

A VACUUM BREAK VALVE STRUCTURE

FIELD OF INVENTION

The present invention relates broadly to a vacuum break valve structure for an internal floating cover of a liquid storage tank and a method for preventing negative pressure buildup on an underside of an internal floating cover in a liquid storage tank.

BACKGROUND

Storage tanks are in common use at storage terminals or processing plants where huge stockpiles of liquid raw materials are necessary for their continuous operations. These storage tanks usually use leg supported or roof hung internal floating covers (IFCs) that move as the liquid levels change. These covers provide protection against contamination to/from the external environment or weather and against evaporation losses. When the liquid is drained from the storage tank, the IFC moves down with the decreasing liquid level.

The final height of the leg supported IFC in the storage tank is determined by the length of the leg supports. For ease of maintenance, the final height is typically about 1.8 m to about 2.5 m in order to accommodate workmen while the storage tanks are empty. When the liquid is drained from the storage tank, the IFC moves down and a stem of a vacuum break valve structure disposed in the IFC being longer in length than the leg supports will engage the tank floor first. The vacuum break valve structure is then lifted or opened before the IFC reaches the final height to prevent negative pressure build-up at the underside of the IFC. However, during the refilling of the liquid, the vacuum break valve structure would remain open until the liquid level reaches about 1.8 m to about 2.5 m before the vacuum break valve structure is closed. This not only affects the quality of the liquid in the storage tanks, but also provides a source of contaminant to the environment.

On the other hand, the final height of the roof hung IFC in the storage tank is determined by the length of suspension elements. The roof hung IFC is secured to the roof of the storage tank with a plurality of the suspension elements. The suspension elements are connected to a beam structure and the length of the suspension elements is controlled outside the storage tanks using a plurality of control mechanisms. As such, it is possible to lower the roof hung IFC to a very low level, e.g. about 50 cm, as the liquid is drained from the storage tank. The roof hung IFC can be raised for maintenance. The roof hung IFC typically comprises a floating trap door, which is hinged to the IFC. The floating trap door opens under gravity when the liquid level drops below the height of the roof hung IFC. However, the floating trap door may fail to open if the hinge fails to operate freely due to e.g. weathering such as corrosion etc.

Hence, there is a need to provide a vacuum break valve structure which seeks to address at least one of the above-mentioned problems.

SUMMARY

In accordance with a first aspect of the present invention, there is provided a vacuum break valve structure for an internal floating cover of a liquid storage tank, the vacuum break valve structure comprising: a valve seat connected to said cover and defining an opening through said cover; a float valve not connected to the valve seat and disposed for substantially free movement under buoyancy between an open state and a closed state; wherein in the closed state the float valve contacts the valve seat and in the open state there is a passageway between the float valve and the valve seat.

The vacuum break valve structure may further comprise a frame structure connected to, and extending through the cover, wherein the valve seat is connected to the frame structure and the float valve is disposed within the frame structure for the substantially free movement under buoyancy between the open state and the closed state.

The vacuum break valve structure may further comprise float valve stoppers disposed on the frame structure for preventing the float valve from moving out of the frame structure.

Each float valve stopper may comprise a longitudinal member disposed across the frame.

The vacuum break valve structure may be secured to a rim portion of the frame structure with a gasket disposed there between.

The frame structure may be dimensioned to function as a manhole for accessing said storage tank through said cover.

The float valve may comprise an annular seat surface disposed near an edge of the float valve for contacting a corresponding annular seat surface of the valve seat.

An airtight and liquid tight seal may be provided in the closed state.

Said cover may comprise a leg supported cover or a roof hung cover.

The float valve and the valve seat may be removable to provide access to said storage tank.

In accordance with a second aspect of the present invention, there is provided a method for preventing negative pressure buildup on an underside of an internal floating cover in a liquid storage tank, the method comprising the steps of: connecting a valve seat to said cover, the valve seat defining an opening through said cover; and disposing a float valve for substantially free movement under buoyancy between an open state and a closed state, the float valve not being connected to the valve seat; wherein in the closed state the float valve contacts the valve seat and in the open state there is a passageway between the float valve and the valve seat.

The method may further comprise the steps of: connecting a frame structure to the cover, the frame structure extending through the cover; connecting the valve seat to the frame structure; and disposing the float valve within the frame structure for the substantially free movement under buoyancy between the open state and the closed state.

The method may further comprise disposing float valve stoppers on the frame structure for preventing the float valve from moving out of the frame structure.

The method may further comprise securing the valve seat to a rim portion of the frame structure with a gasket disposed there between.

The method may further comprise dimensioning the frame structure to function as a manhole for accessing said storage tank through said cover.

The method may further comprise disposing an annular seat surface of the float valve near an edge of the float valve for contacting a corresponding annular seat surface of the valve seat.

The method may further comprise providing an airtight and liquid tight seal in the closed state.

The method may further comprise removing the float valve and the valve seat to provide access to said storage tank.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will be better understood and readily apparent to one of ordinary skill in the art from the following written description, by way of example only, and in conjunction with the drawings, in which:

Figure 1a shows a schematic drawing of a tank with a roof hung internal floating cover (IFC) and incorporating a vacuum break valve structure according to an embodiment;

Figure 1b shows a schematic drawing of the tank of Figure 1a at a lower liquid level.

Figure 2 shows a cross sectional view of the vacuum break valve structure according to the embodiment;

Figure 3 shows a cross sectional view of a float valve stopper of the vacuum break valve structure of Figure 2;

Figure 4a shows a top view of a manhole of the vacuum break valve structure of Figure 2;

Figure 4b shows a cross sectional view of the manhole along line A-A of Figure 4a;

Figure 5a shows a top view of a valve structure seat of the vacuum break valve structure of Figure 2;

Figure 5b shows a cross sectional view of the valve structure seat along line B-B of Figure 5a;

Figure 6a shows a top view of a float valve of the vacuum break valve structure of Figure 2;

Figure 6b shows a cross sectional view of the float valve along line C-C of Figure 6a;

Figure 7a shows a top view of the collar of the vacuum break valve structure of Figure 2;

Figure 7b shows a cross sectional view of the collar along line D-D of Figure 7a;

Figure 8 shows a cross sectional view of the vacuum break valve structure of Figure 2 with the float valve, the valve structure seat and the float valve stoppers removed; and

Figure 9 shows a schematic drawing of a tank with a leg supported IFC and incorporating a vacuum break valve structure according to the embodiment.

DETAILED DESCRIPTION

Figure 1a shows a schematic drawing of a system 100 illustrating a vacuum break valve structure 102 disposed in a roof hung internal floating cover (IFC) 104 of a liquid storage tank 106. The IFC 104 is secured to a beam structure 108 of the tank roof 110 with a plurality of suspension elements 112. The suspension elements 112 are coupled to respective control mechanisms 114 such as manual or motor driven rollers for adjusting the length of the suspension elements 112 to adjust the lowest position of the IFC 104 and for lifting the IFC 104 during maintenance. The suspension elements 112 can be, by way of example and are not limited to, chains, cables, wires, ropes or any other similar device capable of supporting the weight of the IFC 104.

When a liquid 116 in the storage tank 106 is at a level 118, the IFC 104 floats on the liquid 116 and the vacuum break valve structure 102 is closed. The suspension elements 112 connecting the IFC 104 and the beam structure 108 are loose. When the liquid 116 is drained from the storage tank 106, the liquid level 118 drops. The IFC 104 moves down with the decreasing liquid level 116 and the vacuum break valve structure 102 remains closed. The suspension elements 112 eventually become taut and stop the IFC 104 from moving downwards. As the liquid level 118 falls below the level of the IFC 104, the vacuum break valve structure 102 opens to prevent a negative pressure building below the IFC 104, as shown in Figure 1b.

When the liquid 116 is supplied into the empty storage tank 106, the IFC 104 remains at a position where the suspension elements are taut and the vacuum break valve structure 102 is opened. As the liquid level 118 rises in the storage tank

106, the vacuum break valve structure 102 eventually closes. As more liquid 116 is supplied, the IFC 104 floats on the liquid 116 and rises with the rising liquid level 118. A more detailed description of the vacuum break valve structure 102 and its function are provided below.

Figure 2 shows a cross sectional view of the vacuum break valve structure 102. In this embodiment, the vacuum break valve structure 102 is substantially cylindrical. The vacuum break valve structure 102 comprises a frame structure in the form of a manhole 202, a substantially truncated conical valve seat 204 and a substantially round float valve 206. The valve seat 204 and the float valve 206 are disposed in the manhole 202. Two float valve stoppers 208 are disposed in respective holes (not shown) on either side of the manhole 202. The number of float valve stoppers may be different in other embodiments. Each of the float valve stoppers 208 comprises a longitudinal member in the form of a pipe 210 and cotter pins 212.

The diameter of the main body of the float valve 206 is smaller than the diameter of the manhole 202, with radially spaced protrusions (not shown in Figure 2) extending from the main body of the float valve 206 towards the wall of the manhole 202 (compare Figure 6a). The protrusions are dimensioned to allow some residual play between the float valve 206 and the wall of the manhole 202, such that horizontal movement of the float valve 206 is advantageously free from frictional resistance and without any mechanical connection to the manhole 202, and thus the IFC 104. Further, the float valve 206 is not connected to the valve seat 204 and the wall of the manhole 202. The float valve 206 is disposed in the manhole 202 for substantially free movement under buoyancy between an open state and a closed state of the vacuum break valve structure 102. Furthermore, the use of the valve seat 204 enables a circumferential sealing surface to be formed at a distance from the inner wall of the manhole 202, thus sealing can be achieved notwithstanding the smaller diameter of the main body of the float valve 206 compared to the manhole 202. Thus, the vacuum break valve structure 102 is advantageously not readily susceptible to weathering of mechanical connections which otherwise can inhibit operation of the break valve such as in existing trap door valves.

Figure 3 shows a cross sectional view of one embodiment of the pipe 210 of the float valve stopper 208. The pipe 210 has a hole 302, which is formed about 20 mm from each respective end of the pipe 210. The hole 302 has a diameter of about 7 mm. The cotter pins 212 (Figure 2) are disposed in the holes 302 to secure the pipe 210 within the manhole 302 (Figure 2). In this embodiment, the pipe 210 can be made of stainless steel. Other materials may be used to manufacture the pipe 210 in different embodiments. The pipe 210 has a length of about 840 mm and has a diameter of about 32 mm. Other dimensions are also possible in different embodiments.

Referring back to Figure 2, a substantially horizontal portion 214 of the valve seat 204 sits on a rim 216 of the manhole 202. A gasket 218 is disposed between the horizontal portion 214 of the valve seat 204 and the rim 216 of the manhole 202. The gasket 218 has a thickness of about 10 mm. In this embodiment, the gasket 218 can be made of neoprene. Other materials can be used for the gasket 218 in different embodiments. The float valve 206 comprises an annular seat surface 220 disposed near an edge of the float valve 206. When a liquid 116 in the storage tank 106 is at the level 118 as shown in Figure 2, the vacuum break valve structure 102 is in a closed position, whereby the seat surface 220 of the float valve 206 contacts the valve seat 204.

When the liquid 116 is discharged from the storage tank 106, the liquid level 118 decreases. The IFC 104 moves down with the decreasing fluid level 118. Since the IFC 104 is connected to the roof of the storage tank 106 by the suspension elements 104, there is a limitation in how far the IFC 104 is able to move down with the decreasing liquid level 118.

When the suspension elements 112 become taut and stop the IFC 104 from moving downwards, the float valve 206 continues to move down due to the weight of the float valve 206 and increasing air pressure. As a result, the vacuum break valve structure 102 is opened. This advantageously prevents negative pressure build-up below the IFC 104. The float valve 206 continues to move down with the decreasing fluid level 118 until the float valve 206 sits on the float valve stoppers 208.

The vacuum break valve structure 102 can be set to operate at any desired height of the IFC 104 by adjusting a length of the suspension elements 104. The vacuum break valve structure 102 works independently of the tank floor and does not need to engage the tank floor to function.

When the liquid 116 is supplied into an empty storage tank 106, the IFC 104 remains at a position where the suspension elements are taut and the float valve 206 sits on the float valve stoppers 208. As the liquid level 118 rises in the storage tank (not shown), the float valve 206 floats on the liquid 116 and rises with the liquid level 118. At a certain liquid level 118, the float valve 206 contacts the valve seat 204. A watertight and an airtight contact is advantageously provided between the float valve 206 and the valve seat 204. An overflow of the liquid, evaporation of the liquid, and possible air pollution are advantageously prevented. As more liquid 116 is added into the storage tank (not shown), the IFC 104 floats on the liquid 116 and rises with the liquid level 118.

The vacuum break valve structure 102 is secured to the IFC 104 by a securing means in the form of a collar 222. One end of the collar 222 is attached to the manhole 202 of the vacuum break valve structure 102 and to the IFC 104 respectively by lamination.

Figure 4a shows a top view of the manhole 202. Figure 4b shows a cross sectional view of the manhole 202 along line A-A of Figure 4a. The manhole 202 is substantially cylindrical. The manhole 202 comprises a substantially vertical main structure 402. The rim 216 of the manhole 202 is disposed at an upper end of the main structure 402. The rim 216 extends substantially perpendicularly from a top of the main structure 402. The rim 216 can include a plurality of holes 404 arranged around the rim 216. The plurality of holes 404 forms a substantially circular shape with a diameter of about 940 mm. The plurality of holes 404 is arranged such that each hole 404 is substantially equidistant from the respective adjacent holes 404. The holes 404 can have a diameter of about 10 mm. Other dimensions are also possible in different embodiments.

Further, the main structure 402 of the manhole 202 comprises four holes 406 (two on each side) for receiving the float valve stoppers 112 (Figure 1). The four

holes 406 can have a diameter of about 37 mm. The four holes 406 are disposed at a height of about 75 mm from a lower end of the main structure 402 opposite to the end having the rim 216. In this embodiment, the distance between the two holes 406 on each side is about 348 mm. Other hole sizes and separation distances are also possible in different embodiments.

Three stoppers 408 are laminated to and disposed around the main structure 402 of the manhole 202. The three stoppers 408 are arranged such that each stopper 408 is substantially equidistant from the respective adjacent stoppers 408. The stoppers 408 are used as jigs for joining the manhole 202 and the collar 222 (Figure 2). Laminating the stoppers 408 can advantageously provide easy adjustment at site. The collar 222 laminate to the manhole 202 eventually covers the stoppers 408, as shown in Figure 2. In this embodiment, the stoppers 408 have a length of about 75 mm, a width of about 10 mm, and a height of about 40 mm. Other dimensions are also possible in different embodiments. The number of stoppers 408 may be different in other embodiments.

In this embodiment, the manhole 202 can be made of Series S1000, S2000 or S3000 and glass reinforcements. Other materials may be used for manufacturing the manhole 202 in different embodiments. In this embodiment, the rim 216 has a width of about 60 mm and a thickness of about 10 mm. The main structure 402 of the manhole 202 can have a height of about 561 mm, an outer diameter of about 890 mm, an inner diameter of about 870 mm and a thickness of about 10 mm. The diameter of the manhole 202, including the rim 216, is about 990 mm. Other dimensions are also possible in different embodiments.

Figure 5a shows a top view of the valve seat 204. Figure 5b shows a cross sectional view of the valve seat 204 along line B-B of Figure 5a. The valve seat 204 includes the horizontal portion 214 having a plurality of holes 502 arranged around the horizontal portion 214. In this embodiment, the plurality of holes 502 forms a substantially circular shape with a diameter of about 940 mm. The plurality of holes 502 is arranged such that each hole 502 is substantially equidistant from the respective adjacent holes 502. The holes 502 have a diameter of about 8 mm. The holes 502 of the horizontal portion 214 correspond with the holes 404 (Figure 4) of

the rim 216 of the manhole 202 for enabling connection of the valve seat 204 and the manhole 202.

To assemble the valve seat 204 and the gasket 218 to the rim 216 of the manhole 202 as shown in Figure 2, respective holes of the horizontal portion 214 of the valve seat 204, the gasket 218 and the rim 216 of the manhole 202 are aligned and fasteners (not shown) with a diameter of about 10 mm are used to fasten the valve seat 204, the gasket 218 and the rim 216. For example, bolts and nuts can be used as the fasteners in this embodiment. Other types of fasteners can also be used in different embodiments. The gasket 218 also includes a plurality of holes (not shown), which correspond to the holes 502 (Figure 5) of the horizontal portion 214 of the valve seat 204 and the holes 404 (Figure 4) of the rim 216 of the manhole 202, for enabling connection of the valve seat 204 and the manhole 202.

Referring back to Figure 5, the valve seat 204 has a truncated conical shape and includes a sloping portion 504, which extends beneath the horizontal portion 214 from an end of the horizontal portion 214. In this embodiment, the sloping portion 504 forms an angle of about 108° with the horizontal portion. An arc portion 506 is disposed at an end of the sloping portion 504 opposite to the end having the horizontal portion 214.

In this embodiment, the valve seat 204 can be made of Series S1000, S2000 or S3000 and glass reinforcements. Other materials may be used for manufacturing the valve seat 204 in different embodiments. The valve seat 204 is about 10 mm thick. The horizontal portion 214 is about 60 mm wide. The diameter of an end of the horizontal portion 214 opposite to the end having the sloping portion 504 is about 990 mm. The diameter of an end of the arc portion 506 opposite to the end having the sloping portion 504 is about 600 mm. Other dimensions are also possible in different embodiments.

Figure 6a shows a top view of the float valve 206. Figure 6b shows a cross sectional view of the float valve 206 along line C-C of Figure 6a. As described above, the float valve 206 comprises an annular seat surface 220 disposed near the

edge of the float valve 206. In this embodiment, the seat surface 220 can be made of bonded polypropylene. Other materials can be used to manufacture the seat surface 220 in different embodiments. The seat surface 220 has a width (w_s) of about 83.4 mm and a thickness (t_s) of about 5 mm. Other dimensions are also possible in different embodiments.

The float valve 206 further comprises six protrusions 602 around the circumference of the float valve 206. The protrusions 602 are arranged such that each protrusion 602 is substantially equidistant from the respective adjacent protrusions 602. In this embodiment, the length of the largest edge of the protrusions 602 is about 143 mm. The width of the protrusions 602 is about 60 mm. The protrusions 602 can have the same thickness as the float valve 206, i.e. about 66 mm. The protrusions 602 advantageously maintain a position of the float valve 206 within the main structure 402 (Figure 4b) of the manhole 202. The number of protrusions 602 may be different in other embodiments.

In this embodiment, the float valve 206 and the protrusions 602 can be made of Series S1000, S2000 or S3000, glass reinforcements and Celcore Polypropylene Honeycomb. Since this material is less dense than the liquid 116, it allows the float valve 206 to float on the liquid 116. Other materials may be used for manufacturing the float valve 206 and the protrusions 602 in different embodiments. The float valve 206, excluding the protrusions 602, has a diameter of about 750 mm. The float valve 206, including the protrusions 602, has a diameter of about 850 mm.

Figure 7a shows a top view of the collar 222. Figure 7b shows a cross sectional view of the collar 222 along line D-D of Figure 7a. In this embodiment, the collar 222 can be made of resin and glass reinforcements. Other materials may be used for manufacturing the collar 222 in different embodiments. The collar 222 has an outer diameter (d_{c1}) of about 910 mm, an inner diameter (d_{c2}) of about 902 mm, a width (w_c) of about 4 mm and a height (h_c) of about 166 mm with an allowable variation of about ± 3 mm. Other dimensions are also possible in different embodiments.

Figure 8 shows a cross sectional view of the vacuum break valve structure 102 with the float valve 206, the valve seat 204 and the float valve stoppers 208 removed. A manway 802 is advantageously provided to allow access between a top side and a bottom side of the IFC 104 for maintenance. The IFC 104 can be raised by shortening the length of the suspension elements 112 with the control mechanisms 114 to provide space for maintenance of various areas of the storage tank 106.

The vacuum break valve structure can also be implemented in an IFC with leg supports. Figure 9 shows a schematic drawing of a system 900 illustrating a vacuum break valve structure 102 disposed in an IFC 902 of a liquid storage tank 904. Leg supports 906 are attached to the IFC 902.

When a liquid 908 in the storage tank 904 is at a level 910, the vacuum break valve structure 102 is in a closed position. When the liquid 908 is drained from the storage tank 904, the liquid level 910 drops in the storage tank 904. The IFC 902 floats on the liquid 908 and the vacuum break valve structure 102 remains closed until the liquid level 910 falls to a level whereby the leg supports 906 of IFC 902 contact a bottom of the storage tank 904. The IFC 902 stops moving downwards since the leg supports 906 are in contact with a bottom 912 of the storage tank 904. When more liquid is drained from the storage tank 904, the vacuum break valve structure 102 opens as the float valve 206 (Figure 2) of the vacuum break valve structure 102 moves downwards with the decreasing liquid level 910. This advantageously prevents a negative pressure building below the IFC 902.

When the liquid 908 is supplied into the empty storage tank 904, the leg supports 906 of IFC 902 are in contact with the bottom 912 of the storage tank 904 and the vacuum break valve structure 102 is opened. As the liquid level 910 rises in the storage tank 904, the float valve 206 (Figure 2) of the vacuum break valve structure 102 floats on the liquid 908 and rises with the liquid level 910. At a certain liquid level 910, the vacuum break valve structure 102 closes. A watertight and an airtight contact is advantageously provided. An overflow of the liquid, evaporation of the liquid, and possible air pollution are advantageously prevented. As more liquid 908 is

added into the storage tank 904, the IFC 902 floats on the liquid 908 and rises with the liquid level 910.

The shapes of the various components including the manhole, the float valve, the valve seat and the float valve stoppers are not limited to that shown in the described embodiments. Further, it will be appreciated that the dimensions of the various components including the manhole, the float valve, the valve seat and the float valve stoppers may be different in different embodiments.

It will be appreciated by a person skilled in the art that numerous variations and/or modifications may be made to the present invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects to be illustrative and not restrictive.

CLAIMS

1. A vacuum break valve structure for an internal floating cover of a liquid storage tank, the vacuum break valve structure comprising:

a valve seat connected to said cover and defining an opening through said cover;

a float valve not connected to the valve seat and disposed for substantially free movement under buoyancy between an open state and a closed state;

wherein in the closed state the float valve contacts the valve seat and in the open state there is a passageway between the float valve and the valve seat.

2. The vacuum break valve structure as claimed in claim 1, further comprising a frame structure connected to, and extending through the cover, wherein the valve seat is connected to the frame structure and the float valve is disposed within the frame structure for the substantially free movement under buoyancy between the open state and the closed state.

3. The vacuum break valve structure as claimed in claim 2, further comprising float valve stoppers disposed on the frame structure for preventing the float valve from moving out of the frame structure.

4. The vacuum break valve structure as claimed in claim 3, wherein each float valve stopper comprises a longitudinal member disposed across the frame.

5. The vacuum break valve structure as claimed in any one of claims 2 to 4, wherein the valve seat is secured to a rim portion of the frame structure with a gasket disposed there between.

6. The vacuum break valve structure as claimed in any one of claims 2 to 5, wherein the frame structure is dimensioned to function as a manhole for accessing said storage tank through said cover.

7. The vacuum break valve structure as claimed in any one of the preceding claims, wherein the float valve comprises an annular seat surface disposed near an

edge of the float valve for contacting a corresponding annular seat surface of the valve seat.

8. The vacuum break valve structure as claimed in any one of the preceding claims, wherein an airtight and liquid tight seal is provided in the closed state.

9. The vacuum break valve structure as claimed in any one of the preceding claims, wherein said cover comprises a leg supported cover or a roof hung cover.

10. The vacuum break valve structure as claimed in any one of the preceding claims, wherein the float valve and the valve seat are removable to provide access to said storage tank.

11. A method for preventing negative pressure buildup on an underside of an internal floating cover in a liquid storage tank, the method comprising the steps of:

connecting a valve seat to said cover, the valve seat defining an opening through said cover; and

disposing a float valve for substantially free movement under buoyancy between an open state and a closed state, the float valve not being connected to the valve seat;

wherein in the closed state the float valve contacts the valve seat and in the open state there is a passageway between the float valve and the valve seat.

12. The method as claimed in claim 11, further comprising the steps of:

connecting a frame structure to the cover, the frame structure extending through the cover;

connecting the valve seat to the frame structure; and

disposing the float valve within the frame structure for the substantially free movement under buoyancy between the open state and the closed state.

13. The method as claimed in claims 11 or 12, further comprising disposing float valve stoppers on the frame structure for preventing the float valve from moving out of the frame structure.

14. The method as claimed in any one of claims 11 to 13, further comprising securing the valve seat to a rim portion of the frame structure with a gasket disposed there between.

15. The method as claimed in any one of claims 12 to 14, further comprising dimensioning the frame structure to function as a manhole for accessing said storage tank through said cover.

16. The method as claimed in any one of claims 11 to 15, further comprising disposing an annular seat surface of the float valve near an edge of the float valve for contacting a corresponding annular seat surface of the valve seat.

17. The method as claimed in any one of claims 11 to 16, further comprising providing an airtight and liquid tight seal in the closed state.

18. The method as claimed in any one of claims 11 to 17, further comprising removing the float valve and the valve seat to provide access to said storage tank.