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INTERNALLY INSULATED VESSEL-BOTTOM

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Fig. 1

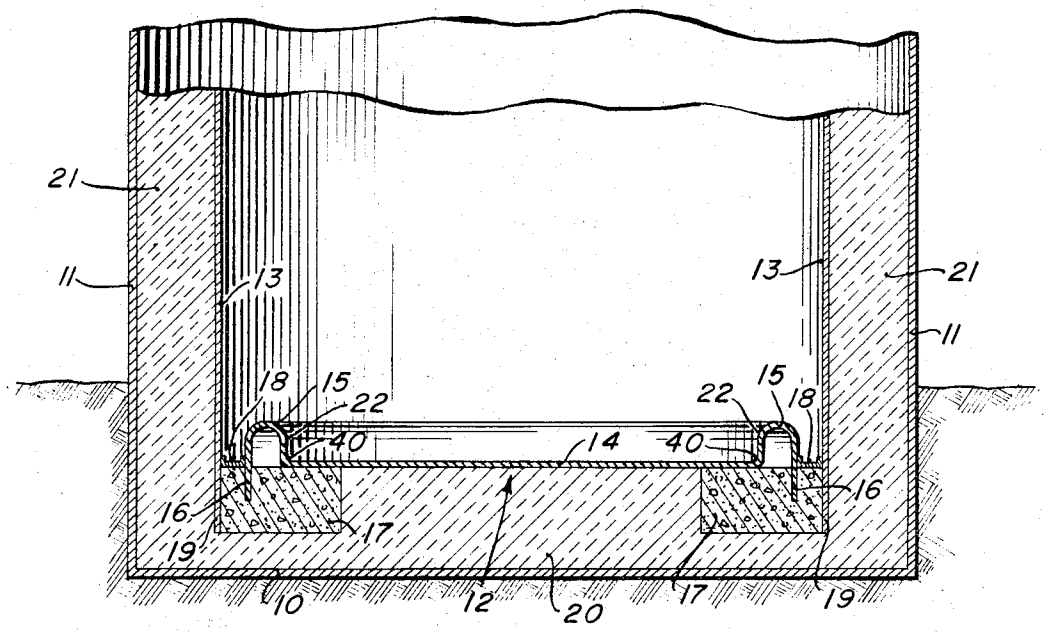
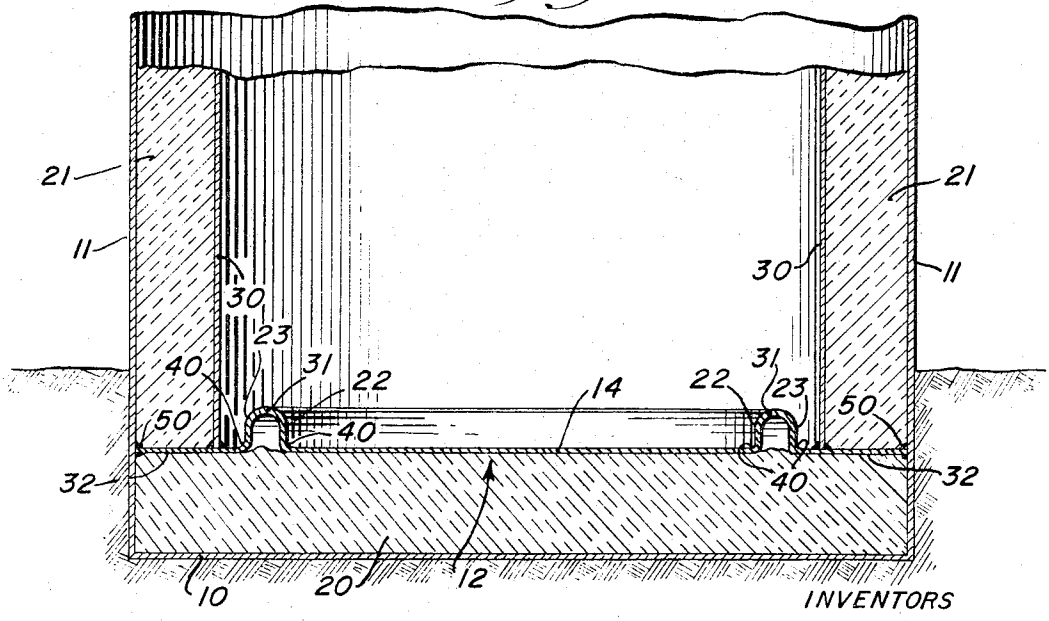


Fig. 2



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INTERNALLY INSULATED VESSEL-BOTTOM

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This invention relates to storage vessels. More particularly, this invention is concerned with large insulated storage vessels.

Insulated vessels are used for storing a wide variety of liquids including materials which are liquid at ambient temperatures and pressures as well as materials which are liquid at increased pressures and/or lowered temperatures. Some of the liquids stored at low temperatures are liquified gases such as ammonia, carbon dioxide, methane, ethane and propane.

The vessels used for storing such liquids are generally large and are field erected from prefabricated materials. While the insulation can be placed on the outside it is advisable in many installations and for particular service to internally insulate the vessel.

Internally insulated vessels broadly comprise a closed outer shell, an inner shell inside the outer shell in spaced relationship thereto and insulation material between the inner and outer shells. Such vessels commonly have substantially flat inner and outer bottom sheets and cylindrical vertical side walls. A roof generally is joined to the outer side wall. This roof can have suspended internal insulation or an internal roof sheet can be joined to the inner side wall and insulation positioned between the inner and outer roofs.

Storing low temperature liquids in such vessels, whether internally or externally insulated, leads to dimensional changes of the inner bottom sheet because of differential contraction. This can create large radial loads, the presence of which are likely to be at least troublesome by causing joint failure and leaks and even severe enough to cause failure of the vessel under service conditions.

There is accordingly provided by the subject invention a novel insulated vessel in which the inner bottom sheet is provided with expansion means, such as in the form of a loop, to facilitate expansion and contraction of the bottom sheet and minimize the creation of radial loads. More particularly, there is provided an inner bottom sheet having the outer edge thereof fixed in position and expansion means which permits the remainder of the bottom sheet to contract and expand with temperature changes. The invention will be further described in conjunction with the attached drawings in which:

FIGURE 1 is an elevational sectional view, partly broken away, of a vessel showing one embodiment of the expansion means; and

FIGURE 2 is similar to FIG. 1 but shows a second embodiment of the expansion means in the bottom.

In each of the drawings identical or substantially similar parts or elements are given the same number in the different figures.

FIGURE 1 shows a vessel having an outer shell having bottom sheet **10** which rests on a suitable foundation or load bearing surface and side wall sheet **11** which joins the bottom sheet. A roof (not shown) is also provided and is joined to the top portion of side wall **11**. Although the lower part of the vessel is shown partly sunk below the ground surface, the vessel bottom **10** can be placed at or above the ground surface.

The bottom **10** is generally circular and the side wall cylindrical. The outer shell, including the bottom, side wall and roof can be made of any suitable material but

advisably is metal, such as low carbon steel or aluminum, although other materials such as reinforced plastics can be used.

The inner shell of the vessel has a bottom sheet **12** and a side wall sheet **13** which is generally a concentric cylinder with respect to outer side wall **11**. An internal roof, not shown, can rest on the inner side wall with insulation placed between it and the outer roof. The bottom **12** is approximately flat and is composed of a major flat sheet **14** which can extend over almost the entire bottom area. At or near the peripheral area of bottom sheet **14** is provided expansion means, such as in the form of loop **15** having a vertical cross-section in the shape of an inverted U. The loop **15** circles around the periphery of the bottom thereby forming a raised annular rib of generally toroidal shape. The expansion loop **15** can be fabricated separately and then joined to the bottom sheet **14** or the loop can be formed as an integral part of plates or strips used in making the bottom.

As shown in FIG. 1 the loop **15** has an inner leg **22** joined to bottom **12** as by rounded transition corner **40** and outer leg **16** projecting below the bottom **14** and into an annular concrete retaining ring **17**, such as of perlite which fixes or secures leg **16** in place. Between the outer circumferential edge of loop **15** and side wall **13** is spacer **18** which joins the loop **15** and wall **13** in a liquid impermeable manner. The lower edge **19** of inner side wall **13** can be secured to the concrete ring **17** and thus held in place against movement. The spacer **18** is advisably made of minimal width so that its differential contraction and expansion during vessel temperature cycles will be insignificant.

Supporting the inner bottom sheet **14** is load bearing insulating material **20**. The bottom sheet **14** is not bonded or joined to insulation **20** or concrete **17** and is free to move thereon through expansion and contraction with temperature changes.

Between the outer side wall **11** and inner side wall **13** is placed suitable insulating material **21**. The insulation **21** must withstand storage loads without appreciable deformation. Insulating plastic foams such as the polyurethane type can be used for this purpose. The side wall **13** can suitably be bonded to the insulation **21**.

Any suitable materials can be used for the inner shell bottom and side wall as well as any inner roof which may be used. Thus, the inner shell can be made of steel, aluminum or a suitable plastic material, advisably reinforced with glass fibers.

When the empty vessel is brought from ambient temperature to a lower temperature by the introduction of a liquefied gas the bottom sheet **14** contracts upon being cooled. As this happens its shrinkage is accommodated by gradual lateral inward movement of inner leg **22** of the loop **15** with moderate deflection of the loop **15** and slidable movement of the sheet **14** on the supporting insulation. The loop **15** is relatively flexible and yields easily with contraction or expansion of bottom sheet **14**. Development of radial loads on the side wall **13** by differential temperature movement of the inner bottom is thus minimized or prevented and all joints are maintained liquid tight. Such structure gives exterior dimensional stability to the vessel by securing the outer edge of the bottom in place while permitting the remainder of the bottom to contract and expand with temperature changes.

The structure of FIG. 2 illustrates a second embodiment of the invention. Those parts which are the same as in FIG. 1 have been numbered the same. The bottom sheet **14** is joined to expansion loop **31** which is similar to loop **15** of FIG. 1 except that it, loop **31**, has no outer

leg **16**. Inner leg **22** and outer leg **23** are alike and each can be joined to the bottom **14** and spacer **32** as by the rounded transition corner **40**. Loop **31** is joined at the lower edges of its sides to bottom sheet **14** and to annular spacer plate **32** which constitutes a flat ring between the loop **31** and outer side wall **11**. The ring **32** is joined to both by suitable means, such as welding in the case of metal loops and side walls. The inner side wall **30** has its lower edge joined to the ring **32** in a leak-proof manner, such as by welding. The loop **31** functions in the same way as loop **15**. Neither plate **32** nor bottom sheet **14** are bonded to the supporting insulation **20** and are free to move with temperature induced dimensional changes. However, the outer edge **50** of plate **32** is joined to side wall **11** and is thus fixed or secured in position against movement. Dimensional change in the inner bottom **14** due to temperature variation is accommodated by loop **31** without changing the position or dimensions of the outer edge **50**.

In the drawings the insulated walls are shown disproportionately thick compared with the internal capacity which would be many times greater in large field-erected storage vessels. The drawing proportions were used however to clearly illustrate the invention.

What is claimed is:

1. A cylindrical insulated liquefied gas above-ground storage vessel comprising an outer metal shell and an inner metal shell with insulation between the shells, said inner shell having a circular essentially flat bottom sheet, an essentially smooth side wall sheet joined to the bottom sheet, an annular metal expansion rib in the bottom sheet in the region of its periphery and parallelingly adjacent to, but slightly spaced from, the side wall sheet, and a ring-like metal sealing strip joining the outer wall

of the expansion rib to the outer shell side wall, and the bottom edge of the side wall sheet is joined to the sealing strip.

2. A cylindrical insulated liquefied gas above-ground storage vessel comprising an outer metal shell and an inner metal shell with insulation between the shells, said inner shell having a circular essentially flat metal bottom sheet, an essentially smooth metal side wall sheet joined at essentially a right angle to the bottom sheet, and a raised annular metal expansion rib in the bottom sheet in the region of its periphery and parallelingly adjacent to, but slightly spaced from, the side wall sheet, the raised rib having an inverted U-shaped cross-section and the outer leg of the rib depends vertically below the bottom sheet and is anchored against lateral movement by restraining means below the rib and between the inner and outer metal shells.

3. A vessel according to claim **2** in which the bottom includes a ring-like metal sealing strip joining the outer leg of the rib to the side wall sheet.

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