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 level of the pan 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 second 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.

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 along a side wall 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 allow 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.
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, gasoline, 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 purposes 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 coat 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 of approximately 220 barrels/hr., which is below the withdrawal rate 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 on the 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 51 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 66. Washers 72 and 73 prevent the upper end of guide pin 69 from passing through aperture 66. Washer 72 is retained in the body by 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 fails 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 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 is automatically removed by 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 se-
cured 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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