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Laverman

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[54] **CRYOGENIC STORAGE TANK FACILITY WITH DIKE WALL COOLED BY LEAKING LIQUEFIED GAS**

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[52] **U.S. Cl.** ..... **62/50,** 220/9 LG, 220/18

[51] **Int. Cl.** **F17c 7/03**

[58] **Field of Search**... 62/45, 50; 220/DIG. 6, 9 LG, 220/15, 18

[56] **References Cited**

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[57] **ABSTRACT**

A storage tank facility for a liquefied gas having an enclosed tank, a vertical dike wall around and spaced from the tank side wall thereby defining a well space between the dike wall and the tank side wall and a plurality of vertical conduits in the dike wall communicating with the bottom of the well space for venting cold liquefied gas vapors therethrough to the atmosphere.

9 Claims, 5 Drawing Figures

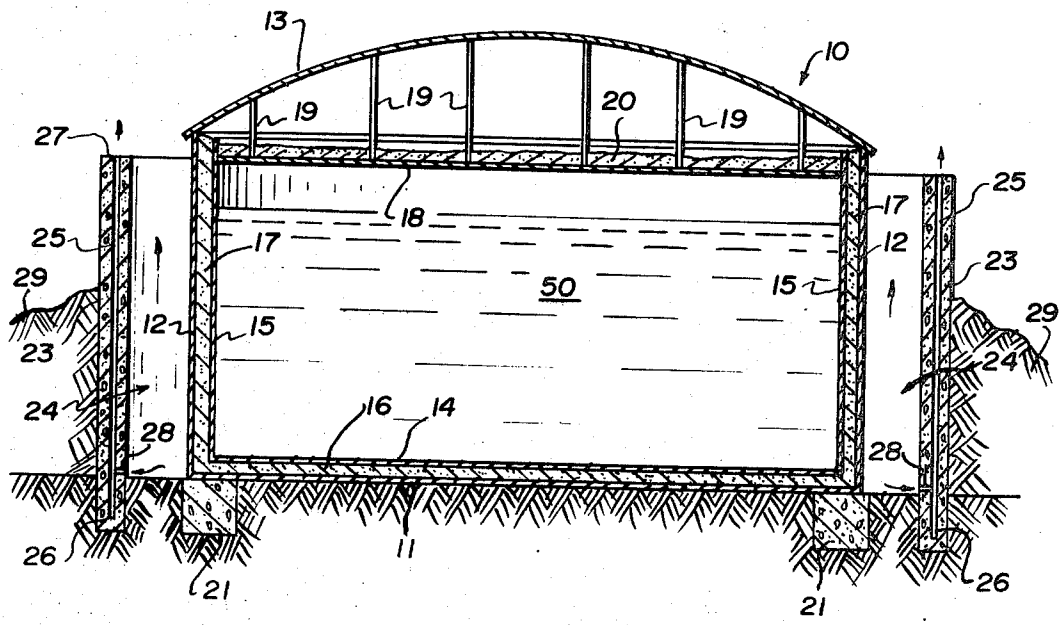


FIG. 2

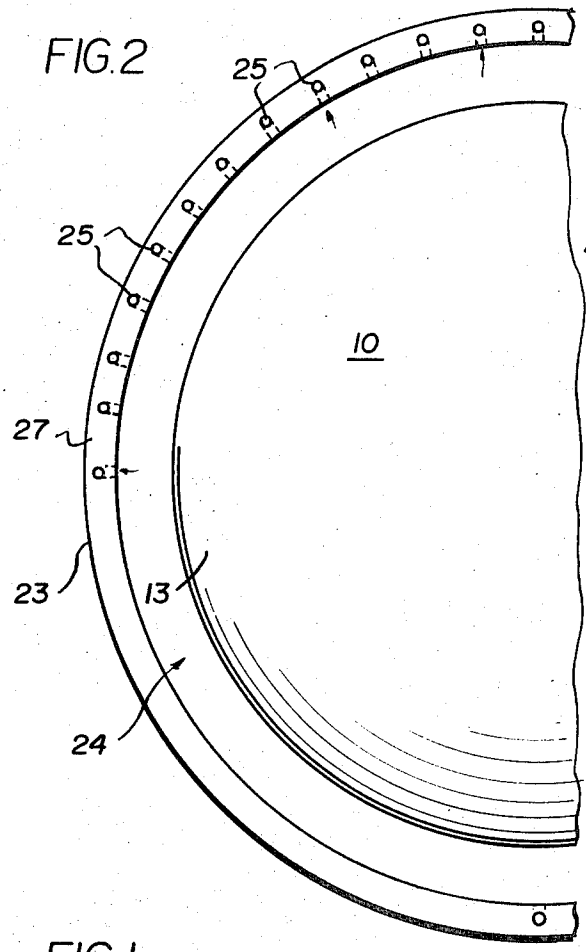


FIG. 3

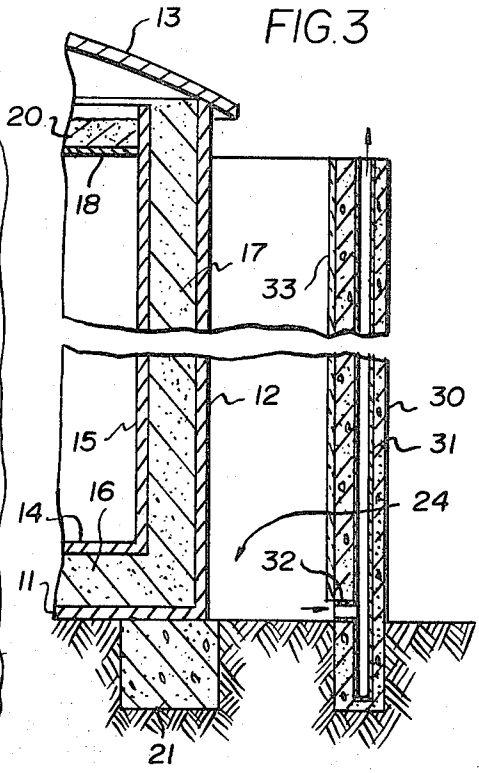


FIG. 1

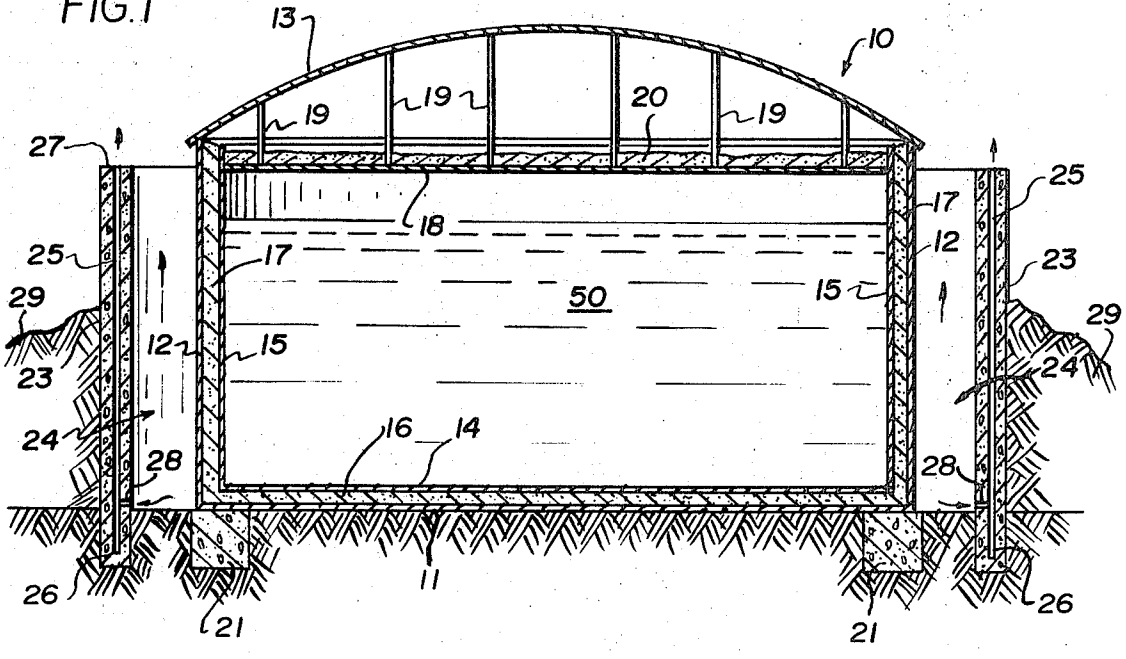


FIG. 4

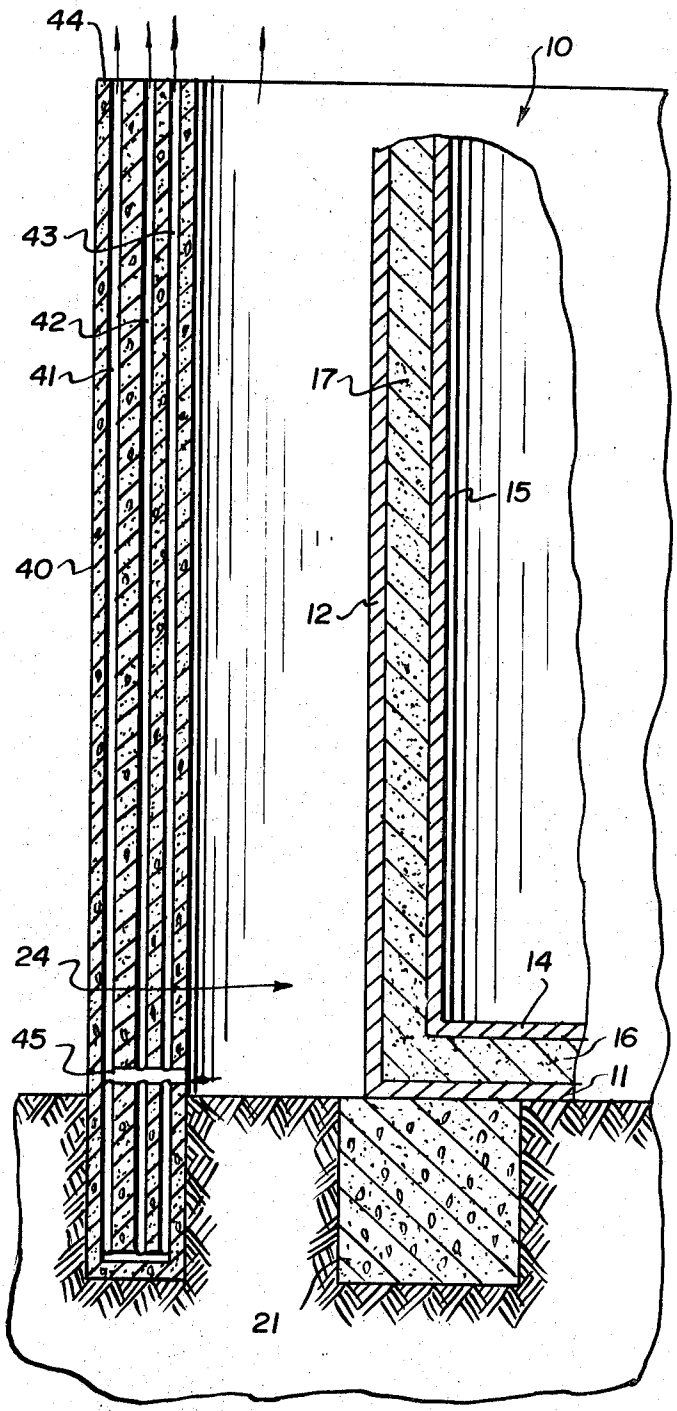
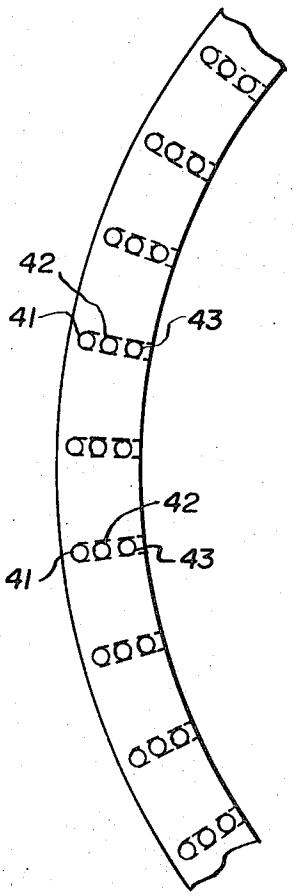


FIG. 5



CRYOGENIC STORAGE TANK FACILITY WITH DIKE WALL COOLED BY LEAKING LIQUEFIED GAS

The invention relates to storage tanks for liquefied gases. More particularly, this invention is concerned with an improved storage tank facility having a storage tank with a dike wall, around the tank, which is cooled, even during a fire, by vaporization of liquefied gas which may leak from the tank so that the structural integrity of the dike wall is preserved even if the leaked liquefied gas burns.

Enclosed storage tanks are used for storing cryogenic fluids or liquefied gases, including flammable liquefied gases such as liquefied natural gas. Leakage of a liquefied gas, particularly one which is flammable, from a storage tank presents a serious problem. It has therefore previously been proposed to place a dike wall around the storage tank to restrain spreading of liquefied gas escaped from the storage tank. A dike wall however can be subjected to temperatures which jeopardize its structural integrity such as if escaped flammable liquefied gas in the well space between the dike wall and tank catches fire. There is accordingly a need for a storage tank facility for liquefied gas having a dike wall which maintains its strength in the event of a fire.

According to the present invention, there is provided a storage tank facility for a liquefied gas comprising an enclosed tank, a vertical dike wall around and spaced from the tank side wall thereby defining a well space between the dike wall and tank side wall, and a plurality of vertical conduits in the dike wall for venting cold liquefied gas vapors therethrough to the atmosphere. The well space advisably should be wide enough and high enough to provide a volume adequate to hold a volume of escaped liquid in the well space at the same level as the resulting liquid level in the tank after the volume of liquid in the tank has been reduced by the escaped liquid. Liquefied gas which escapes from the enclosed tank flows into the well space and then through inlet ports in the bottom inner side of the dike wall which communicate with the vertical conduits. The liquefied gas level in the conduits rises until it is at the same level as the excaped liquefied gas in the well space. The liquefied gas vaporizes in the conduits and the cold vapor so formed flows upwardly through the conduits and out the outlets thereof at or near the top of the dike wall. The dike wall is cooled by heat exchange with the cold liquefied gas and cold vapors in the conduits and is thereby prevented from reaching high temperatures, caused by burning of liquefied gas around the tank and in the well space, which might otherwise reduce or destroy the structural integrity of the dike wall.

The invention will be described further in conjunction with the attached drawings in which:

FIG. 1 is a vertical sectional view of a storage tank facility having a concrete dike wall around a storage tank;

FIG. 2 is a partial plan view of the storage tank facility of FIG. 1;

FIG. 3 is a partial vertical sectional view of a storage tank side wall and a dike wall spaced therefrom having a tube lined internal conduit;

FIG. 4 is a partial vertical view showing the side wall of a storage tank and a spaced away dike wall having a series of adjacent vertical conduits therein; and

FIG. 5 is a partial plan view of the dike wall shown in FIG. 4.

So far as is practical, the same parts or elements which appear in the figures comprising the drawings will be identified by the same numbers.

With reference to FIGS. 1 and 2, enclosed storage tank 10 has an external metal shell comprising a metal bottom 11, a vertical circular cylindrical metal side wall 12 and a domed metal roof 13. The tank also has an internal shell comprising metal bottom 14 and circular vertical metal side wall 15. Insulation 16 is placed between the outer bottom 11 and inner bottom 14. Similarly, insulation 17 is placed between the outer side wall 12 and inner side wall 15. A horizontally positioned metal deck 18 is suspended from roof 13 by a plurality of rods 19. Insulation 20 is placed on the top of deck 18 to thereby completely insulate the storage space 50 inside of the tank so that it can be used for storing a cryogenic liquid or a liquefied gas at atmospheric pressure and a suitably low temperature. Foundation 21 aids in supporting tank 10. The detailed construction of such a tank is well known in the art, as see Sattelberg et al. U.S. Pat. No. 3,352,443. Other representative tank constructions which can be used are disclosed in the U.S. Pats. of Lange 3,559,835; Engdahl 3,419,174 and Waugh 3,338,010. However, the particular construction of the storage tank employed in the subject invention is not critical since many other forms of tanks and tank consructions can be employed in utilizing the invention contribution hereby disclosed.

Spaced away from tank 10 is dike wall 23. Dike wall 23 is advisably vertically positioned and equally spaced away from tank outer side wall 12 thereby defining a well space 24 of uniform width between the tank outer side wall and the dike wall. The dike wall, while preferably perpendicular to the earth, can be moderately sloped inwardly or outwardly if desired and if so sloped is to be treated as vertical for the purpose of this invention. Dike wall 23 can be made of any suitable material, but advisably is made of a strong nonflammable material or construction such as concrete. Embankment 29, advisably of earth fill, if desired can be placed around and in contact with the outside of dike wall 23 to reinforce it. A plurality of vertical spaced apart conduits or holes 25 are located in dike wall 23. Conduits 25 extend from their lower end 26 in the bottommost portion of dike wall 23 to the top edge 27 of the dike wall at which location the conduits 25 terminate to provide outlets therefor. The lower ends of the conduits 25 are advisably extended into the lower portion of dike wall 23 below the earth surface so that cooling of the dike wall is effected uniformly, by any liquefied gas which escapes from the tank, to prevent or minimize development of local temperature-induced stresses in the dike wall which might lead to its failure. A plurality of conduit inlets 28 are positioned to communicate with the bottom portion of well sapce 24 and with conduits 25.

Any liquefied gas which escapes from tank 10 flows into well space 24 and then through conduit inlets 28 into conduits 25. The level of liquefied gas in conduits 25 continues to rise until it reaches a level equal to the level of liquefied gas in well space 24. Since the ambient atmospheric temperature of dike wall 23 is higher than the temperaure at which a liquefied gas is stored, there is heat exchange therebetween. The liquefied gas in conduits 25 vaporizes and the cold vapors flow upwardly through the conduits and out the top ends

thereof to the atmosphere. Since the cryogenic liquid or liquefied gas as well as the vapors produced therefrom by heat exchange with the dike wall and the surrounding atmosphere are cold, the dike wall is cooled and maintained cold even if liquefied gas in well space **24** catches fire and burns. The cooling action of the liquefied gas and cold vapor in conduits **25** result in maintenance of dike wall **23** at a temperature substantially below the elevated temperatures to which it would otherwise be subjected through burning of the liquefied gas. The dike wall structural integrity is accordingly maintained throughout the existence of any such fire so that it continues to provide a barrier to spreading of liquefied gas beyond the well space thereby preventing spreading of the liquefied gas and the fire.

FIG. **3** illustrates a slightly different embodiment of the invention than is illustrated by FIGS. **1** and **2**. The partially shown storage tank in FIG. **3** is like that shown in FIGS. **1** and **2**. However, dike wall **30** is different in construction in that a plurality of vertically positioned metal tubes **31** are located in dike wall **30** and function as conduit liners. Any suitable metal which can withstand cryogenic tmperatures without failure can be used for the tube liners. Ports or inlets **32** communicate with the vertical metal tubes **31** and with the bottom part of well space **24**. The inlet ports **32** are advisably made of a metal tubular element. The use of metal tubular elements **31** facilitates formation of the conduits and strengthens the dike wall. The tubes **31** can be positioned in spaced apart relationship to one another around the entire circumference of the dike wall. An adequate number of tubular elements **31** are employed so that the cooling action of escaped liquefied gas and the resulting vapors formed therefrom will adequately cool the dike wall during a fire in and around the tank in well sapce **24** to prevent the dike wall from reaching a sufficiently high temperature to endanger its structural integrity. If desired, a layer of insulation **33**, such as of asbestos, can be placed adjacent or on the inside surface of dike wall **30** to keep it cool and protect it in case of fire.

FIGS. **4** and **5** illustrate still another embodiment of the invention. The storage tank shown partially in FIG. **4** is of the same construction as described with respect to FIGS. **1** and **2**. The embodiment of FIGS. **4** and **5**, however, is concerned with the structure of dike wall **40**. Dike wall **40** is vertically positioned around the tank in a manner identical to the dike wall described with reference to FIG. **1**. Dike wall **40** as shown in FIGS. **4** and **5**, however, has a series of three closely spaced vertically positioned conduits **41, 42** and **43** extending from the bottom portion of the dike wall placed below the surface of the earth to the top edge **44** of the dike wall. Opening or inlet conduits **45** extend from the inner face of dike wall **40** in communication with well space **24** to the vertical conduits **41, 42** and **43** so that escaped liquefied gas can flow into the conduits from well space **24**. A plurality of groupings of the three conduits **41, 42** and **43** can be located around the full circumference of dike wall **40** as shown in partial plan view in FIG. **5**.

It will be obvious that other arrangements of conduits in a dike wall can be employed and therefore it is not intended that the invention be restricted to the specific embodiments disclosed in the drawings and described herein. The particular shape and number of the conduits is to be arrived at according to the cooling required to maintain the dike wall at a suitably low temperature if liquefied gas escapes from the storage tank and catches fire in and around the well space.

Although the invention has been described in conjunction with tanks and dike walls which are circular, it is to be understood that other shapes can be suitably employed such as polygonal tanks and dike walls. In addition, the storage tank need not be cylindrical or have the bottom entirely supported by the earth. Spherical and ellipsoidal tanks, insulated or not, and supported on columns can also be suitably employed in combination with the dike wall constructions disclosed herein as well as obvious variations thereof.

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom, as modifications will be obvious to those skilled in the art.

What is claimed:

1. A storage tank facility for a liquefied gas comprising:
- an enclosed tank;
- a vertical dike wall around and spaced from the tank side wall thereby defining a well space between the dike wall and the tank side wall; and
- a plurality of vertical cooling conduit means in the dike wall communicating with the bottom of the well space for venting cold liquefied gas vapors therethrough to the atmosphere and for cooling the interior of the dike wall.

2. A storage tank facility for a liquefied gas comprising:
- an enclosed tank having a bottom, vertical side wall and roof;
- a vertical dike wall surrounding and spaced from the tank side wall and extending from the earth upwardly for a substantial portion of the height of the tank side wall thereby defining a well space between the dike wall and tank side wall; and
- a plurality of vertical cooling conduit means in the dike wall for venting liquefied gas vapors to the atmosphere and for cooling the interior of the dike wall.

3. A storage tank facility according to claim **2** in which an embankment is in contact with the outside of the dike wall.

4. A storage tank facility according to claim **2** in which insulation is placed adjacent the inner surface of the dike wall.

5. A storage tank facility according to claim **2** in which the cooling conduit means in the dike wall communicate with the bottom of the well space, and the cooling conduit means project through the dike wall near the top thereof.

6. A storage tank facility according to claim **5** in which the side wall of the tank and the dike wall are vertical circular cylindrical walls about equally spaced from each other.

7. A storage tank facility according to claim **5** in which the dike wall is concrete.

8. A storage tank facility according to claim **7** in which the tank is fully insulated.

9. A storage tank facility according to claim **7** in which the cooling conduit means are defined by metal tubes embedded in the concrete dike wall.

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