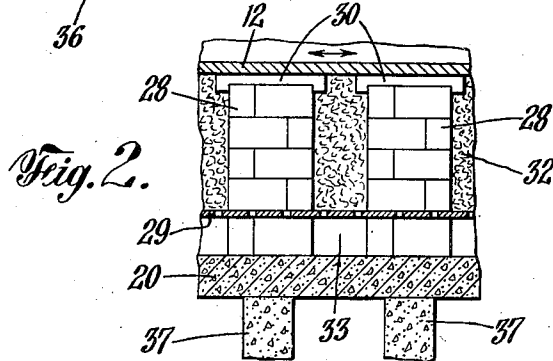
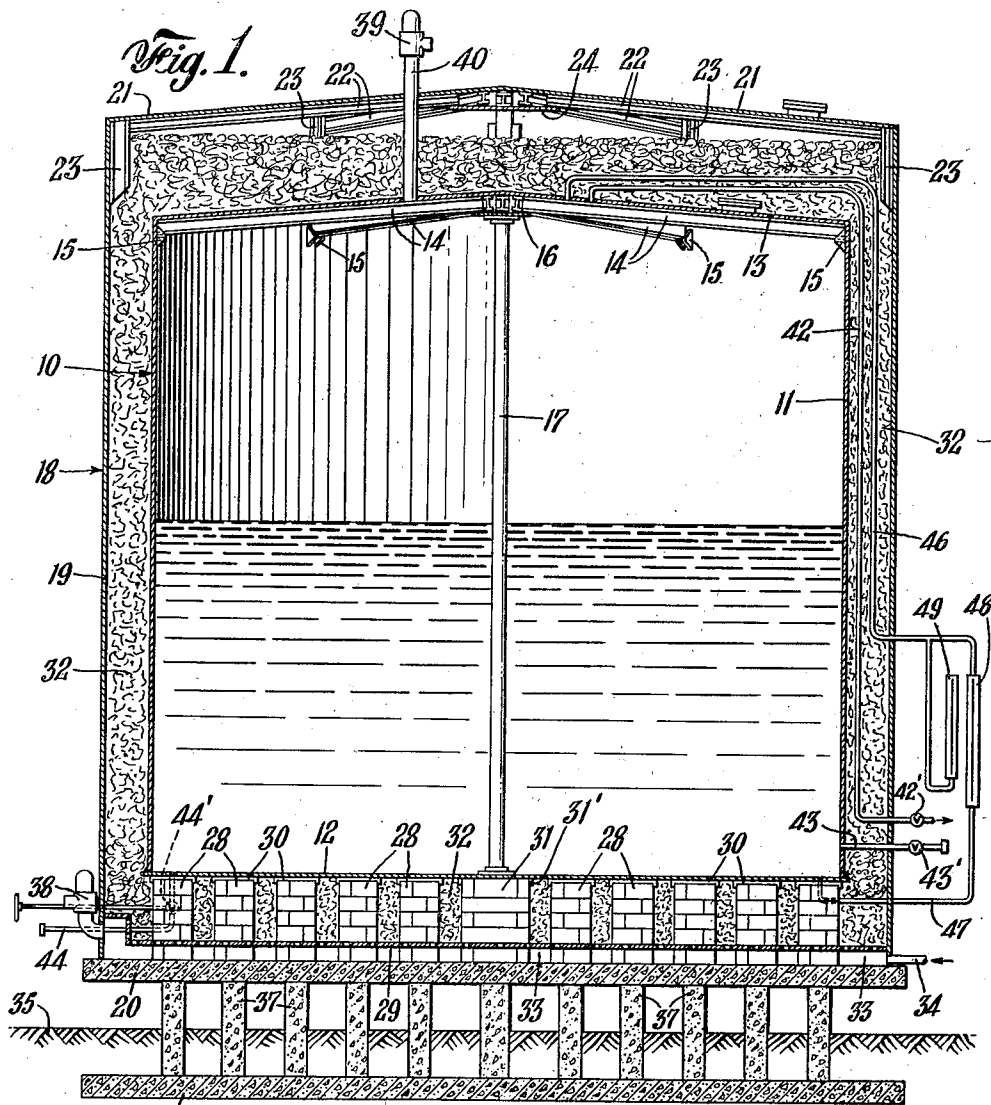


Aug. 29, 1950

H. C. KORNEMANN ET AL
CONTAINER FOR LIQUEFIED GASES
Original Filed July 11, 1942

2,520,883



INVENTORS
HENRY C. KORNEMANN
GEORGE W. PATCH, JR.

BY

E. L. Greenwald
ATTORNEY

UNITED STATES PATENT OFFICE

2,520,883

CONTAINER FOR LIQUEFIED GASES

Henry C. Kornemann and George W. Patch, Jr.,
Kenmore, N. Y., assignors to The Linde Air
Products Company, a corporation of Ohio

Original application July 11, 1942, Serial No.
450,644. Divided and this application Novem-
ber 4, 1944, Serial No. 561,868

8 Claims. (Cl. 220-10)

1

This invention relates to containers for holding cold liquids and more particularly to apparatus for the storage of a liquefied gas having a relatively low boiling-point temperature such as liquid oxygen.

In order to store liquefied gases having boiling-point temperatures below 233° K. such as liquid oxygen at atmospheric pressure or at pressures slightly above atmospheric pressure, it is necessary that the vessel holding the liquefied gas be well protected from the heat of the atmosphere so that losses due to evaporation are maintained at a low value. It is customary to envelope completely the liquid-holding vessel with a relatively thick layer of insulating material, and thoroughly protect such insulation from the effects of atmospheric moisture by providing a closed outer shell about the vessel and insulation. The insulating material customarily employed for a liquid oxygen container is a loose powder such as magnesium carbonate or a fibrous material such as mineral wool or a combination of such materials. Such insulation has a density such that it is only self supporting and cannot provide any support for the inner vessel. For moderate sized liquid oxygen containers the inner vessel is customarily supported in suspension by rods or cables secured to the outer shell or to a frame associated with the outer shell. For relatively large liquefied gas storage containers such method of supporting the inner vessel would require the provision of excessively heavy side walls for the outer shell or expensive and heavy bracing and frame construction.

It is a principal object of the present invention to provide an improved construction for containers for the storage of liquefied gases and particularly for containers of relatively large sizes. Other objects of the invention are to provide improved means for supporting the inner vessel of a liquefied gas storage container which shall permit free expansion and contraction of the inner vessel due to temperature changes, which shall avoid the transfer of excessive heat to the inner vessel, and which shall maintain the thickness of insulation around the lateral sides of the inner vessel substantially equal irrespective of the expansion and contraction due to temperature changes; to provide a container for liquefied gases of relatively large size having supporting means arranged to prevent frosting and heaving of the ground under the supporting means due to conduction of heat out of the ground to the vessel; and to provide for the distribution of a dry gas to all portions of the insulation contained be-

2

tween the inner vessel and outer shell of a liquefied gas container, and for the uniform release of excess gas pressure from all portions of the insulation.

These and other objects and novel features of the invention will become apparent from the following description and accompanying drawing, in which:

Fig. 1 is a view mainly in vertical section of a relatively large liquefied gas storage container embodying the principles of the present invention; and

Fig. 2 is a fragmentary detailed view on an enlarged scale showing two of the inner vessel supporting piers.

Referring now to the drawing the liquefied gas to be preserved is held within an inner vessel 10 which preferably has a vertical cylindrical or lateral side wall 11, and a horizontal flat bottom 12. The upper end of the vessel is preferably sealed by a head or roof 13 which may be dome shaped or flat, or preferably conical as shown. The head 13 might be made of metal thick enough to be self-supporting but it is preferably constructed of thinner sheet metal which is supported upon a series of radial rafters 14. The rafters 14 are supported at their outer ends on brackets 15 secured to the upper portion of the cylindrical wall 11. The inner ends of the rafters 14 are supported upon a circular plate 16 carried by a vertical column 17. The column 17 is substantially concentric with the cylindrical wall 11 and is supported on the bottom 12.

A shell 18 completely envelopes the inner vessel 10 to provide an insulating space all around the inner vessel. The shell 18 has a cylindrical wall 19 concentric with the wall 11 and a horizontal floor or bottom 20. Such floor may be made of sheet metal, if desired, but in the embodiment shown in Fig. 1 the floor 20 is made of reinforced concrete. The upper end of the outer shell 18 is closed by a sheet-metal roof 21 supported upon radial rafters 22 having their outer ends supported in brackets 23 secured to the upper portion of the cylindrical wall 19 and their inner ends secured to a circular plate 24.

The inner vessel 10 is supported on the floor 20 of the outer shell by supporting means comprising a suitable number of piers or supporting members 28. The supports 28 are spaced outwardly from the center of the bottom of the inner vessel at suitable positions, the greatest number of supports 28 being positioned adjacent the outer rim of the bottom 12. The supports 28 are shown as being preferably built up of brick-

3

shaped blocks of a material which has a low heat conductivity and sufficient compressive strength. In constructing the supports 28 the lower course of blocks is placed on the floor 20 and may be cemented thereto. A pervious sheet 29 which may be a screen such as a perforated plate or wire mesh is then placed upon the lower course of blocks. The remaining courses of blocks are then built up over the screen 29 to a desired height, such desired height being preferably a distance above the screen 29 slightly greater than the thickness of the insulation space between the cylindrical walls 11 and 19. On top of each pier 28 there is preferably placed a metal plate 30 having a smooth, flat upper surface. The plates 30 are grouted in place so that they are all at a uniform level.

The under surface of the bottom 12 of the inner vessel is smooth to form bearing surfaces for resting on the bearing surfaces of the plates 30. Between the bearing surfaces of the plates 30 and the bearing surfaces on the bottom 12, there is preferably provided an antifriction means. Such antifriction means should be of a character which retains its antifriction properties at the low temperature to which it is subjected when a liquefied gas is placed in the inner vessel. For example, when liquid oxygen is stored in the inner vessel the antifriction means should not become inoperative at temperatures as low as 90° K. A preferred material in such cases is graphite applied by coating the bearing surfaces of the plates 30 with a layer of flake graphite. Obviously, other materials might be employed or sets of rollers may be interposed between the bearing surfaces of the bottom 12 and the plates 30.

In addition to the supports or piers 28 there is provided a central pier or supporting member 31 which may be constructed similarly to the piers 28 but is not provided with antifriction means at its upper end. The central pier 31 serves to prevent general lateral displacement between the bottom 12 of the inner vessel and the floor 20 of the shell and thereby provides for equalized spacing of the inner vessel and said outer shell when said inner vessel has contracted a predetermined amount due to the introduction of liquefied gas or has expanded due to the removal of portions of the liquefied gas. The weight of the column 17 and the load on the central portions of the head 13 tend to clamp or anchor the bottom 12 tightly to the pier 31. Four lugs 31' may also be welded to the bottom 12 to engage with the sides of pier 31 in order to provide a positive anchorage against relative displacement between the bottom 12 and the floor 20. It will be seen that the above-described arrangement for supporting the inner vessel permits free expansion and contraction of the vessel in the horizontal plane and that such expansion and contraction cannot displace the inner vessel out of concentricity with respect to the outer shell so that the insulation thickness between the cylindrical walls 11 and 19 remains equal at all points.

The insulation space between the cylindrical walls 11 and 19 is completely filled with an insulating material 32 preferably comprising magnetism carbonate or mineral wool or a mixture thereof. The insulation 32 is added to a desired depth over the upper head 13 of the inner vessel and completely fills the space between the screen 29 and the bottom 12 of the inner vessel which is not taken up by the piers 28 and 31. It will be seen that the screen 29 supports the insulation 32

4

off the floor 20 to provide a free space 33 adjacent the floor 20. The screen 29 also acts to prevent any lateral shifting of the piers 28 and the piers 28 support the screen 29 at the desired level.

Sudden temperature changes such as will occur when first adding a cold liquefied gas to the inner vessel will cause contraction of the air held within the pores of the insulation 32. If the outer shell were hermetically sealed such contraction would cause a considerable reduction of pressure in the insulation space. With a very large storage container the pressure difference between the atmospheric pressure and the reduced internal pressure would tend to collapse the outer shell unless it were constructed strongly enough to resist such pressure changes. According to the present invention, it is possible to use a light-weight construction for the outer shell by counteracting such pressure changes by the addition of a dry gas under a slight superatmospheric pressure. Such dry gas is preferably a portion of the waste nitrogen customarily passed to the atmosphere in an air-separation plant. A supply of waste nitrogen is conducted from the liquid oxygen-producing plant through a conduit 34 which connects to the outer shell 18 at a point below the screen 29 and into the space 33. The space 33 thus permits rapid distribution of the dry nitrogen equally to the insulation 32. By thus maintaining a slightly superatmospheric pressure within the outer shell 18, it is possible to dispense with a metal bottom for the outer shell 18 since any slight leakage at the joint between the walls 19 and the floor 20 cannot permit the inflow of moist atmospheric air, the moisture of which would become condensed within the insulating material 32 and reduce its insulating value.

The floor 20 is preferably supported upon a foundation of such nature that excessive amounts of heat are not conducted out of the ground. A flow of heat always tends to occur from a warm region such as the ground, toward a cold region such as the very cold liquefied gas in the vessel 10. Thus, heat flows upwardly from the floor 20 toward the vessel 10. Such heat flow, if continuous for a period of time, would tend to lower the frost line in the ground so as to cause freezing below foundation levels. To counteract the tendency to freeze the ground, the floor 20 is elevated above the normal ground level indicated at 35. A foundation slab 36 is provided below ground level at a depth such that it is only slightly below the normal frost line and the floor 20 is supported upon the foundation slab 36 by a series of columns or piers 37 which are spaced apart and arranged to allow free circulation of atmospheric air around piers 37 and between the floor 20 and the ground 35.

In the event that an excessive pressure should develop within the shell 18 which might occur, for example, if the inner vessel should spring a leak and allow some liquefied gas to pass into the insulation space wherein it would rapidly vaporize, one or more safety valves 38 are provided. At least one of such safety valves 38 is connected to the shell 18 at a point where it will communicate with the space 33, which space will permit an equalized flow of gas out of the insulation 32 and free passage of such gas to the valve 38. The inner vessel 10 is similarly protected by a safety device 39. The valve 39 is connected to a conduit 40 which passes gas-tightly through the roof 21 to the upper head 13.

5

Suitable connections for supplying and drawing liquid or gas to and from the inner vessel 10 are also provided. Thus, a connection 42 leading from the head 13 through the wall 19 and controlled by a valve 42' is provided to withdraw vapors from the space above the liquid in the vessel 10. For supplying liquid to the vessel 10, there is provided a connection 43 controlled by a valve 43' which connection is at a lower portion of the wall 11 and passes through the wall 19. For the withdrawal of liquid from the container 10 for the purpose, for example, of filling a transport vehicle with a supply of liquefied gas, a connection 44 is provided leading from the bottom 12 through the wall 19. Connection 44 is controlled by a valve 44'. Other connections such as the upper and lower connections 46 and 47 for a liquid level gauge indicated at 48, may also be provided. A pressure gauge indicated at 49 may be connected to the connection 46.

It will be seen that certain features of the invention may be used independently of others and that changes may be made in certain features of the apparatus without departing from the essentials of the invention. For example, the supporting members 28 could, if desired, be of monolithic construction and made by casting a suitable insulating material in molds or the supporting members could be constructed of metal of small cross-sectional area and having a relatively low heat conductivity. Obviously, the length of the supports may be increased to reduce their heat conductivity.

When it is desired to operate the inner vessel 10 at maximum pressures in excess of atmospheric it will be preferable to weight the head 13 sufficiently to resist the upward force of gas pressure against the head rather than make the head of a shape and strength sufficient to resist the internal pressure. Such weight may be provided by; increasing the number of steel rafters 14 and welding or otherwise securing them to the head 13, by increasing the size and weight of the rafters 14, by placing weights such as scrap rails on top of the head 13, or by otherwise loading the head 13 such as by placing concrete in slab form thereon.

This application is a division of the abandoned joint application of James G. Van Vleet, George W. Patch, Jr., and Henry C. Kornemann, Serial No. 450,644, filed July 11, 1942.

What is claimed is:

1. An apparatus for the storage of liquids and/or gases comprising a large inner vessel for holding the liquids and/or gases having side and bottom portions subject to expansion and contraction, an outer shell enveloping said inner vessel and spaced from the portions thereof, said outer shell having a bottom or floor, means for spacing the bottom portion of the inner vessel from the bottom or floor of the outer shell for supporting the inner vessel, said spacing means being so constructed as to allow for lateral contraction and expansion of the bottom portion of the inner vessel relative to the bottom of the outer shell, and means for anchoring centrally thereof the bottom portion of the inner vessel to the outer shell to prevent general relative horizontal displacement therebetween.

2. An apparatus for the storage of liquids and/or gases comprising an inner vessel for holding the liquids and/or gases, an outer shell enveloping said inner vessel and spaced therefrom to provide an insulating space therebetween, means for supporting said outer shell in an up-

6

right position, supporting members spaced outwardly from the center of the bottom of said inner vessel and extending upwardly from the bottom of said outer shell, said supporting members being provided with smooth flat horizontal upper bearing surfaces, horizontal flat surfaces on said inner vessel positioned to rest on said upper surfaces of said supporting members, the arrangement of said supporting members and horizontal surfaces being such as to support and maintain the inner vessel in desired spaced relation to the outer shell, and a support disposed centrally of the bottom of said inner vessel between the bottom of the inner vessel and the bottom of the outer shell, such central support being arranged to prevent any general horizontal relative displacement between the central bottom portion of the inner vessel and the outer shell.

3. An apparatus for the storage of liquids and/or gases comprising an inner vessel for holding the liquids and/or gases, an outer shell enveloping said inner vessel and spaced therefrom to provide an insulating space therebetween, means for supporting said outer shell in an upright position, supporting members spaced outwardly from the center of the bottom of said inner vessel and extending upwardly from the bottom of said outer shell, said supporting members being provided with smooth flat horizontal upper bearing surfaces, horizontal flat surfaces on said inner vessel positioned to rest on said upper surfaces of said supporting members, the arrangement of said supporting members and horizontal surfaces being such as to support and maintain the inner vessel in desired spaced relation to the outer shell, a support disposed centrally of the bottom of said inner vessel between the bottom of the inner vessel and the bottom of the outer shell, such central support being arranged to prevent any general horizontal relative displacement between the central bottom portion of the inner vessel and the outer shell, and antifriction means between the surfaces of said inner vessel and the corresponding surfaces on said supporting members, said antifriction means being of a character having adequate antifriction properties at the temperature of said liquids and/or gases, whereby said inner vessel may freely contract and expand radially with respect to said outer shell.

4. Apparatus for the storage of liquefied gas comprising an inner vessel for holding the liquefied gas, an outer shell enveloping said inner vessel and spaced therefrom to provide an insulating space, said vessel and said shell being cylindrical and having their main axes vertical and substantially coincident, the bottom of said vessel and the floor of said shell being substantially horizontal; means for supporting said outer shell in upright position; a central supporting pier having its vertical axis substantially coinciding with said main vertical axis and extending from the floor of said outer shell to the bottom of said inner vessel, such central pier being arranged to prevent general horizontal relative displacement between the central bottom portion of the inner vessel and the outer shell; a plurality of additional supporting members extending from the floor of said outer shell to the bottom of said inner vessel for supporting the same; a roof sealing the upper end of said inner vessel; a column resting on the bottom of said inner vessel immediately above said central pier and extending to the middle of said roof to support the same; and means for loading

7

said roof sufficiently to prevent upward displacement thereof when the pressure in said inner vessel reaches the maximum working pressure.

5. An apparatus for the storage of liquids and/or gases comprising an inner vessel for holding the liquids and/or gases, an outer shell enveloping said inner vessel and spaced therefrom to provide an insulating space therebetween, means for supporting said outer shell in an upright position, supporting members spaced outwardly from the center of the bottom of said inner vessel and extending upwardly from the bottom of said outer shell, said supporting members being provided with smooth flat horizontal upper bearing surfaces, horizontal flat surfaces on said inner vessel positioned to rest on said upper surfaces of said supporting members, the arrangement of said supporting members and horizontal surfaces being such as to support and maintain the inner vessel in desired spaced relation to the outer shell, a foundation platform positioned below ground level at a depth greater than the normal frost line, and a series of supporting piers extending upwardly from said platform to the bottom of said outer shell, said piers extending above ground level and providing space between them and between the ground level and the bottom of said outer shell for free circulation of air.

6. Apparatus for the storage of liquefied gas comprising an inner vessel for holding the liquefied gas, an outer shell enveloping said inner vessel and spaced therefrom to provide an insulating space; means for supporting said outer shell in upright position; supporting members extending from the floor of said outer shell to the bottom of said inner vessel for supporting the same; insulating material in the space between said vessel and said shell; and a pervious insulation supporting sheet disposed between the bottom of said inner vessel and the floor of said outer shell said sheet being relatively closer to said shell and arranged to support said insulating material be-

8

tween it and the inner vessel and to provide an insulation-free space adjacent the floor of said outer shell.

7. Apparatus for the storage of liquefied gas according to claim 6 which includes a pressure relief device connected to said outer shell to communicate with said insulation-free space, and means for supplying a moisture-free gas to said insulation-free space.

8. Apparatus for the storage of liquefied gas comprising an inner vessel for holding the liquefied gas; an outer shell enveloping said inner vessel and spaced therefrom to provide an insulating space; means for supporting said outer shell in upright position; a plurality of supporting piers extending upwardly from the floor of said outer shell to the bottom of said inner vessel, the piers which are spaced away from the center of said inner vessel having means at their upper ends permitting relative movement between them and the bottom of the inner vessel due to expansion and contraction of the inner vessel; a screen substantially parallel to and spaced from the floor of said outer shell, said screen passing transversely through said piers whereby the piers hold the screen in position and the screen holds the piers against lateral displacement; and insulating material in the space above said screen and enveloping said inner vessel.

HENRY C. KORNEMANN.
GEORGE W. PATCH, JR.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,260,570	John	Oct. 28, 1941
2,303,126	Koppel	Nov. 24, 1942
2,332,227	Jackson	Oct. 19, 1943