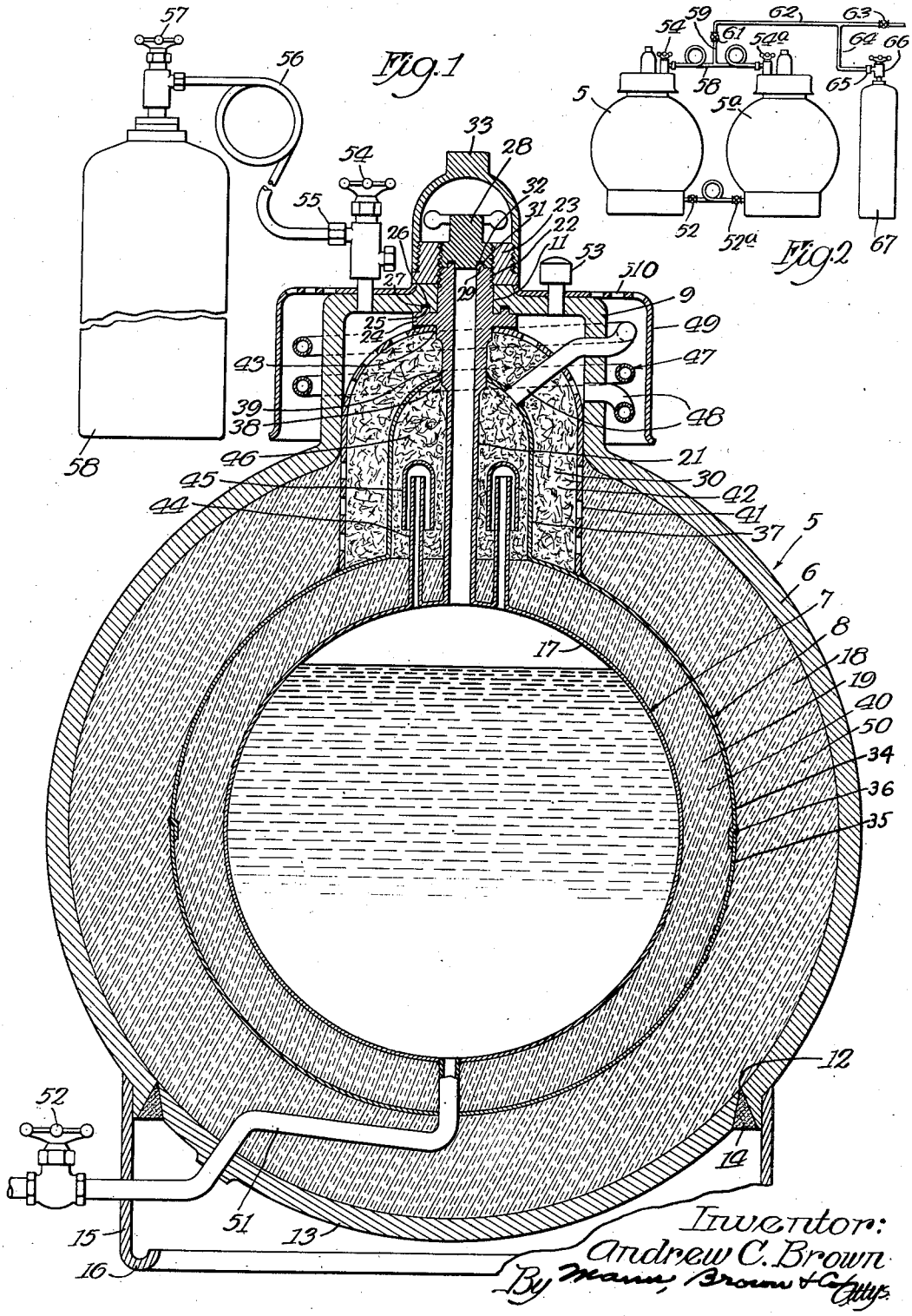
March 26, 1940. A. C. BROWN 2,195,077

PRESSURE CONTAINER FOR LIQUEFIED GASES

Filed July 11, 1938



Patented Mar. 26, 1940 2,195,077

UNITED STATES PATENT OFFICE

2,195,077

PRESSURE CONTAINER FOR LIQUEFIED GASES

Andrew C. Brown, Wilmette, Ill., assignor to Compressed Industrial Gases, Inc., a corporation of Delaware

Application July 11, 1938, Serial No. 218,522

14 Claims. (Cl. 62—1)

This invention relates to a method of and apparatus for storing, transporting and dispensing liquid material volatile at normal atmospheric temperature and pressure and more particularly to liquefied gases which, when under atmospheric pressure, can be stored in the liquid phase only when their temperatures are far below 0° C.

One of the objects of the invention is the provision of a new and improved container which combines the desirable features of a pressure container and the conventional Dewar type of flask for the storing, transporting and dispensing of gases in the liquid phase.

Another object of the invention is the provision of a new and improved container having a plurality of receptacles in addition to the liquid receptacle and provided with novel means for equalizing the pressure throughout the interior of the container whereby the walls of the receptacle which encloses the gas in the liquid phase will not be subjected to unequal pressure on their exterior and interior sides except for the weight of the liquid.

A further object of the invention is the provision of a new and improved liquefied gas container having an outer shell for resisting pressure developed within the container by the evaporation of the liquefied gas contained therein and an inner receptacle of comparatively thin material for containing the gas in the liquid phase together with means for maintaining an equalized pressure and a desirable temperature gradient between the interior of the receptacle and the atmosphere.

Another object of the invention is the provision of a new and improved container for gases in both the liquid and gaseous phase that is provided with a receptacle for the liquefied gas and has one or more gas containing spaces surrounding the receptacle that are in communication with the receptacle and that contain gas adsorbing and absorbing material for refrigerating the inner receptacle, providing a proper temperature gradient between the inner receptacle and the atmosphere, and for reducing the thermosyphon action of the gas to a minimum.

A still further object of the invention is the provision of a new and improved container for liquefied gas having a plurality of chambers surrounding the same for containing the evaporated gas together with means for removing such gas for commercial uses as desirable or as occasion may require.

Another object of the invention is the provision of a new and improved liquefied gas container that is simple in construction, inexpensive to manufacture, that may be readily assembled and that is efficient in use.

Other and further objects and advantages of the invention will appear from the following description, taken in connection with the accompanying drawing, in which—

Fig. 1 is a vertical section of a portion of the apparatus showing the container in vertical section, and with parts broken away; and

Fig. 2 is a side elevation of the apparatus showing the connections in transferring the liquefied gas and in which parts are broken away.

Referring now to the drawing, the reference character 5 designates the container in which the liquefied gas is adapted to be stored or transported and comprises an outer or pressure resisting receptacle 6, an inner receptacle 7 for the liquefied gas and an intermediate receptacle 8, all of which are of suitable forms and constructions. In the form of the construction shown, which is by way of example only, the outer receptacle 6 is spherical and its upper portion is provided with an elongated neck or projection 9 having an opening 11 in its upper end. The receptacle 6 may be of any suitable construction and material so long as it is adapted to resist considerable pressure at low temperatures. The material is that conventionally employed for gas container cylinders such as nickel or a nickel alloy or the like. This receptacle may be made of any approved type but for the purposes of convenience of assembly, the receptacle is originally made with an opening 12 in its lower portion which is of sufficient width to permit the insertion of an assembly comprising the remaining containers, as will presently appear.

The opening 12 is adapted to be closed by a lower section 13 when the parts have been assembled and is then secured in position by any suitable means such as the weld 14. The edges are arranged at an acute angle to the radius of the receptacle whereby materially increased surfaces are exposed to the weld material 14. A base or support 15, which may be cylindrical in form with a rolled lower edge 16, is attached to the lower side of the receptacle 6 for supporting the same as clearly indicated on the drawing.

The vessel for containing the liquefied gas is mounted within the pressure resisting receptacle 6 and comprises what may be termed the inner receptacle or container which may be of any appropriate form and preferably, though not necessarily, has its wall 17 concentric with the

pressure resisting receptacle 6 and the intermediate receptacle 8 and is spaced inwardly from the intermediate receptacle to form an inner insulating chamber 19 which is adapted to be filled with gas adsorbing or insulating material 40. The intermediate receptacle 8 is spaced inwardly from the pressure resisting receptacle 6 to form an outer chamber 18 adapted to be filled with heat insulating material 50.

The inner receptacle 7 is of the Dewar type; that is, it has a very thin wall and is spaced from the intermediate wall 8 and in order to support the same, it is provided with an elongated stem or neck 21 extending upwardly through the opening 11 in the projection 9 and is threaded at its upper end as at 22 and is of such material and form as to reduce conduction of heat to the inner receptacle to a minimum. The upper end of the neck is held in the opening 11 by a nut or threaded sleeve 23 which engages the threaded portion of the neck and rests on the upper surface of the projection 9. The upper end of the neck 21 is provided with an annular flange 24 having an upwardly extending rib 25 which is adapted to engage in a corresponding groove or circular depression 26 on the lower surface of the extension 9. A suitable gasket 27 may be interposed between the rib 25 and the bottom of the groove 26 in order to form a gas-tight joint between these members. The nut or sleeve 23 has its upper end extending above the neck 21 for receiving a threaded plug 28 which is adapted to be screwed downwardly into the sleeve 23 as clearly shown in Fig. 1 of the drawing. The plug 28 is preferably provided with a circular groove 29 for receiving a circular lip or projection 31 on the upper end of the neck 21. A suitable gasket 32 is adapted to be clamped between the upper end of the lip or projection 31 and the bottom of the groove 32 for forming a gas-tight joint at this point. A cap 33, internally threaded at its lower end, is adapted to be attached to the upper exteriorly threaded end of the sleeve or nut 23 for enclosing the plug 28. It will thus be seen that the neck 21 is adapted to support the inner receptacle 7 within the pressure resisting receptacle 6.

The wall 17 of the receptacle 7 is made very thin and is preferably of an alloy that does not become brittle at the temperature of the liquefied gas contained therein, such, for instance, as silicon bronze, or the like. In order that the wall may be of thin material, it is necessary that means be provided for equalizing the pressure on the inner and outer sides of this wall. It is also desirable that means also be provided for normalizing the heat on the two sides of the wall of the receptacle 6 and to so insulate the walls 6 and 17 that a minimum of heat will be transferred to the wall 17.

Any suitable arrangement may be employed for this purpose. In the form of the device selected to illustrate one embodiment of the invention, which is by way of example only, the intermediate container 8, together with suitable insulating material on each side thereof, together with a heat exchanging device, is used for this purpose.

The intermediate receptacle 8 is adapted to contain the inner receptacle 7 and in turn is contained in the outer receptacle 6. Its walls are spaced from the walls of the inner and outer receptacles to form insulating spaces 18 and 18. In order that the inner receptacle 7 may be positioned within the intermediate receptacle 8 when assembling the device, the latter is made in sections. As shown, the intermediate receptacle comprises an upper section 34 and a lower section 35 which, after the insulating and adsorbing material and the inner receptacle are placed in position therein, are overlapped and welded together as at 36. The upper section 34 terminates in an integral upwardly extending imperforate dome section 37 in communication with the receptacle 8 and has an opening 38 in its upper portion through which an enlarged portion of the stem 21 of the inner receptacle extends. A suitable weld 39 rigidly connects the dome to the neck 21 and forms a gas-tight joint therewith.

The intermediate receptacle 8 is also provided with an upwardly extending dome 41 of foraminous material which surrounds the dome section 37. The space 30 between the dome sections 37 and 41 is preferably filled with fibrous insulating material 42 as mineral wool, or the like, which functions as a filter for preventing entrainment of the insulating material contained in the insulating space or chamber 19 when gas is removed from said chamber, as will presently appear.

The dome shaped member 41 is rigidly connected at its lower end to the receptacle 8 as by being welded thereto but is not in direct communication therewith. The dome member 41 extends upwardly into the neck or projection 9 of the outer receptacle and is of such diameter as to engage the side walls thereof. It is provided with an axial opening 43 for receiving the enlarged end of the neck or stem 21 below the flange 24 and is welded to said flange, as clearly shown in Fig. 1 of the drawing.

It is desirable that means be provided for refrigerating the outer surface of the inner receptacle 7 in order to retard the evaporation of the liquefied gas contained therein. In order to accomplish this function, the insulating chamber 19 is filled with material that has a maximum adsorbing property or is filled with a mixture of gas adsorbing and insulating material such, for instance, as magnesium carbonate and activated alumina, or, if desired, this space may be filled entirely with gas adsorbing material such as activated alumina or with suitable insulating material alone. In any case, the material used is of such porosity as to permit a ready equalization of pressure on both sides of the wall 17 without any objectionable effects of thermo-syphon action due to the difference of temperature on opposite sides of the wall of this chamber, as will appear hereinafter.

Appropriate means are provided for permitting an equalization of the pressure on opposite sides of the wall 17 of the inner receptacle. In the form of the device selected to illustrate one embodiment of the invention, which is by way of example only, one or more conduits 44 are provided adjacent the neck 21 and are secured in the upper portion of the wall 17 and extend upwardly in the dome member 37 and have their upper ends shielded by cup member 45 held in position by the insulating material 46 which fills the dome member 37 and surrounds the cup member 45. The insulating material 46 may be, and preferably is, mineral wool or other filter material which will prevent the entrainment of the insulating material 40 through the heat exchanger, as will presently appear.

The tubes 44 extend upwardly from the upper portion of the inner receptacle and are elongated

and of smal bore so that the liquefied gas will not pass over into the insulating chamber 19 during the agitation of the liquid incident to its handling during transportation of the container.

Suitable means are provided for normalizing the temperature on opposite walls of the receptacle 6 and at the same time equalizing the pressure on both sides of the walls of the intermediate receptacle 8. In order to normalize the temperature on opposite sides of the wall of the outer receptacle 6 and establish a gradient temperature between the inner receptacle and the exterior of the outer receptacle and incidently raising the temperature of the gas contained in the outer insulating chamber 18, a heat exchanging device 47 extending to the exterior of the container 5 is provided. This heat exchange device 47 comprises a conduit or metal tube 48 having its inner end rigidly secured in the upper end of the dome member 37 and extending through the neck 9, being coiled around the neck or projection 9 of the outer receptacle and having its outer end rigidly secured in the neck or projection 9 of the outer receptacle as clearly shown in Fig. 1 of the drawing. The tube 48 places the interior of the dome 37, and with it the interior of the chamber 19, in communication with the outer insulating chamber 18 thereby permitting equalization of the pressure on opposite sides of the walls of the receptacle 8. A guard in the form of an inverted cap 49 extends about the coil of the heat exchanger 47 and is provided with openings 510 in its upper wall for permitting circulation of air over the tube 48. The lower edge of the shield or cup member 49 is spaced from the wall of the outer chamber and its top portion is provided with an opening for receiving a boss on the extension 9. The threaded sleeve 23 holds the shield or cup member in position.

Suitable means are provided for removing the liquefied gas from the container. As shown, a conduit 51 having one end secured in the lower portion of the wall of the inner container and extending outwardly through the intermediate container and the outer container is provided with a valve 52 for this purpose. In order to limit the pressure developed by the evaporated liquid gas within the container 5, a safety valve 53 on the upper end of the projection 9 of the outer receptacle 6 is provided. This valve may be set to operate at any suitable pressure so that when the pressure exceeds the predetermined amount, the valve will open and permit gas to escape from the interior of the outer receptacle 6 through this valve.

In the use of the device, the liquefied gas being supplied to the inner container 7 will slowly evaporate and as it evaporates, it will pass over into the insulating chamber 19 through the passages 44 for equalizing the pressure on both sides of the wall 17 of the receptacle and as the pressure increases, gas will pass from the dome member 37 through the heat exchange device 47 into the insulating chamber 18 thereby equalizing the pressure between the chambers 18 and 19 and since the gas has been passed through the heat exchanger, the temperature of the gas in the outer insulating chamber 18 will be above that in the chamber 19 but will be below that of the atmosphere so that there will be a heat gradient between the temperature of the liquid on the inside and the atmosphere on the outside of the container. In other words, the heat will be normalized on the opposite sides of the outer container and the pressure will be equalized on both sides of the walls of the inner and intermediate containers, the pressure being resisted solely by the wall of the outer container 6.

Suitable means are provided for removing gas from the container 5. As shown, a valve 54 is employed for this purpose. The valve has its lower end fixed in the upper wall of the projection or neck 9 and is provided with a fitting 55 for attachment to a conduit 56 which in turn is connected to a hand valve 57 in communication with a gas containing cylinder 58. In supplying gas to the cylinder 58, the parts are connected as just described and as shown in Fig. 1 and when the valves 54 and 57 are opened, the gas, under pressure, will flow from the chamber 18 through the insulating material contained in the dome 41 and through the valve and passage 56. Simultaneously with this movement, gas will pass from the inner insulating chamber 19 to the outer insulating chamber and from the receptacle 7 into the chamber 19 for equalizing the pressure. Gas will thus be supplied to the storage cylinder 58 at a higher temperature than if taken directly from the inner chamber 7.

In Fig. 2 is shown, more or less diagrammatically, means for supplying gas in a liquid phase to the container 5 from a similar container 5a. The valves 52a and 54a of the container 5a containing the liquid gas, being closed during the transporting of the liquid, are now connected to the valves 52 and 54, respectively, of the container 5 to be supplied with the liquid gas. Assuming that the container 5 contains more or less liquefied gas and that the pressure therein is greater than that of the container 5a, the valves 54 and 54a are connected by a conduit 58 which has a branch conduit 59 having a valve 61 therein. The valve 61 is placed in communication with the gas line 62 which has a valve 63 therein and also has a branch conduit 64 with a connector 65 thereon which may be attached to the valve 66 of a gas storage cylinder 67.

In order to reduce the gas pressure in the container 5, the parts are connected as described above, the valve 63 is closed, the valves 66, 61 and 54 are opened to permit the escape of the gas from the container 5 into the cylinder 67 thereby reducing the pressure in the container 5. The valves 66 and 54 are now closed and the valves 52 and 52a may be opened whereby the pressure in the container 5a will force the liquid into the container 5. The pressure in the two containers may be equalized, if desired, by opening the valves 54 and 54a but if it is not desired to equalize the pressure in the two containers after the liquid is transferred, the valves 52 and 52a are closed and the connectors between the containers may then be removed.

It is understood that the outer or pressure resisting receptacle 5 is of such material and so constructed as to be capable of resisting high pressures, as much as 200 atmospheres, for instance. It is not uncommon for pressures from 100 to 150 atmospheres to be developed within the receptacles 7 and 8 during handling and transportation of the container, but since the pressure is equalized on both sides of each of the receptacles 7 and 8, these receptacles are not affected by such pressures. Since pressure elevates the boiling points of any liquid, high pressures within the container greatly impede evaporation of the liquefied gas and consequently the same remains in the liquid phase to a very

large extent after high pressure develops within these containers.

It is thought from the foregoing, taken in connection with the accompanying drawing, that the construction and operation of my device will be apparent to those skilled in the art and that changes in size, shape, proportion and details of construction may be made without departing from the spirit and scope of the appended claims.

I claim as my invention:

1. A container for storing and transporting liquefied gases comprising an outer pressure resisting receptacle, an inner thin wall receptacle within said outer receptacle and spaced therefrom for forming a space for containing liquefied gases, a long, narrow passage leading to opposite sides of the wall of said inner receptacle, a cup member over the upper end of said passage, said cup member being in spaced relation to said passage, gas absorbing material surrounding said passage and cup member, and means for refrigerating the outer wall of said inner receptacle, said means comprising gas adsorbing material within said space.

2. In a container for storing gases in both the liquid and gaseous phases which comprises an outer pressure resisting receptacle, an inner receptacle having a thin wall for containing liquefied gas spaced inwardly from the walls of said outer receptacle to form a chamber enclosing said inner receptacle, and means including a heat exchanging device in communication with said inner receptacle and extending to the exterior of said outer receptacle for supplying evaporated liquefied gas at an elevated temperature to said chamber from said inner receptacle.

3. In an apparatus of the class described, an outer pressure resisting receptacle, an inner receptacle for containing a liquefied gas of low boiling point supported within the walls of said vessel and spaced therefrom, gas adsorbing material in the space between said receptacles, a heat exchange device for placing said receptacles in communication, said device extending about a portion of the exterior of said outer receptacle, and means for conducting gas from said inner vessel to said adsorbing material.

4. In an apparatus of the class described, an outer pressure resisting receptacle, an inner thin wall liquefied gas receptacle, a plurality of gas containing chambers surrounding said inner receptacle, means for conducting gas evaporated from the liquid in said inner receptacle to each of the chambers for equalizing the pressures therein, said means comprising a heat exchange device extending about portions of said outer receptacle.

5. In an apparatus of the kind described, an outer receptacle for resisting gas pressures, an inner receptacle adapted to hold liquefied gas, the walls of said receptacles being spaced apart to form an insulating chamber between the walls of said receptacles, a porous insulating material in said space, means for filling said chamber with gas at a low temperature and for retaining the same therein at high pressure, and a tube for conducting gas from said inner receptacle to said outer receptacle, said tube extending to the exterior of said outer receptacle.

6. In a container for liquefied gas, an outer receptacle adapted to resist the pressure of gases, an inner receptacle having thin walls adapted to hold gas in a liquid stage, an intermediate receptacle having a thin wall intermediate the walls of said other two vessels, the construction being such as to leave a space between the wall of said inner vessel and said intermediate wall, and a space between said intermediate wall and said outer wall, said inner vessel opening to the first-named space, a heat exchanger, the first-named space opening through said heat exchanger to the other of said spaces, and porous insulating material in said spaces.

7. In an apparatus of the kind described, a container for gas in liquid and gaseous stages comprising an outer receptacle adapted to sustain the pressure of the gases, an inner receptacle adapted to hold the liquefied gas, an intermediate receptacle having a wall intermediate the walls of said other two vessels, said walls being concentric and spaced apart to form an inner and an outer insulating chamber, insulation in said chambers, a passage between said inner receptacle and said inner chamber for equalizing the pressure of gas on the walls of said inner receptacle, a passage between said inner and outer chambers, said outer receptacle having a cylindrical upstanding projection, said last-named passage extending about said upstanding projection on the exterior thereof, and a discharge passage for gas in communication with the interior of said upstanding cylindrical projection.

8. In a container for gas in both liquid and gaseous stages, an outer receptacle adapted to sustain the pressure of the gases, an inner receptacle adapted to hold the liquefied gas, a third receptacle having a wall intermediate the walls of said other two receptacles, the construction being such as to leave a space between the wall of said inner vessel and said intermediate wall, a space between said intermediate wall and said outer wall, said inner receptacle opening to the first-named space, a heat exchanger, the first-named space opening through said heat exchanger to the other of said spaces, porous insulating material in said spaces, adsorbent material in the first-named space, and means for withdrawing gas from the last-named space.

9. In a container for gas in both liquid and gaseous stages, an outer receptacle having a pressure resisting wall and provided with an upstanding projection forming an outer restricted space, an inner liquid containing receptacle having an elongated neck extending upwardly through said projection, means for securing said neck to said projection, an intermediate receptacle, the walls of said intermediate receptacle forming an upwardly extending dome, mineral wool in said dome, a conduit extending from the wall of said inner receptacle into said dome, a dome member of foraminous material surrounding said first-named dome, spaced therefrom and secured to the walls of said intermediate receptacle, mineral wool in the space between said dome and dome member, a conduit extending from said inner dome through said dome member and upstanding projection and coiled about the exterior of said projection and having its inner end extending through the wall of said upstanding projection, said inner and intermediate receptacle being spaced apart to form an inner and an outer insulating chamber, magnesium carbonate and activated alumina in said inner chamber and magnesium carbonate within said outer chamber whereby the pressure developed by the evaporation of the liquefied gas in said inner container will be equalized on both surfaces of the walls of said inner and inter-

mediate receptacles, and the temperature on both sides of the wall of said outer receptacle will be normalized.

10. In a container for transporting and storing gases in liquid and gaseous phases comprising an outer receptacle, a plurality of inner receptacles, said receptacles having substantially concentric walls, and means for equalizing the internal pressures within said receptacles regardless of the pressures developed, said means including a tube having one end in communication with one of said inner receptacles and its other end in communication with the outer receptacle and having its central portions coiled about a portion of said outer receptacle.

11. In an apparatus of the kind described, an outer receptacle having thick walls for resisting pressure of gases, an inner receptacle supported within said outer receptacle in spaced relation thereto and adapted to hold liquefied gas, the walls of said receptacles spaced apart to provide a gas receiving space, a porous insulating material in the space between said receptacles, an intermediate receptacle between said inner and outer receptacles, a passage between said inner and intermediate receptacles and a passage between said intermediate and outer receptacles, whereby the pressure on opposite sides of the walls of said inner and intermediate receptacles will be equalized and the temperature of the gases within said receptacles will be gradually warmer from the innermost on outward.

12. In an apparatus of the kind described, an outer receptacle provided with an upwardly extending neck portion having an integral closure, said closure having an axial opening and provided on its inner side with an annular recess surrounding said opening, a gasket in said opening, said receptacle having heavy walls for resisting pressure of gases adapted to be contained within said receptacle, an inner receptacle adapted to hold liquefied gas, said inner receptacle having an elongated neck on its upper portion extending upwardly through said opening and having a flange extending about the same, said shoulder having an upwardly extending rib engaging said gasket, means for clamping said rib against said gasket, means engaging said neck for supporting said inner receptacle from said outer receptacle with a space about said inner receptacle, a porous insulating material in said space, said inner vessel being in communication with said space, and an adsorbent material in said space.

13. In an apparatus of the class described, a container for gas in liquid and gaseous phases comprising an inner receptacle, an outer receptacle surrounding said inner receptacle, an intermediate receptacle within said outer receptacle and surrounding said inner receptacle and having its walls spaced from the walls of said inner and outer receptacles, and means including intercommunicating passages between said inner and intermediate receptacles and between said intermediate and outer receptacles for equalizing the pressure within said receptacles regardless of the pressures developed within any of said receptacles.

14. A container for storing and transporting liquefied gases comprising an outer pressure resisting receptacle, an inner receptacle for containing a liquefied gas surrounded by said outer receptacle and spaced inwardly thereof to form an insulating space between said receptacles, means for placing the interior of the inner receptacle in communication with the space between said inner and outer receptacles for equalizing the pressure on opposite sides of the wall of the inner receptacle, said means comprising a heat exchange device carried by said outer receptacle exteriorly thereof, means for conducting liquefied gas from said inner receptacle, and means for conducting gas from said space between said receptacles.

ANDREW C. BROWN.