This invention relates to large metal tanks of the kind that are used for holding liquid, grain and various other materials, and particularly oil storage tanks of the type that are equipped with a stationary roof formed by a metal diaphragm rigidly attached at its periphery to the side wall of the tank and at its center to a stationary, vertical roof support, and having its top surface shaped so as to form an annular water collection trough that extends circumferentially around the roof between two oppositely inclined drainage surfaces that constitute the central and peripheral portions of the roof and both of which drain into said collection trough.

The main object of my present invention is to enhance or improve the drainage characteristics of a stationary tank roof of the general type above referred to without substantially increasing the cost of building and erecting the roof.

Another object is to provide a stationary tank roof of the general type mentioned, which is of such design or construction that the amount of water which can possibly collect on the roof before it overflows, is not great enough to impose a dangerous load on the roof that might create a hazard which has to be considered and guarded against in designing the roof.

And still another object of my invention is to provide a liquid storage tank of the general kind mentioned, that can be gaged accurately even when the liquid in the tank is at its maximum designed height or level.

I have herein illustrated my present invention embodied in a liquid storage tank of the general kind disclosed in my pending applications for patent Serial Number 458,163 and 458,164, filed September 24, 1954, and both now abandoned, wherein the roof of the tank is capable of being constructed as a complete unit on or adjacent the bottom of the tank and thereafter raised or hoisted into its operative position and rigidly attached to the top edge of the tank side wall and to a vertical roof support at the center of the tank, so that the roof will be suspended between said two supporting structures. However, I wish it to be understood that my present invention is applicable to a tank roof composed of metal plates that are joined together and attached to the tank side wall and to a center roof support, while said plates are resting on and supported by a suitable framework located adjacent to the top edge of the tank side wall and shaped or constructed so as to produce a roof that has the characteristics above mentioned, namely a peripheral portion that slopes downwardly and inwardly from the top edge of the tank side wall, a central portion that slopes downwardly and outwardly from the center roof support, and an annular water collection trough that extends circumferentially around the roof and which receives drainage from said central and peripheral roof portions.

Figure 1 of the drawings is a side elevational view of a tank constructed in accordance with my invention.

Figure 2 is a top plan view of said tank.

Figure 3 is a diagrammatic view showing how the side wall of the tank would look if it were rolled out straight, and

Figure 4 is a diagrammatic view illustrating a side wall of slightly different construction from the side wall shown in Figure 3.

In the drawings 1 designates the side wall of the tank which is of circular form, 3 designates the bottom of the tank, and 4 designates, as an entirety, a vertical roof support or tower at the center of the tank whose height is greater than the height of the tank side wall 1. The roof of the tank is constructed of conventional metal roof plates, fabricated or welded to each other in such a way as to produce a circular diaphragm comprising an annular peripheral portion B that slopes inwardly and downwardly from the top edge A of the tank side wall, and a central portion C of slightly curved shape or form that slopes downwardly and outwardly from the center roof support 4, said two roof portions B and C merging into each other so as to form a water collection trough E of annular form and of substantially V shape in cross section, that extends circumferentially around the roof at a point of distance inwardly from the side wall 1 of the tank. Generally the peripheral portion B will constitute from 30% to 50% of the total area of the top surface of the roof and one or more outlet drains D will be provided for discharging or carrying off the water that drains into the trough E from the roof surfaces B and C. If the roof is fabricated or built as a complete unit on or adjacent the bottom of the tank, as shown in broken lines in Figure 1 and designated by the reference characters B', C' and E', the roof plates will be permanently and rigidly attached to annular shaped frame members H and K at the periphery and at the center of the roof that hold the roof in shape while it is being hoisted into its operative position and which are also used in conjunction with a flange S on the tank side wall and a member S' on the center roof support to rigidly attach the roof to said side wall and roof support.

By referring to Figure 1 it will be noted that the tank side wall 1 is built so that, starting at one point, the top edge A of said wall slopes upwardly both ways to the opposite end of the diameter from which the start was made. In other words, instead of making the top edge of the tank side wall level or at the same height above the ground, around the entire circumference of said wall, I make the south portion (left hand side of Figure 1) of said wall of considerably less height than the north portion (right hand side of Figure 1) of said wall, so that the top edge A of the wall will slope upwardly both ways, from the south portion to the north portion. If the roof is constructed as a complete unit on the bottom of the tank, it is built in a level position or in such a manner, that the water collecting trough E' will be disposed in a horizontal plane and the peripheral portion B' and central portion C' will be disposed in symmetrical relation, sloping upwardly in opposite directions from said trough E', as shown in broken lines in Figure 1. When the roof is hoisted into its operative position, the right hand side of the roof has to be raised considerably higher than the left hand side due to the greater height of the north portion (right hand side) of the tank side wall. Accordingly, in attaching the roof to the tank side wall, the roof, as an entirety, has to be tilted up sufficiently into a plane which is at an angle to the horizontal, in order to make the roof conform to the slope of the top edge A of the tank side wall to which the roof is permanently and rigidly attached. This causes the water collection trough E to be disposed at an angle to the horizontal and if the discharge pipe or outlet D is located at the lowest point of said trough, effective discharge of water from said trough is assured because all portions of the
surface of said trough slope downwardly at a constant rate toward the outlet D from the trough. Also effective drainage of water over the roof portions B and C and into the trough E is assured because all radial lines of said roof portions B and C slope downwardly to the trough E at varying rates. To state it in another way, the peripheral portion B and central portion C of my improved roof will drain dry, due to the fact that they have a steep downward pitch towards an annullar trough E which extends around the entire circumference of the roof, and said trough will drain dry, due to the fact that it is disposed at such an angle that water in one half of said trough will flow clockwise to the outlet D and water in the other half of said trough will flow counterclockwise to said outlet.

In tanks of relatively great diameter it may be desirable to construct the tank side wall so that the top edge of some has two or more low points each of which has an outlet or drain pipe D. In the case of two low points in the top edge of the tank side wall said top edge would rise to the deepest point and then descend to the half point of the circumference of the wall. The other half of the circumference of the top edge of the wall would be similarly sloped as shown in Figure 4. Even though the roof is built level and symmetrical on the bottom of the tank as shown in Figure 1, the distortion of the roof is only of an amount such that the member H and the roof diaphragm will easily flex and conform to the shape of the top edge of the tank side wall, whether said top edge has a continuous and gradual upward slope from a low point to a high point, or whether said top edge is of substantially serpentine shape and comprises several low points arranged intermediate a corresponding number of high points. In all instances part of the water traveling to an outlet of the trough will flow clockwise and the remainder of the water escaping through that particular outlet will flow counter clockwise.

In a roof of the construction herein illustrated it is impossible for a pool of water of relatively great area and depth to collect and remain upon the roof in the event the drainage means for the water collection trough E fails to function properly, or in the event an abnormal rain load is suddenly imposed on the roof. This is because the two self draining surfaces B and C of the roof discharge into a water collection trough E that is self draining and which is provided with one or more outlets located in sufficiently close proximity to the periphery of the roof to insure that a pool of water which starts to build up on the roof will overflow and escape at the edge of the roof before said pool becomes large enough to impose a dangerous load on the roof. In Figures 1 and 2 of the drawings the reference character 7 designates a pool of water that has collected on the roof and the reference character F designates the contour of said pool. By referring to Figure 1 it will be seen that said pool is relatively shallow and is of gradually diminishing depth from its center to its edges, and by referring to Figure 2 it will be seen that said pool is crescent shape in general outline and the widest portion of said pool is located in such close proximity to the peripheral edge of the roof that the pool will overflow or start to spill over the peripheral edge of the roof before the pool can become of such magnitude as to create a hazard or abnormal load that the roof cannot safely carry.

Thus my roof is superior to prior roofs of the general type previously mentioned, because the amount of water which can possibly collect on the roof before it overflows, is a comparatively small portion of the amount that normally collects on such roofs in the event of a sudden and abnormal downpour of rain or imperfect functioning of the drainage means relied upon to discharge water from the roof. This is a highly desirable characteristic of a stationary tank roof as it reduces the cost of the roof by overcoming the necessity of constructing the roof supporting means so as to carry a load far in excess of the designed load or any load that might possibly be imposed on the roof when it is in service. In my roof, the upper can accurately determine the maximum load the roof supporting means will have to carry due to the fact that the area and depth of a pool of water that can possibly collect on the roof can be easily calculated.

In addition to the desirable features or characteristics previously pointed out, my improved tank has the added advantage of being constructed in such a manner that it can be gaged accurately even when the liquid in the tank is at its maximum designed height or level. I attain this highly desirable result by providing the tank side wall I at its upper end with a false portion or extension G, as shown in Figures 1, 3 and 4 which maintains the roof in such a position that when the tank is filled to its designed height or level, designated by the reference character 6 in Figure 1, the inner edge part of the peripheral roof portion B and the outer edge part of the central roof portion C that cooperate with each other to form the water collection trough E, will not be submerged or contacted by the liquid in the tank. Hence the tank can be accurately gaged even when it contains the designed maximum quantity of liquid, for as there is no portion of the roof that touches the liquid or displaces any of the liquid, it is unnecessary for the gage to make an allowance for inaccurate resulting from a portion of the roof submerging in the liquid and thus raising the level of the liquid. In order to make this feature of my invention clear I have shown a shallow bowl 2 in Figure 4 which is intended to represent the upper edge of the highest horizontal ring of a tank wall of normally designed tank wall height. What I have done is to increase the height of the tank side wall an amount (represented by the two arrows and the reference character G) sufficient to provide for the 12" to 14" downward slope of the peripheral roof portion B at the low point of the top edge of the tank side wall, and thus maintain said portion at a point higher than the designed level or maximum level 6 of the liquid. No liquid ever presses against the false portion or extension G at the upper end of the tank side wall and accordingly said false portion does not have to be constructed so as to take care of any hydrostatic head resulting from liquid rising into the space bounded or defined by the extension G of the tank side wall.

Having thus described my invention, what I claim and desire to secure by Letters Patent is the following:

1. A liquid storage tank having a circular side wall, and a roof attached to the top edge of said wall and provided with a peripheral portion that slopes downwardly and inwardly towards the center of the tank and constitutes a large portion of the total area of the top surface of the roof, the inner edge of said peripheral portion having a circular contour and the top edge of said side wall sloping upwardly from a low point to a high point, the circular contour at the inner edge of the peripheral portion of the roof sloping in approximate conformity to the slope of the top edge of the tank side wall, the sloping side wall and the sloping inner edge of the peripheral roof portion providing means for limiting the height of the roof in such a manner as to provide the capacity of said roof, and also providing means constituting said low point of the top edge of said side wall as an emergency water overflow.

2. A structure of the kind defined in claim 1, provided with a water drain located at the lowest point of the water body and at the inner edge of the peripheral portion of the roof.

3. A structure of the kind defined in claim 1, in which the tank side wall is provided at its upper end with an extension of sufficient height to maintain the peripheral portion of the roof in a plane higher than the designed level of the body of liquid stored in the tank.
4. A structure of the kind described in claim 1, in which the roof also comprises a central portion that cooperates with said peripheral portion to form a water collection trough of approximately V shape in cross section that conforms to the contour and slope of the peripheral portion of the roof, and a water discharge outlet leading from the low end of said trough.

5. A liquid storage tank, comprising a stationary side wall of circular form, a roof formed by a metal diaphragm rigidly attached at its periphery to the top edge of said side wall and arranged so that the peripheral portion of said diaphragm projects inwardly and downwardly from said wall, and a water collection trough in said diaphragm, located at the inner edge of the downwardly inclined peripheral portion of the diaphragm and extending circumferentially around the roof, the top edge of the tank side wall being shaped so as to maintain said diaphragm in such a position that diametrically opposite portions of said water collection trough will be disposed at a sufficiently steep angle to the horizontal to cause the water which enters said trough to flow, clockwise and counter clockwise through said trough, to an outlet located between the diametrically opposite portions of the trough, the shaping of the top edge of said side wall to provide a low point in the collection trough providing means for limiting the total water carrying capacity of the roof, and also providing means constituting the outer edge of said diaphragm an emergency overflow at a point adjacent said outlet.

6. A structure of the kind described in claim 5, in which the diaphragm is maintained in the position described in said claim, by shaping the top edge of the tank side wall so that diametrically opposite portions of said top edge, slope downwardly from a high point on the wall to a low point on the wall, adjacent which the said outlet of the trough is located.

7. A structure of the kind described in claim 5, in which the diaphragm is maintained in the position described in said claim, by providing the tank side wall with a top edge that slopes upwardly from a low point on one portion of the wall to a high point on a diametrically opposite portion of the wall, the outlet of the trough being located adjacent the said low point and the angle at which the diametrically opposite portions of the trough are disposed being in substantial conformity with the angle of slope of the top edge of the tank side wall.

8. A liquid storage tank, comprising a stationary, circular side wall whose height at one side of the tank is lower than the height of the wall at the opposite side of the tank, the top edge of said wall sloping upwardly from said low side to said high side, a vertical roof support at the center of the tank of greater height than the tank side wall, a roof formed by a metal diaphragm suspended between the tank side wall and said vertical roof support and rigidly attached at its periphery to the top edge of the tank side wall whereby the roof, as an entirety, will be caused to assume a tipped or tilted position that conforms approximately to the slope of the top edge of the tank side wall, said diaphragm comprising a central roof portion that slopes downwardly and outwardly from the center roof support, a peripheral roof portion that slopes downwardly and inwardly from the tank side wall and an annular water collection trough between said two roof portions disposed in a downwardly inclined position that conforms substantially to the slope of the top edge of the tank side wall, and a water discharge outlet leading from the lowest point of said trough, the sloping of said tank side wall and the corresponding tilted position of the roof diaphragm providing means for limiting the total water carrying capacity of said roof, and also providing means constituting the edge of said side wall at a low point as an emergency overflow.

References Cited in the file of this patent

UNITED STATES PATENTS

1,842,735  Spencer -- Jan. 26, 1932
1,846,294  Wiggins -- Feb. 23, 1932
2,073,358  Williamson -- Mar. 9, 1937
2,327,085  Wiggins -- Aug. 17, 1943
2,386,022  Wiggins -- Oct. 2, 1945
2,606,684  Wiggins -- Aug. 12, 1952