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APPARATUS FOR STORING AND DISPENSING LIQUEFIED GASES

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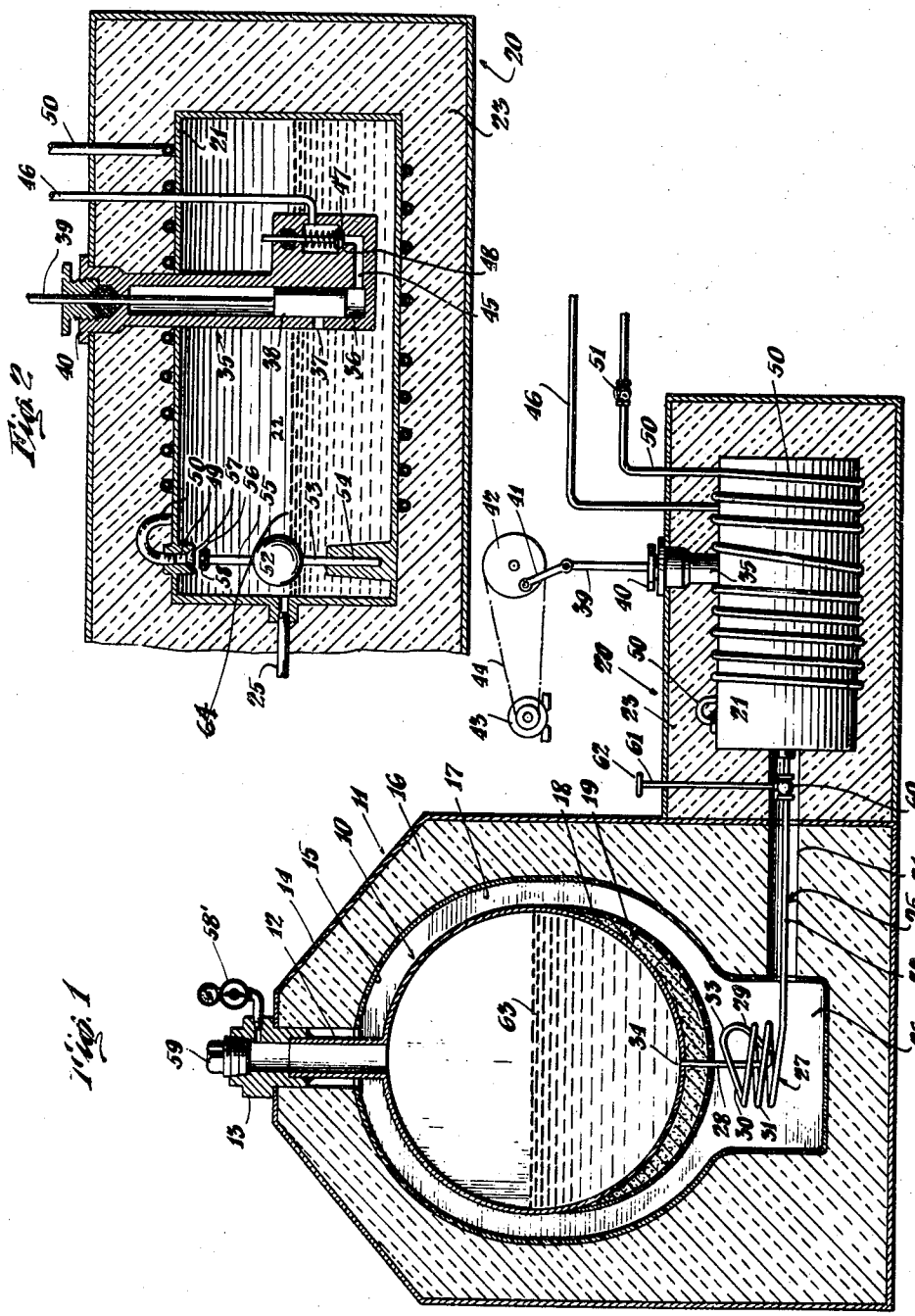


Fig. 2

Fig. 1

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APPARATUS FOR STORING AND DISPENSING LIQUEFIED GASES

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9 Claims. (Cl. 62—1)

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This invention relates to apparatus for storing, transporting and dispensing liquids which are volatile at normal atmospheric pressure and temperature, such liquids being those commonly known as liquefied gases, such liquefied gases having a relatively low boiling point. Liquid oxygen is an example and its characteristics with respect to evaporation and volatility are representative of the kind of liquids with which the invention is concerned.

The invention has for its object generally to provide apparatus in which liquid oxygen, and other liquefied gases, such for example as nitrogen and the like may be stored and transported, and from which the liquefied gas may be dispensed while stored at relatively low pressure to a receiving container under relatively much higher pressure.

According to one embodiment of the invention there is provided an apparatus which comprises a vacuum insulated storage chamber enclosed in a housing for holding the liquefied gas, an auxiliary or pumping chamber outside this housing, a relatively long conduit bent in peculiar shape, as hereinafter described, connecting the storage chamber and pumping chamber, and pumping means associated with the auxiliary chamber whereby the liquefied gas at relatively low pressure may be transferred from the storage chamber to a receiving container at relatively much higher pressure. Also, the pumping chamber embodies means, hereinafter described, for utilizing escaping gas to maintain that chamber cool and also means, when the pumping mechanism is in use, for maintaining a substantially constant body of liquefied gas in the pumping chamber to insure a supply of liquid to the pump.

Although the novel features which are believed to be characteristic of the invention are pointed out in the claims appended hereto, the invention itself as to its objects and advantages and the manner of constructing the apparatus and the manner of using it may be better understood by reference to the following description taken in connection with the accompanying drawings forming a part hereof, in which,

Fig. 1 is a view in cross-section of an apparatus constructed according to the invention, certain parts of which are shown more or less diagrammatically; and

Fig. 2 is a view in cross-section to larger scale of that part of the apparatus shown in Fig. 1 comprising the pumping chamber, pumping mechanism, float valve and its associated parts.

Referring to the drawings, in which like reference characters represent corresponding parts, the apparatus shown is for storing, transporting and dispensing liquid oxygen although it will be understood that apparatus according to the invention may be used for the same purpose in connection with other liquefied gases having a relatively low boiling point of the same order as liquid oxygen.

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As shown in the drawings, a metal storage container 10 is mounted in a housing 11. The container 10 may be of a standard known construction. It has a neck 12 suspended from an adapter 13 carried on the housing. The housing is of double wall construction having an outer wall 14 and an inner wall 15 between which is inserted a suitable insulating material 16, such, for example, as magnesia. There is provided a space 17 between the container 10 and the inner wall 15 of the housing. This space is evacuated and thus a vacuum insulated storage container 10 is provided. A foraminous tray 18 is suspended on the container 10. This tray carries an adsorptive material 19, such as charcoal, for adsorbing gases which might find their way into the vacuum space 17. This aids in maintaining the vacuum.

Secured to the outer wall 14 of the housing 11 is an auxiliary housing 20. This housing covers an auxiliary metal container 21 which provides a pumping chamber 22. The space between the outer walls of the housing 20 and the container 21 is filled with a suitable insulating material 23, such, for example, as magnesia. It will be observed that a conduit 24 connects with the vacuum space 17 and extends to the container 21.

The container 21 which is below the bottom of the storage container 10 is connected to the storage container by a relatively long tube 25. This tube is a relatively thin wall metal tube of low heat conductivity and it will be noted that it is positioned within the vacuum space 17, the inner wall 15 of the housing 11 being provided with a pocket 26 to accommodate a substantial length of the tube 25 when the latter is bent and coiled as hereinafter described. A suitable material for this tube is nickel silver, monel metal, or the like.

The tube 25 is bent in a peculiar shape and preferably in the form of a spiral, as shown at 27. It is particularly important to note that the tube 25 has a short downwardly extending portion 28 and upwardly extending portion 29 and then a downwardly extending portion 30 and finally spiral turns 31 terminating in a straight

portion 32, which connects to the interior of the pumping chamber 22. It is significant to note that the tube 25 is bent in such fashion that it has a middle portion at a higher level than either side of the middle portion. In other words, the tube is bent so as to form a portion of it in the general shape of an inverted U, this part being shown in that portion of the tube 25 designated by the reference character 33. Other shapes of bends may be used but it is important to have an inverted U portion near the outlet 34 of the storage container 10 and a relatively long run of the tube connecting the inverted U portion with the pumping chamber 22. The high middle portion 33, that is, the inverted U-shaped portion just mentioned, forms a gas trap as described in further detail hereinafter.

The auxiliary container 21 is provided with a pump, designated generally by reference character 35. The pump comprises a cylinder 36 provided with one or more intake ports 37. Mounted to reciprocate in the cylinder 36 is a piston 38 connected to a piston rod 39 passing through a stuffing box 40. The pump may be operated by hand, or, if desired, mechanical means may be provided for operating the pump. Such mechanical means are shown diagrammatically in Fig. 1 and may comprise a pitman 41 connected to the piston rod 39. The pitman may be eccentrically mounted upon a drive wheel 42 which in turn may be driven by a prime mover, such as electric motor 43, which drives the wheel 42 by a belt 44.

The cylinder 36 of the pump 35 is provided with a discharge port 45 connected to a discharge conduit 46. A check valve 47 is mounted in the discharge conduit 46. Thus liquid pumped by the pump 35 through the discharge port 45 can pass only in one direction, namely, out of the chamber 22. If, under certain conditions, a higher pressure is exerted in discharge tube 46 in a direction toward the interior of chamber 22, liquid is prevented from passing backwards into chamber 22 by reason of the check valve 47 resting in its seat 48. As shown, the check valve 47 is mounted in an outwardly extending portion of the pump casting.

There is provided in an upper portion of the auxiliary container 21 a vent port 49. Connected to the vent port 49 is a vent tube 50, which is spirally wound around and adjacent to the walls of the container 21. The vent tube 50 passes through the housing 20 and is provided with a valve 51. This valve is adapted to open and close the vent tube 50. While the vent tube in the illustrated embodiment is shown in the drawings as being spirally wound around the container 21, it may be otherwise positioned adjacent the container by winding it horizontally or vertically or otherwise.

The container 21 is also provided with a float valve arrangement, the purpose of which is described hereinafter. The float valve comprises a float 52 to which is fixed a downwardly extending guide rod 53 vertically slidable in a guideway 54 in a post fixed to the inside of the container 21. Also secured to the float 52 is a valve stem 55 having at its outer end a valve plug 56 shaped to seat in a corresponding valve seat 57 at the vent port 49. The valve plug itself is provided with a groove 58 so that when the plug 55 is seated in its corresponding seat 57 there is still a small passageway connecting the chamber 22 with the vent tube 50.

The storage container 10 is also provided with a pressure relief valve 58', which may be adjusted to relieve pressure in the interior of the storage container at any predetermined pressure as desired. A threaded plug 59 is provided for closing the neck of the storage chamber 10 and may be removed for purposes of charging liquid into it. There is also shown in tube 25 a valve 60 having its stem 61 extending through the housing 20. Thus the hand wheel 62 on the valve stem 61 is available for opening and closing the tube 25 between the storage container 10 and auxiliary container 21 when and if desired. However, this valve 60 may, under certain conditions, advantageously be dispensed with and the tube 25 connected directly to the container 21.

The device described may be used and operated as follows: It may be assumed that valve 60 is opened or dispensed with entirely, as it is not essential to the operation, and it may be assumed that the liquefied gas to be stored in and dispensed from the container 10 is liquefied oxygen. The plug 59 is removed and the liquid oxygen is poured into the container through the neck 12 while the vent valve 51 is closed. A sufficient amount of liquid oxygen may be poured in to bring the level fairly close to the top of the container 10 but leaving some space above the level of the liquid. As the liquid oxygen 63 is poured into the container a small amount of liquid will gravitate into the discharge tube 25 and thence into the auxiliary chamber 22. As the liquid comes into contact with the warmer metal of the walls of the tube 25 and the container 21, it will evaporate. This evaporated gas will fill the chamber 22 and the discharge tube 25, but due to the fact that the middle portion of the tube 25, that is the inverted U portion 33, is higher than the portion 32 of tube 25, the gas will be trapped in that higher middle, or inverted U portion 33, and will not be able to escape upward through the liquid 63 in the container 10 and into the upper gas space above the liquid level in this container. This trapped gas in the inverted U portion 33 will prevent any more liquid from passing out of the container 10 through the terminal portion 32 of the tube 25 into the auxiliary chamber 22. Therefore, there will not be any more loss of liquid from the container 10 while the liquid is in storage in this container except the normal loss due to the small amount of heat losses that are normally present with this type of container not equipped with a transfer pumping chamber. It will be understood, of course, that the apparatus may be transported from place to place, if desired, for dispensing the liquid oxygen.

When it is desired to transfer any liquid from the storage container 10 into the high pressure line 46 by means of the liquid pump 35, then valve 51 is opened. This will allow the gas which will have collected in chamber 22 and tube 25 to vent itself through the vent tube 50 and thus provide a lower pressure in chamber 22 than in the container 10. Consequently, the liquid will flow from the storage container through the tube 25 into auxiliary chamber 22. In other words, gas which has been trapped in chamber 22 and in the gas trap portion 33 of tube 25 is vented through valve 51. Then the liquid will flow from the storage container to the auxiliary chamber 22, because the outlet of tube 25 into the chamber is lower than the liquid in the container 10. It will be noted that the liquid level in chamber 22 will rise above the intake port 37 of the pump 35. When the liquid level is thus above the intake port 37 of the pump, the liquid in the chamber 22 upon

actuation of the piston 38 will be forced by the pump through the discharge port 45 past the check valve 47 into discharge conduit 46 and the pump will force the liquid through conduit 46 at a higher pressure than the pressure in the chamber 22. The discharge conduit 46 may be connected to a vaporizer through which the liquid is forced and vaporized and the gas may be forced into high pressure cylinders or to pipe lines for use, as desired.

During the storage period or during the period of transfer, it may be preferable to have the storage container plug 59 closed to reduce the evaporation loss of the liquid in the storage container. If the plug 59 is in place and the pressure inside the container 10 should exceed the safe working pressure of the container, the safety valve 58' will relieve the pressure by letting out the excess evaporated gas.

During the dispensing operation, valve 51 will be slightly open in order to discharge any gas that may accumulate above the surface 64 of the liquid in chamber 22, because if too much gas accumulates in this chamber, it will cause the liquid level in this chamber to drop below the intake ports 37 of the pump, and the pump would then not receive liquid. If it should happen that the vent valve 51 is open too much, and the liquid level in the chamber 22 should reach its top, some liquid might find its way out through vent port 49 into the vent tube 50, where it would be evaporated and go out as gas through valve 51 and be wasted. To avoid that, the auxiliary pumping chamber 22 is provided with a float valve arrangement to control automatically the amount of gas going out through vent tube 50 and valve 51. This arrangement comprises the float valve described above. As the liquid level 64 rises in chamber 22 it will raise the float 52 and at a predetermined level the valve plug 56 will seat in its seat 57 and substantially close the vent port 49. Since this port will be substantially closed but for the small passageway 58 in the plug 56, the gas pressure above the surface 64 in chamber 22 will tend to rise and thus offer a greater resistance to flow of liquid from container 10. The result is that a substantially constant body of liquid is maintained in the chamber 22 during the dispensing operation without unnecessary loss of liquid oxygen through the vent tube 50.

It may be noted also that such gas as flows through the vent tube 50 will tend to maintain the container 21 cool. This is an added advantage in devices of this character wherein conservation of heat or prevention of heat losses is very desirable.

While a specific embodiment has been described to illustrate the invention, it will be understood that various changes, modifications, substitutions and omissions of parts may be made by those skilled in the art without departing from the spirit and scope of the invention comprehended by the annexed claims.

What is claimed is:

1. A device of the character described which comprises an insulated storage container for holding liquefied gas, a discharge tube having one end connected to the interior of said container near its bottom, an insulated housing about said container and tube, the other end of said tube extending through said housing, a valve to close said tube, said tube being bent to form a gas trap within the insulated housing between said container and valve.

2. In a storage and dispensing apparatus for liquefied gases of the character described, an insulated storage container for holding liquefied gas, an insulated auxiliary container to receive liquid from said storage container from which the liquid may be pumped, and an insulated tube connecting with the interior of said storage container and auxiliary container for transferring liquid from said storage container to said auxiliary container, said tube being located below the storage container and having a short portion extending downwardly from said container, an inverted U shaped portion having one leg thereof connected to said short portion and the other leg connected to the remaining portion of said tube, said remaining portion being longer than said first mentioned short portion.

3. In a device for storing and dispensing liquefied gases of the character described, an insulated storage container for holding liquefied gas, an insulated auxiliary chamber to receive liquid from said storage container from which the liquid may be pumped, an insulated tube connecting with the interior of said storage container and auxiliary chamber for transferring liquid from said container to said chamber, said tube being located below the storage container and having a bent portion forming a gas trap in said tube between said storage container and auxiliary chamber, a pump to transfer liquid from said chamber, an openable and closable vent connected to said chamber, and means including a float valve responsive to change in liquid level in said chamber and coactive with said vent for maintaining a substantially constant liquid level in said chamber.

4. Apparatus for storing and dispensing liquefied gas of the character described which comprises an insulated storage container for holding liquefied gas, an insulated pumping chamber from which liquid from said storage chamber may be pumped, an insulated conduit below said storage container and connecting said storage container and pumping chamber to transfer liquid from said container to said chamber, said conduit having a downwardly extending portion connected to said container near its bottom, a U shaped portion and a remaining portion, one leg of said U shaped portion being connected to said downwardly extending portion and the other leg being connected to said remaining portion whereby to form a gas trap in said conduit between said container and chamber, a pump in said chamber for pumping liquid, which has been transferred from said container to said chamber, and a discharge conduit connected to said pump to carry liquid pumped from said chamber at a higher pressure than the pressure in said chamber.

5. Apparatus for storing and dispensing liquefied gas of the character described which comprises an insulated storage container for holding liquefied gas, an insulated substantially closed pumping chamber from which liquid from said storage chamber may be pumped, an insulated conduit below said storage container and connecting said storage container and pumping chamber to transfer liquid from said container to said chamber, a pump in said chamber for pumping liquid, which has been transferred from said container to said chamber, a discharge conduit connected to said pump to carry liquid pumped from said chamber at a higher pressure than the pressure in said chamber, a vent tube connected to said chamber and wound about said chamber through which to pass gas evaporated in

said chamber and a valve to open and close said vent tube.

6. Apparatus for storing and dispensing liquefied gas of the character described which comprises an insulated storage container for holding liquefied gas, an insulated substantially closed pumping chamber from which liquid from said storage chamber may be pumped, an insulated conduit below said storage container and connecting said storage container and pumping chamber to transfer liquid from said container to said chamber, said conduit being shaped to form a gas trap between said container and chamber, a pump in said chamber for pumping liquid, which has been transferred from said container to said chamber, and a discharge conduit connected to said pump to carry liquid pumped from said chamber at a higher pressure than the pressure in said chamber, a vent tube connected to said chamber and wound around said chamber and a valve to open and close said vent tube.

7. A device of the character described for storing and dispensing liquefied gas such as liquid oxygen which comprises an insulated container for storing said liquid, a pumping chamber below said container, a conduit connecting said container and chamber for transferring liquid from said container to said chamber, a pump for pumping liquid from said chamber which has been transferred from said container to said chamber to discharge said liquid at a higher pressure than the pressure in said chamber, a discharge conduit, connected to said pump through which to dispense said liquid, a vent in the upper portion of said chamber and a float valve movable in response to change in liquid level in said chamber and coacting with said vent for maintaining a substantially constant body of liquid in said chamber.

8. A device of the character described for storing and dispensing liquefied gas such as liquid oxygen which comprises an insulated container for storing said liquid, a pumping chamber below said container, a tube connecting said container and chamber for transferring liquid from said container to said chamber, said tube having a bent portion forming a gas trap between said container and chamber, a pump for pumping liquid from said chamber which has been transferred from said container to said chamber to discharge said liquid at a higher pressure than the pressure in said chamber, a discharge conduit connected to said pump through which to dispense said liquid, a vent port in the upper portion of said chamber, a float valve for maintaining a substantially constant body of liquid in said chamber, a vent tube connecting with said vent port and having a substantial length wound around said chamber and a valve for opening and closing said vent tube.

9. A device of the character described for storing and dispensing liquefied gas such as liquid oxygen which comprises an insulated container for storing said liquid; a pumping chamber below said container; a tube connecting said container and chamber for transferring liquid from said container to said chamber, said tube being located below said storage container and having a short portion extending downwardly from said container, an inverted U shaped portion having one leg thereof connected to said short portion and the other leg connected to the remaining portion of said tube, said remaining portion being longer than said first mentioned short portion; a pump for pumping liquid from said chamber which has been transferred from said container to said chamber to discharge said liquid at a higher pressure than the pressure in said chamber; a discharge conduit connected to said pump through which to dispense said liquid; a vent port in the upper portion of said chamber, a float valve for maintaining a substantially constant body of liquid in said chamber; a vent tube connected to said vent port and wound around said chamber; and a valve to open and close said vent tube.

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