sealing arrangement **30** is supported from the periphery of floating roof **28** so as to frictionally engage the shell **16**, irrespective of the position of the floating roof **28** within the tank **10**. The floating roof **28** is suitably apertured, as indicated by reference numeral **32**, to accommodate support and guidance columns **20** and is suitably apertured, as indicated by reference numeral **34**, to accommodate the ladder **22**. Conventional sealing arrangements (not shown) are provided on the floating roof **28** to respectively coact with the columns **20** and ladder **22** for purpose of preventing vapor loss.

The specific construction of the floating roof **28** in general is immaterial to the instant invention. The floating roof **28** is a simple pan, having a rim **29** about 15 inches high, that floats on the surface of the liquid product. Supporting the floating roof **28** above the floor **12** during the start-up, cleaning operations, and repair operations are support means **41**. Support means **41** are affixed to roof **28** through sleeves **33** and are economically designed not to support any load except the weight of the roof and a few inches of liquid standing above the pan.

For reasons previously discussed liquid will occasionally accumulate on the roof causing same to sink to the bottom of the tank. It then becomes necessary to remove all the liquid from the tank for repair purposes. After sinking, the floating roof, including the liquid contained thereabove, is supported on the floor of the tank by support means **41**. Support means **41** will support the sunken roof as long as it is balanced by a counter pressure of liquid in the bottom of the tank underneath the pan. But when liquid is withdrawn from the tank to allow workers to repair the tank and sunken pan, then the liquid underneath the roof must be removed, thus resulting in an unbalanced force of about 15 inches of liquid above the pan which cannot normally escape. This causes the legs **41** to fail.

The present invention provides a method of removing the liquid from the tank without increasing the resultant downward force on the roof supporting means. Liquid is withdrawn from the tank at the standard withdrawal rate through the shell nozzle **14**, which is below the roof, until the level reaches down to approximately 1 inch below the top of the rim **29** of the floating roof. At this time the withdrawal rate is decreased and liquid is siphoned from above the floating roof to below the floating roof until the roof is substantially cleared of liquid. The withdrawal rate is decreased in order to prevent liquid from being withdrawn from below the floating roof at a greater rate than liquid being siphoned from above to below the floating roof. If a 6 inch standard pipe siphon is employed the withdrawal rate is decreased to approximately 220 barrels/hr. Should a different size siphon be used then the withdrawal rate has to be changed to make certain that the withdrawal rate is equal to or less than the rate in which liquid is siphoned from above to below the floating roof. By so regulating the withdrawal rate and siphon rate, structural damage to the floating roof, caused by an unbalanced downward force of accumulated liquid in the pan, is eliminated. The withdrawal rate may be increased to the standard withdrawal rate after the accumulated liquid is removed from above the roof.

Referring now to FIGS. 1 and 2, the preferred embodiment of the present invention includes apparatus having a siphon drain **50** fabricated from 6 inch standard pipe and mitered at two joints to form an inverted U shaped pipe. Siphon drain **50** has first and second upstanding leg portions **51** and **52** respectively connected together at their respective upper ends by a connecting portion **53**. The bottom end of leg portion **52** extends through and below floating roof **28**. Leg portion **51** is positioned above floating roof **28**. Leg portion **51** is positioned above floating roof **28** with the bottom end being about 2 inches above the deck of the floating roof to enable the siphon drain to flow at full capacity. It should be noted that leg portion **51** is positioned above nozzle **14** thereby allowing liquid exiting from leg portion **52** to be withdrawn through nozzle **14**. Support means **41** insure that leg portion **51** will not fall below nozzle **14**.

A ½-inch check valve **60** is attached to connecting portion **53** in a suitable manner, as by welding, so as to permit fluid communication with siphon drain **50**. As seen in FIG. 3 check valve **60** includes a cylindrical body **62** having open top and bottom ends **63** and **64** respectively. Extending inwardly about the inner periphery of body **62** is horizontal member **65** having an aperture **66** therethrough. Positioned below member **65** is diametrically extending cross bar **67** having an aperture **68** therethrough. Guide pin **69** passes through apertures **66** and **68** and has nut means **70** and **71** at its respective ends. Nut means **71**, being larger in diameter than aperture **68**, prevents the lower end of guide pin **69** from passing completely through aperture **68**. Washers **72** and **73** prevent the upper end of guide pin **69** from passing through aperture **66**. Washer **72** is rubber thereby effecting a seal closing off aperture **66** when valve **60** is in the closed position as illustrated in FIG. 3. As the floating roof **28** sinks, air and liquid are forced upwardly through aperture **66** lifting guide pin **69** and washer **72** and allowing communication between siphon drain **50** and atmosphere. Check valve **60** prevents air pockets from developing in the siphon drain which would prevent the siphon from operating.

In operation, as the floating roof **28** accidentally sinks an air pocket is developed in the top of the siphon drain **50** below check valve **60**. The air is trapped since liquid begins to enter into both ends of leg portions **51** and **52** of the siphon drain; however, check valve **60** quickly allows for this trapped air to escape, therefore making the siphon drain operable immediately after it has sunk below the surface of the liquid. Eventually, floating roof **28** will land on its support means **41** on the tank floor **12**. Liquid is then withdrawn from the tank at the standard withdrawal rate through shell nozzle **14**, until the liquid level reaches down to about 1 inch below the top of the floating roof rim **29**. Liquid passes from above the roof to below the roof through seals **30**, apertures **32** and sleeves **33**. At this time the withdrawal rate is decreased to approximately 220 barrels/hr. until the roof is cleared of liquid. Liquid from above the roof automatically flows up leg portion **51**, across connecting portion **53** and down leg portion **52** to below the roof at a rate equal to or less than the withdrawal rate. The approximate time required for unloading the roof would be 8 hours for a 100 foot

diameter tank and 31 hours for a 200 foot diameter tank. This is a small amount of time compared to the amount of time spent in the past repairing damage to a roof that has been overloaded.

As can be appreciated by those skilled in the art, the present invention provides a novel method and apparatus for removing liquid from a sunken floating roof of a liquid storage tank. The invention eliminates the need for personnel entering the tank or damaging the tank shell or floating roof. The method and apparatus for carrying out the method, are safe and may be economically installed on new and existing floating roof storage tanks.

While the embodiment described herein is at present considered to be preferred, it is understood that various modifications and improvements may be made therein, and it is intended to cover in the appended claims all such modifications and improvements as fall within the true spirit and scope of the invention.

What is claimed is:

1. A floating roof storage tank comprising:

(a) a tank shell;

(b) a nozzle means communicating with the lower portion of said tank shell to permit withdrawal of stored liquid;

(c) a roof arranged to float on a product within said tank shell;

(d) support means depending from the bottom of said roof to support said roof on the floor of said tank shell above said nozzle means;

(e) a generally inverted U-shaped siphon drain having first and second upstanding leg portions connected together at their respective upper ends by a connecting portion, the bottom end of said second portion extending below the roof and the bottom end of said first portion being positioned above the roof; and

(f) check valve means attached to said connecting portion to allow air to escape from said drain.

2. A storage tank as in claim **1** wherein said check valve means only allows air to escape in a vertically upward direction.

3. A covered floating roof storage tank comprising:

(a) an upwardly extending generally cylindrical tank shell, having a generally circular floor portion secured about its lower periphery and a fixed roof extending about its upper periphery;

(b) a nozzle means communicating with the lower portion of said tank shell to permit withdrawal of stored liquid;

(c) support columns extending between said floor portion and said fixed roof;

(d) roof means adopted to float on liquid product within said tank shell, said roof means having an upwardly extending rim portion about its periphery, said roof means further having apertures therein to receive said support columns;

(e) a generally inverted U-shaped siphon drain positioned above said roof means having first and second upstanding leg portions connected together at their respective upper ends by a connecting portion, the bottom end of said second portion extending through an aperture in said roof means below said roof means and the bottom end of said first portion being positioned above said roof means; and

(f) check valve means attached to said connecting portion to allow air to escape from the drain.

4. A storage tank as in claim **3** wherein support means depend from the bottom of said roof to support said roof on the floor of said tank shell above said nozzle means.

5. A storage tank as in claim **3** wherein the bottom end of said first portion is approximately 2 inches above said roof means to enable the siphon to flow at a high capacity.

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