Dec. 7, 1965 J. R. RYSGAARD 3,221,916

DESIGN OF AN ALL PLASTIC CRYOGENIC STORAGE CHAMBER

Filed June 17, 1963

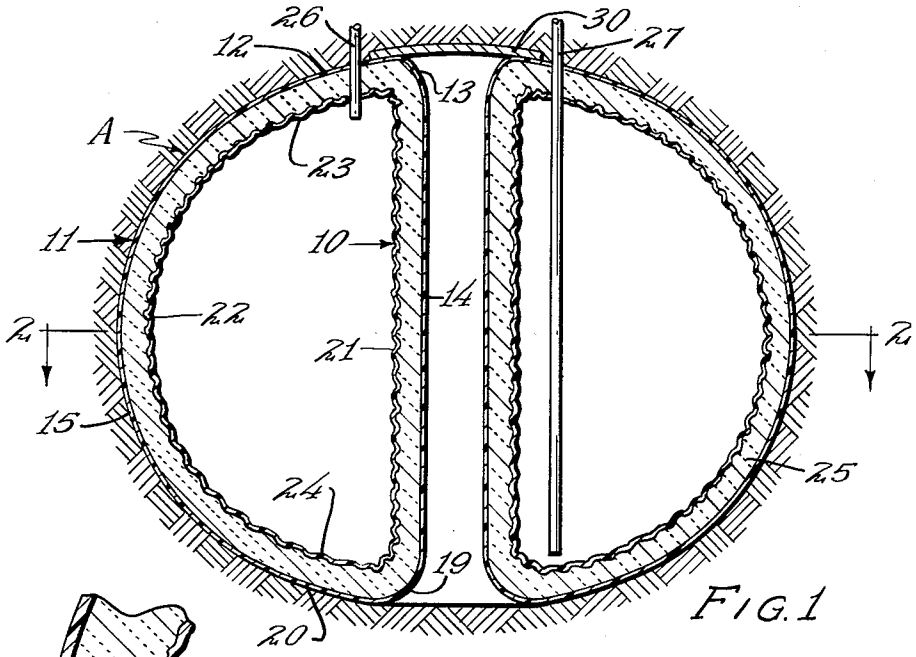


FIG. 1

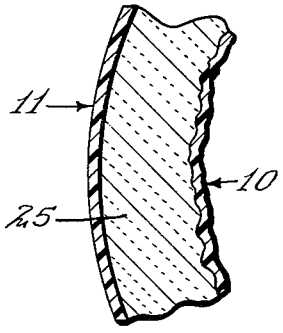


FIG. 3

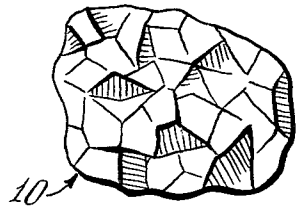


FIG. 4



FIG. 5

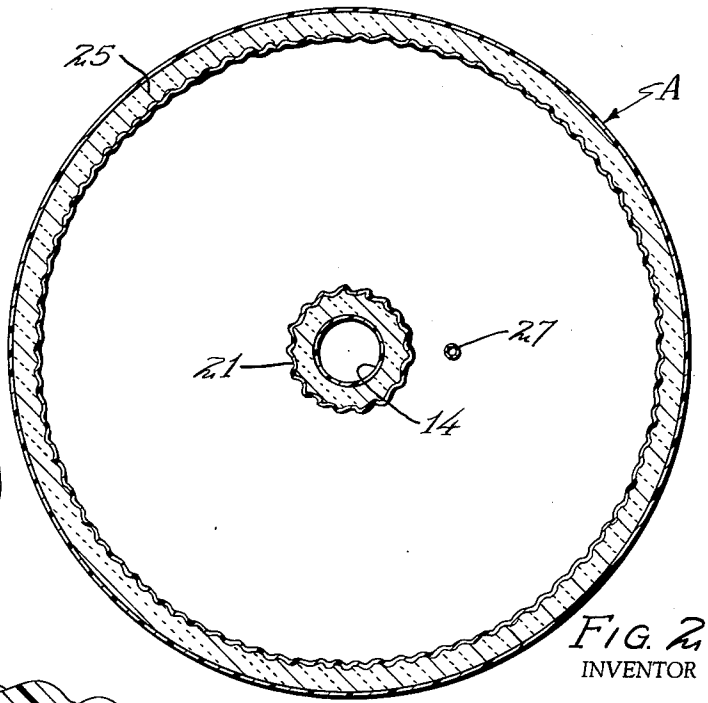


FIG. 2

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DESIGN OF AN ALL PLASTIC CRYOGENIC STORAGE CHAMBER

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This invention relates to an improvement in underground storage tanks for liquified gases at low temperatures, and deals particularly with a large capacity storage tank capable of expanding and contracting to compensate for variations in temperature to which such tanks are subjected.

Tanks of the type used for the storage of liquified gases are subjected to extreme variations in temperature which provides stresses in the material which would not normally be experienced in other types of storage tanks. Tanks of this type must be constructed at what may be considered normal temperature in an area. However, when the tank is filled with a liquid gas, such as the liquid petroleum gases, temperatures of two to three hundred degrees below zero Fahrenheit are experienced, which place a tremendous strain upon the wall of the tank. Obviously, unless the wall is capable of enduring this strain, the stresses will rupture the tank and render it useless. Any rupture of a tank of this type is not only extremely costly, but also often dangerous due to lack of control of the volatile gases. Thus it is essential that the tank be able to withstand the strain and to resist the tremendous forces in order to be practical.

An object of the present invention lies in the provision of a tank which, in its preferred form, includes an inner shell and an outer shell, and a thick wall of insulation between the two shells. At least the inner shell is formed of material, such as resin impregnated glass fibers, which has been wrinkled or creped in such a manner that the wrinkles run at random in all directions. This creped material acts to absorb and distribute strain through contraction by temperature, thus avoiding any localized stresses. The material also will allow expansion of the tank due to loading; but any such expansion merely serves to allow the tank to maintain full contact with the supporting insulation.

The nature and appearance of the surface of the wall is hard to illustrate, and is similarly hard to explain. However, it should be understood that if a sheet of paper is crumpled into a ball, or crumpled in all directions, and is then straightened out, the surface will be full of wrinkles extending in random directions. As tension is applied to the sheet from opposite sides thereof, the sheet tends to flatten out. However, when the sheet is released, the paper tends to revert to its previous wrinkled form. A wall of resin impregnated glass fibers will tend to return to its original form much more than the sheet of paper mentioned by way of example, as this material may be flexed out of its normal form repeatedly without losing its natural ability to return to its original form when the stresses are released.

A further feature of the invention lies in the fact, that in preferred form, the outer wall is also made of a material such as resin impregnated glass fibers, but the outer wall is either uncreped or unwrinkled or else is creped or wrinkled to a lesser extent than the inner wall.

The insulation used is preferably under compression when in place, so that when the inner chamber shrinks due to the very low temperature to which it is subjected, the insulation may relax to compensate for this movement. The insulation must also be capable of supporting a vacuum within its cell structure, as the service

may be in a temperature range below the liquid point of the gas used to form the cells.

A further feature of the present invention resides in the provision of a tank of the type described which is preferably of ring-shaped form. In other words, the two chambers which are arranged one within the other, are generally of doughnut shaped form. This arrangement provides a tank of great strength which may be buried beneath the surface of the ground, and yet which is capable of expanding and contracting readily.

These and other objects and novel features of the present invention will be more clearly and fully set forth in the following specification and claims.

In the drawings forming a part of the specification:

FIGURE 1 is a vertical sectional view through the center of the tank showing the general construction thereof.

FIGURE 2 is a horizontal sectional view through the tank, the position of the section being indicated by the line 2—2 of FIGURE 1.

FIGURE 3 is an enlarged sectional view showing diagramatically the inner and outer tank walls with the insulation therebetween.

FIGURE 4 is a plan view of a portion of the surface of the inner tank, showing the manner in which the surface is creped or wrinkled.

FIGURE 5 is an enlarged sectional view through a portion of the inner tank wall showing the manner in which the wall is creped or wrinkled.

The tank A is preferably shaped as indicated in FIGURES 1 and 2 of the drawings. The tank includes an inner skin or shell **10** which is enclosed within a similarly shaped outer skin or shell **11**. The outer shell **11** includes a dome-shaped or convex upper surface **12** connected along an arc **13** to a generally cylindrical inner wall **14**. The convex upper surface **12** is connected to a peripheral arcuate outer wall **15**. A convex bottom wall **20** connects the arcuate outer wall **15** to the inner cylindrical wall **14** through an arcuate connecting area **19**. In other words, the structure is generally doughnut shaped. The outer wall **15** may include a generally cylindrical central portion in the event it is desired to increase the height of the shell relative to the diameter thereof.

A cover panel **30** may overlie the tubular passage through the center of the shells if desired so that this area may be used for containing pumps or other equipment if desired.

This particular shape has been found desirable in view of the fact that the dome-shaped top surface is capable of supporting the weight of the ground overlying the top of the tank. While the bottom surface can be rounded, the generally flat area provides stability. Furthermore, expansion of the inner cylindrical wall **14** may be transmitted to the dome-shaped top portion **12** and generally flat bottom portion **17** to the outer cylindrical wall **15**. The particular shape illustrated lends itself very well to the transmission of the strain in all directions.

The inner shell or skin **10** is similar in shape to the outer enclosing skin or shell, and includes generally concentric cylindrical inner portion **21** and arcuate outer portion **22** which are connected by a dome-shaped or convex top portion **23** and an opposed convex bottom portion **24**. Insulation **25** fills the space between the inner and outer shells and tends to slow down the transmission of heat from one shell to the other. The skins or shells must be thick enough to withstand the stresses to which they are subjected, and must at the same time be thin enough to flex when subjected to stresses, the flexing tending in general to increase the depth of the

wrinkles or to flatten the surfaces by increasing or reducing the depth of the various wrinkles.

The inner skin or shell **10** is creped or wrinkled along lines extending in random directions. The outward appearance may be likened to that of a sheet of paper which has been wadded into a ball and then straightened out. Because of the fact that the wrinkles extend in all directions, the shell may expand and contract in all directions. The shell is formed in this creped condition and form, and accordingly will tend to return to the same shape or form when stresses acting against the shell are relieved. The shell is preferably made of a material commonly known as resin impregnated glass fibers or of a material having similar properties. In other words, material made of resin impregnated glass fibers has great strength, great flexibility without fracturing, can be readily formed in any desired shape, and tends to revert to its original shape after being flexed out of this shape. The material is also capable of withstanding extremely low temperatures and temperature changes without cracking.

In usual practice, the tank is formed on the property in sections by the use of suitable forms, and the various sections are connected together to form the complete unit. The tank may be assembled in a hole which has been excavated, or else the dirt may be excavated beneath the tank after it has been completed. The tank is usually covered over with the desired layer of dirt or the like. The site of the tank is preferably a location where there is no drainage problem, or where any drainage problem may be readily solved. The tank may be filled and emptied by suitable connection such as **26** and **27** which are not illustrated in detail.

In preferred form, the outer shell **11** may either be unwrinkled, or may be creped or wrinkled to a lesser extent than the inner shell and is therefore usually less sensitive to expansion and contraction.

In accordance with the Patent Statutes, I have described the principles of construction and operation of my improvement in Underground Storage Tanks, and while I have endeavored to set forth the best embodiment thereof, I desire to have it understood that changes may be made within the scope of the following claims without departing from the spirit of my invention.

I claim:

1. A tank of large capacity adapted for the underground storage of a liquified gas comprising:

(a) a generally doughnut-shaped body including an outer enclosure capable of supporting the weight of dirt placed thereon used to bury the tank underground,

(b) a generally similar shaped structurally self-sustaining inner enclosure enclosed within said outer enclosure and in spaced relation thereto,

(c) said inner enclosure being formed of a thermally responsive material, such as resin impregnated glass fibers, which is creped substantially throughout its surface area whereby said inner enclosure is adapted to accommodate, absorb, and distribute strain of contraction due to temperature drop in all directions simultaneously,

(d) a resilient cellular insulation in a contacting relation between opposed surfaces of said inner and outer enclosure and under compression between the walls of the inner and outer enclosures,

(e) whereby said insulation expands to maintain contacting relation when said inner enclosure contracts,

(f) means communicating with the interior of the inner enclosure and extending through said outer enclosure providing access to the inner enclosure for filling and draining the same.

2. The structure of claim **1**, and in which said outer enclosure comprises a shell of non-metallic material such as resin impregnated glass fibers.

3. The structure of claim **1**, and in which said insulation is adapted to support a vacuum within its cell structure.

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