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APPARATUS FOR DISPENSING A LIQUEFIED GAS

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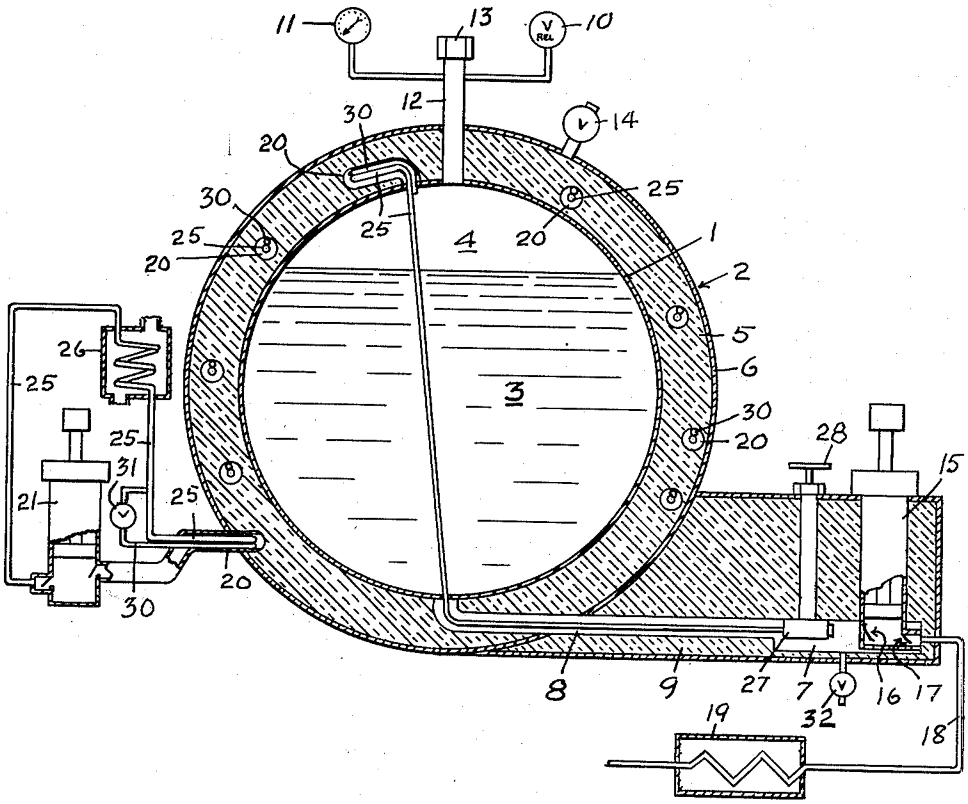

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APPARATUS FOR DISPENSING A LIQUEFIED GAS

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7 Claims. (Cl. 62—1)

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This invention relates to apparatus for storing, transporting and dispensing a liquified gas from a container, and to a method of sub-cooling such liquified gas, preferably adjacent the point of withdrawal from the container. This apparatus and method are particularly suitable for liquified gases having boiling point temperatures at atmospheric pressure below 273° K., one example of which is liquid oxygen.

Heretofore, liquified gases, such as the kind with which this invention is concerned, were stored and transported at relatively low pressures in insulated containers. However, a certain amount of evaporation is inevitable because of unavoidable heat leaks in the insulation. Many times this gas or a considerable portion thereof, has been exhausted and lost when the pressure has risen to a predetermined degree.

Prior to the present time, relatively expensive and complicated means has been employed to sub-cool the liquid gas before pumping the same from the container in order to insure proper operation of the pump.

One of the objects of the present invention is the provision of improved apparatus and an improved method for utilizing the gas of evaporation for sub-cooling the liquid in the container to insure proper operation of the pump. Thus, the gas of evaporation is not wasted, nor is apparatus required for bottling the same in order to save such possible waste, and at the same time, the liquid gas is sub-cooled.

Another object of the invention is the provision of an improved construction and arrangement of component devices in apparatus of the character described whereby the storing, transporting and dispensing of liquified gas is more efficiently and simply effected than heretofore.

Another object of the invention is the provision of simple and effective means for converting the gas of evaporation from liquified gas in a storage or transporting and dispensing tank back into liquid within said tank in a simple and effective manner, and which means includes structure enabling the control of gas pressure within said tank to facilitate pumping liquid gas therefrom.

It is a well known fact that the standard reciprocating liquid oxygen pumps will not pump liquid oxygen unless the oxygen is cooled down to a temperature below its boiling point under whatever pressure is on the liquid oxygen in the pump chamber. The reason for this is that the liquid oxygen keeps evaporating all the time and causes vapor lock in the pump. By sub-cooling the liquid oxygen that is delivered to the inlet valve of the pump, vapor lock is eliminated.

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One of the objects of this invention is to eliminate vapor lock in an efficient manner by employment of the gas of evaporation in the liquid gas container from which the liquid gas is pumped.

Other objects and advantages will appear in the description and in the drawing, and it is to be understood that the invention is not to be restricted to oxygen gas, since it would be applicable to gases having the same characteristics of liquification at relatively low temperatures.

The drawing is diagrammatic, and is illustrative of the invention.

In the drawing, 1 represents the inner shell of a container generally designated 2, adapted to receive and hold a charge 3 of liquified gas, such as oxygen, with a space 4 above the level of the liquid in said container in which gas of evaporation is held, and which gas applies a pressure on the charge 3.

Said shell 1 is enclosed by heat insulation material 5 that is between inner shell 1 and an outer shell 6.

Communicating with the interior of the main container 2 is a pump chamber 7. A passageway 8 connects the chamber 7 with the interior of container 2 through the bottom of the latter. Chamber 7 and passageway 8 are enclosed by heat insulation material 9.

Connected with the container 2 at the top thereof is a safety valve 10 and pressure gauge 11 for respectively effecting a release of gas of evaporation within the container should the pressure increase to the danger point, and to indicate the pressure within said tank. These are conventional devices on practically all tanks of this general nature.

A pipe 12 that carries the gauge 11 and valve 10 also constitutes the means for filling the container when a cap 13 closing said pipe is removed.

The outer shell 6 of container 2 is also provided with a conventional relief valve 14 for discharging any gas that may leak into the space containing the insulation 5.

Passageway 8 opens into the upper end of the pump chamber 7 so that there will be no space within said chamber at a level above the opening of passageway 8 into said chamber.

A conventional reciprocating or plunger type oxygen pump 15 has its lower end projecting into said chamber 7. An inlet 16 provided with the usual inlet valve is at the lower end of pump 15 and an outlet 17 provided with the conventional outlet valve is also at the lower end of the pump and in chamber 7.

An outlet pipe 18 connects with the outlet and may lead through any suitable vaporizer 19 for evaporation of the liquid oxygen, and from said vaporizer the oxygen may be pumped into the conventional containers or piped elsewhere for use.

From the upper end of container 2 extends a conduit 20 that extends spirally around the inner shell 1 in a downward direction, being imbedded in the insulation material 5, but progressively moving outwardly from the inner shell 1 toward the outer shell 6 from the upper to the lower end of the spiral portion thereof that is between said shells. At its lower end the conduit 20 passes outwardly through the outer shell at a point adjacent the lower end of the container 2.

From the above structure it will be seen that the portion of conduit 20 that is between shells 1, 6 progressively moves to a warmer zone in the insulation material as it moves toward the point of emergence from the outer shell 6.

This conduit 20 is adapted to carry the oxygen of evaporation from the space 4 above the liquid oxygen 3 in container 2, and this oxygen is progressively warmed as it moves outwardly in the insulation material 5.

Conduit 20 extends from outer shell 6 to a conventional oxygen compressor 21. By the time the oxygen reaches the compressor it is at substantially room temperature, and said oxygen is drawn into the compressor where it is compressed to a medium pressure.

Inasmuch as there will be an increase in the temperature of the oxygen gas due to compression, the compressed gas is conducted through a pipe 25 through any suitable heat exchanger 26, where it is cooled. This heat exchanger may use air or a cooling fluid or any conventional cooling means.

From the heat exchanger, the pipe 25 passes into the container 6 through conduit 20, being spaced within said conduit. By this arrangement there will be a heat exchange between the outflowing gas and the incoming compressed gas, the latter being progressively cooled as it flows back through pipe 25 counter to the flow of gas outwardly through conduit 20.

The pipe 25 passes into container 2 through the upper end thereof and then through the liquid oxygen 3 within said container to passageway 8, and through passageway 8 into the pump chamber 7 where it is provided with an expansion valve 27. A hand wheel 28 accessible from outside the container and chamber 7 is provided for manually manipulating said valve.

In certain installations the valve 27 may be positioned within the body of liquid that is in the container, in which case the pipe 25 would terminate within said container.

The compressed oxygen from the compressor thus flows through the pipe 25 counter or opposite to the direction of flow of the gas of varporization in conduit 20.

From conduit 20 the pipe 25 extends into the liquid oxygen, and is gradually cooled down to the temperature of the liquid oxygen, becoming liquid, and after such liquification it is expanded by means of expansive valve 27 and is discharged into the pump chamber 7 or within the container 2, according to the installation. The use of a pump chamber and the discharge of the liquid oxygen from pipe 25 into the liquid oxygen in the pump chamber is preferable. If the liquid were discharged into the body of liquid within the container 2, sub-cooling of said body would occur, but it would be slower.

In order to provide for a rapid and efficient regulation of the pressure in container 2, a second pipe 30 may extend through conduit 20 to outside the container 2, and connect with pipe 25 outside said container. A manually manipulatable valve 31 in pipe 30 outside the container 2 is provided to enable gas from pipe 25 to be admitted into the container 2 through pipe 30. The pipe 30 preferably terminates within container 2 above the level of the liquid in the latter.

The pipe 30 may pass directly through the container walls to the outside without passing through conduit 20, if desired, or in some installations, the valve could be connected in pipe 25 within the container and above the level of the liquid within said container. In any event, when and if desired, the above structure is intended to provide means for releasing compressed oxygen from pipe 25 within the container 2 and into space 4, which would be helpful when the pump 15 is in operation by creating some back pressure for said pump.

Compression of the gas phase of the liquid in containers similar to that shown herein is known to the trade, but for the purpose of reducing the pressure in the container, or to produce a certain amount of refrigeration by causing the liquid in the container to evaporate, or for increasing the purity of the liquid oxygen in the system. Sometimes this evaporated oxygen gas has been compressed and either returned to the oxygen producing column or it has been delivered to a gas holder or to a high pressure oxygen compressor to compress it for storing into cylinders. However, I am not aware that anyone has heretofore compressed the evaporated gas, precooled, and expanded the same in the manner and for the purpose described in this invention.

It is obvious that in certain instances the liquified gas, after compression and cooling could be expanded in the container 2, particularly where the pump is in said container. The pump chamber is preferable, however.

It is also obvious that the conduit 20 need not in all instances be imbedded in the insulation between shells 1, 6 in its spiral course. In some instances the coil could be positioned outside the container, although the structure shown is usually preferable.

A drain valve 32 may also be provided in the pump chamber.

The evaporator 19 may be of any desired type. In some instances, the heat from the exhaust gases from the engine of a vehicle is employed for supplying the heat, particularly where the container is mounted on such vehicle, it being understood that the present invention is particularly adapted for being mounted on a truck or vehicle during transportation of the liquid gas from one place to another. The invention is not, however, to be restricted to such use.

I claim:

1. Apparatus for dispensing gas material that has a boiling point temperature below 273° K. which comprises a thermally insulated container for holding a charge of said material below its boiling point temperature under a predetermined pressure of such gas material in said container in the gaseous phase, a discharge pump having an inlet in communication with such charge in said container, a conduit opening at one end into the upper end of said container for communicating with the said gas in such gaseous phase and

terminating at its opposite end within the charge adapted to be held in said container, said conduit extending outwardly of said container between its opposite end portions and including a compressor for withdrawing and compressing part of said gas in its gaseous phase, a heat exchanger between said compressor and said container for cooling the gas compressed by said compressor, and the end portion of said conduit adjacent said opposite end being positioned within said charge for a substantial distance and in direct heat transfer relation with such charge for reducing the temperature of the gas therein to below 273° K., a valve in said conduit and positioned within said charge for controlling the discharge of liquified gas material therefrom into said charge and under the pressure of said compressor.

2. Apparatus for dispensing gas material that has a boiling point temperature below 273° K. which comprises a thermally insulated container for holding a charge of said material below its boiling point temperature under a predetermined pressure of such gas material in said container in the gaseous phase, a discharge pump having an inlet in communication with such charge in said container, a conduit opening at one end into the upper end of said container for communicating with the said gas in such gaseous phase and terminating at its opposite end within the charge adapted to be held in said container, said conduit extending outwardly of said container between its opposite end portions and including a compressor for withdrawing and compressing part of said gas in its gaseous phase, a heat exchanger between said compressor and said container for cooling the gas compressed by said compressor, and the end portion of said conduit that is adjacent said opposite end being positioned within said charge for a substantial distance and in direct heat transfer relation with the charge for reducing the temperature of the gas therein to below 273° K., a valve in said conduit and positioned within said charge for controlling the discharge of liquified gas material therefrom into said charge and under the pressure of said compressor, a substantial length of said conduit between said valve and said heat exchanger being spaced within and extending longitudinally of a corresponding length of the conduit extending from the upper end of said container to said compressor, whereby said lengths will be in heat exchange relationship to each other.

3. Apparatus for dispensing gas material that has a boiling point temperature below 273° K. which comprises a thermally insulated container for holding a charge of said material below its boiling point temperature under a predetermined pressure of such gas material in said container in the gaseous phase, a discharge pump having an inlet in communication with such charge in said container, a conduit opening at one end into the upper end of said container for communicating with the said gas in such gaseous phase and terminating at its opposite end within the charge adapted to be held in said container, said conduit extending outwardly of said container between its opposite end portions and including a compressor for withdrawing and compressing part of said gas in its gaseous phase, a heat exchanger between said compressor and said container for cooling the gas compressed by said compressor, and the end portion of said conduit that is adjacent said opposite end being positioned within said charge for a substantial distance and in direct heat transfer relation with the charge for reducing the temperature of the gas therein to below 273° K., a valve in said conduit for controlling the discharge of liquified gas material therefrom into said charge and under the pressure of said compressor, a heat insulated well below said container and in communication therewith and a passageway communicating between the bottom of said container and said well for conducting said material into said well, said inlet and said valve being in said well.

4. Apparatus for dispensing liquid gas material that has a boiling point temperature below 273° K. which comprises a thermally insulated container for holding a charge of said material below its boiling point temperature under the pressure of the gas of evaporation from said gas material in said container, a discharge pump having an inlet in communication with such charge in said container, a conduit opening into the upper end of said container at one end for conducting said gas of evaporation from said container, a compressor connected with said conduit for compressing the gas so conducted from said container, heat exchange means for cooling the gas compressed by said compressor, a pipe extending from said compressor and heat exchanger into said container and through the liquid gas material in said container under the pressure of said compressor for reducing the temperature of said material in said pipe to substantially the temperature of the charge in said container and below the boiling point thereof, means comprising said compressor for applying a greater pressure to the liquified gas material in said pipe than that of the pressure of the gas of evaporation in said container, said pipe extending to a point adjacent said inlet, and a valve in said pipe and positioned within said charge for releasing the liquified gas material therein into the liquid gas material in said container at said point.

5. Apparatus for dispensing liquid gas material that has a boiling point temperature below 273° K. which comprises a thermally insulated container for holding a charge of said material below its boiling point temperature under the pressure of the gas of evaporation from said gas material in said container, a discharge pump having an inlet in communication with such charge in said container, a conduit opening into the upper end of said container at one end for conducting said gas of evaporation from said container, a compressor connected with said conduit for compressing the gas so conducted from said container, heat exchange means for cooling the gas compressed by said compressor, a pipe extending from said compressor and heat exchanger into said container and through the liquid gas material in said container under the pressure of said compressor for reducing the temperature of said material in said pipe to substantially the temperature of the charge in said container and below the boiling point thereof, means comprising said compressor for applying a greater pressure to the liquified gas material in said pipe than that of the pressure of the gas of evaporation in said container, a branch from said pipe opening into said container, and a valve in said pipe and positioned within said charge for releasing the liquified gas material therein into the liquid gas material in said container, a valve in said branch to permit release of gas material gaseous phase in said branch into said container for increasing the gas pressure on said

charge as desired, said branch being connected with said pipe at a point where the material in said pipe is still in the gaseous phase.

6. Apparatus for dispensing gas material that has a boiling point temperature below 273° K. which comprises a thermally insulated container for holding a charge of said material below its boiling point temperature under a predetermined pressure of such gas material in said container in the gaseous phase, a discharge pump having an inlet in communication with such charge in said container, a conduit opening at one end into the upper end of said container for communicating with the said gas in such gaseous phase and terminating at its opposite end adjacent said inlet and in communication with a charge adapted to be held in said container, said conduit extending outwardly of said container between its opposite end portions and including a compressor for withdrawing and compressing part of said gas in its gaseous phase, a heat exchanger between said compressor and said container for cooling the gas compressed by said compressor, and the end portion of said conduit that is adjacent said inlet being positioned within said charge for a substantial distance and in direct heat transfer relation with the charge for reducing the temperature of the gas therein to below 273° K., a valve in said conduit adjacent said inlet for controlling the discharge of liquified gas material therefrom into said charge and under the pressure of said compressor.

7. Apparatus for dispensing gas material that has a boiling point temperature below 273° K. which comprises a thermally insulated container for holding a charge of said material below its boiling point temperature under a predetermined pressure of such gas material in said container in the gaseous phase, a discharge pump having an inlet in communication with such charge in said container, a conduit opening at one end into the upper end of said container for communicating with the said gas in such gaseous phase and terminating at its opposite end adjacent said inlet and in communication with a charge adapted to be held in said container, said conduit extending outwardly of said container between its opposite end portions and including a compressor for withdrawing and compressing part of said gas in its gaseous phase, a heat exchanger between said compressor and said container for cooling the gas compressed by said compressor, and the end portion of said conduit that is adjacent said inlet being positioned within said charge for a substantial distance and in direct heat transfer relation with the charge for reducing the temperature of the gas therein to below 273° K., a valve in said conduit adjacent said inlet for controlling the discharge of liquified gas material therefrom into said charge and under the pressure of said compressor, a heat insulated well in communication with said container and a passageway communicating between the bottom of said container and said well for conducting said material into said well, said inlet and said valve being in said well.

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