This invention relates to an improved storage tank structure and to a method of forming a concrete bottom in a storage tank to provide a prestressed joint between the bottom and wall of the tank.

Large steel tanks often become unsuitable due to corrosion of the tank bottom and resulting leakage. It is well known that the noisy metal tank bottom can be repaired by pouring a layer of reinforced concrete therein. However, in such instances it is often difficult to maintain a seal between the metal tank shell and the new concrete bottom since, as the tank is filled, the shell expands, pulling away from the concrete. The present invention comprises an improved structure and method for preventing this leakage.

According an object of the invention is to provide an improved tank structure for sealing a tank bottom to the side wall. Another object is to provide a novel method of forming a poured cement bottom in a storage tank so as to provide a prestressed joint between the tank bottom and the flexible wall of the tank. A further object is to provide a novel form in a storage tank for pouring the bottom of the tank so as to form a prestressed joint between the bottom and the wall of the tank. Other objects of the invention will become apparent from a consideration of the accompanying disclosure.

A more complete understanding of the invention may be had by reference to the accompanying drawings of which Figure 1 is a perspective view of a steel storage tank with a cut-away section; Figure 2 is a fragmentary elevational view of the bottom corner of the tank of Figure 1; and Figure 3 is a similar view to that of Figure 2 at an intermediate stage of forming the prestressed joint in the tank. The various views are schematic and corresponding parts are correspondingly numbered.

Referring to the drawing numeral 8 designates a metal tank having a roof 9, a wall 10, and a bottom 11. The metal tank wall 10 is attached to the metal tank bottom 11 by corner brace 12 and rivets 13 and 14. A divider 15, formed of a length of flat sheet-metal curved to form a continuous ring inside the tank wall 10 adjacent the metal bottom 11 is spaced from tank wall 10 by spacer 16 to form an annular space 17. A plurality of grout inlets 18 and outlets 19 are provided, spaced at intervals around the circumference of the tank. A supply ring 20 is connected with grout inlets 18 for injection of grout into annulus 17 under the pressure of pump 21 in supply line 30 which is connected to a suitable source of grout.

In preparing the form for the concrete, sheet metal divider 15 is positioned upright on the bottom 11 and may be welded thereto, at least at spaced intervals; however it is not essential to weld this form in position since its weight will hold it on the tank bottom and spacers 16, which may be U-shaped or rectangular metal strips as shown in Figure 1, position the form or divider 15 laterally. Spacers 16 are suitably welded to form 15 and merely function to hold the form in upright position during the pouring of concrete bottom 20 and concrete annulus 21. It is not essential that spacers 16 be in the form shown, as other types of spacers may be used for the purpose. Figure 3 shows valves 22 and 23 in conduits 18 and 19, respectively, which are useful in the method of the invention. A flexible imperforate liner 24 may be placed in the tank as shown before pouring the concrete bottom and annulus. This liner may be made of coal tar mastic, rubber, or other water proof material which forms a cushion between the tank and concrete.

In accordance with the invention upright form 15 is positioned in the tank as shown in the drawing and the reinforced concrete tank bottom 20 is then poured in the space within the form. After this bottom has set, the tank is filled with water, thereby expanding tank wall 10. Grout pipes are connected to grout inlets 18 and grout is pumped into annular space 17, thus forcing water from this space. When space 17 is filled with grout up to the height of outlets 19, grout will flow therefrom to indicate this fact. Openings 18 and 19 are then closed, and the grout allowed to set. When the water is removed from the tank, tank wall 10 contracts, thereby placing the grout in annular space 17 and the concrete tank bottom 20 in compression. Since the stored product is lighter than the water which filled the tank when the grout was being placed, shell 10 is expanded and forms a prestressed joint with the concrete annulus 21.

In some instances, to prevent forcing grout over the top of divider 15, it may be desirable to restrict the opening at the top of divider 15 between this member and tank wall 10. This can be done by placing divider 15 at such an angle so that its upper edge is adjacent tank wall 10 or by placing a partial closure, such as a welded metal ring, across the opening; but this closure must not seal off annulus 17 as water should invade this area and be expelled therefrom by the grout, unless the shell is expanded by other means.

It is also feasible to prestress flexible tank wall 10 by other means than by filling the tank with a heavy liquid. Mechanical pressure might be utilized or the stressing might be accomplished by gas pressure. It is essential that the grout in annulus 17 be allowed to set and harden while tank wall 10 is at the expanded position. Tank wall 10 should be expanded at least as much as the expansion that will take place when the tank is filled with the liquid to be stored in the same. In the usual storage situation in the petroleum industry, storage tanks of this type are used for storing liquids lighter than water. Hence, water is a good prestressing agent and provides the simplest means of expanding the tank to the desired extent for forming a prestressed joint between the tank bottom and the tank wall.

The invention is described particularly with regard to the formation of a concrete tank bottom and prestressing annulus; however other self-setting plastic materials may be utilized in the method and construction of the invention.

Certain modifications of the invention will become apparent to those skilled in the art and the illustrative details disclosed are not to be construed as imposing unnecessary limitations on the invention.

1. A method of forming a tank bottom in an expandable tank shell comprising forming a poured imperforate bottom in said shell with an annular wall spaced apart a short distance from the wall of said shell forming an annular space open into said tank; expanding said shell by a force at least equal to the expanding force of the liquid to be stored therein; while said shell is expanded, introducing a self-setting fluid sealing material into the space between said tight retaining wall and said shell which sets to a rigid mass capable of
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holding said shell in expanded condition; and allowing
said material to set while said shell is expanded.

2. The method of claim 1 wherein said shell is cylin-
drical and said upright wall comprises a sheet metal band
extending several inches above said imperforate bottom.

3. The method of claim 1 wherein water is intro-
duced into said tank so as to effect the expansion.

4. A method of forming a tank bottom in a storage
tank having an expandable shell comprising positioning
an upright continuous form extending completely around
said bottom for self-setting cement adjacent the tank
bottom and spaced inwardly a small distance from the
tank shell; pouring cement into the space within said
form to provide a tank bottom therein; after said cement
has set, filling said tank with liquid of a density at least
as great as the density of the liquid to be stored in said
tank so as to expand said shell; while said shell is ex-
panded, forcing a hard-setting cement into the space
outside of said form so as to displace the liquid therein
and fill said space to a substantial height; and allowing
said cement to set before emptying said tank.

5. The method of claim 4 wherein said cement is
forced into the lower section of the space surrounding said
form until said cement reaches a predetermined level
above that of the poured tank bottom.

6. A method of forming a concrete bottom in a cylin-
drical sheet metal storage tank comprising setting an up-
right sheet metal form on the bottom of said tank spaced
from the wall of said tank to provide a small annular
space between said wall and said form open to the inside
of said tank; pouring a concrete bottom within said form;
then substantially filling said tank including said annular
space with water so as to expand said wall; thereafter
injecting concrete into a lower section of said annular
space at spaced intervals around said tank so as to fill
said space to a depth above the level of the top sur-
face of said bottom and displace water therein; and
after the resulting concrete annulus has set, removing
the water from said tank.

7. A form for prestressing a tank wall comprising in
combination a tank; an upright band of metal resting on
the bottom of said tank forming an annulus open on top
directly into said tank; individual spacers in said annulus
engaging said band and said wall at intervals around
said annulus; and conduits leading thru said wall into
the lower part of said annulus at spaced intervals around
said wall for introducing concrete there thru.

8. The form of claim 7 including conduits thru said
wall at a level adjacent an upper level of said annulus
for testing for the presence of concrete at said level.

9. The form of claim 8 including valves in the conduits
at both levels.

10. A method of forming a poured rigid bottom in a
cylindrical sheet metal storage tank comprising setting an
upright sheet metal form on the bottom of said tank
spaced from the wall thereof to provide an annular space
between said wall and said form open to the inside of
said tank; pouring a self-setting material into said form
so as to form a rigid bottom therein; after said material
has set, substantially filling said tank including said annu-
lar space with a liquid so as to expand said wall; thereafter
injecting into a lower section of said annular space at
spaced intervals around said tank a self-setting material
which sets to a rigid mass and holds said wall in expan-
sion after removal of said liquid, said self-setting mate-
rial being injected to fill said space to a depth above the
level of the top surface of said bottom and displace liquid
therein; and after the self-setting material in said annulus
has set, removing the liquid from said tank.

11. A metal tank having an upright expansible cylin-
drical wall; a rigid cement bottom in said tank extending
to within a few inches of said wall; an upright separator
in the form of a continuous band around the edge of
said bottom extending at least to the upper side thereof
and forming an annular space between said band and said
wall open to said tank at its top; and a separate rigid
solid annulus in said space holding said wall adjacent
said annulus in expanded condition so that when said
tank is filled with liquid said wall retains tight contact
with said annulus.

12. The tank of claim 11 wherein said annulus ex-
tends above said bottom.

13. The tank of claim 11 wherein said cement bottom
is disposed on a metal bottom and said separator
extends upwardly from said metal bottom between said
annulus and said cement bottom to a level above the
upper side of said bottom.

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