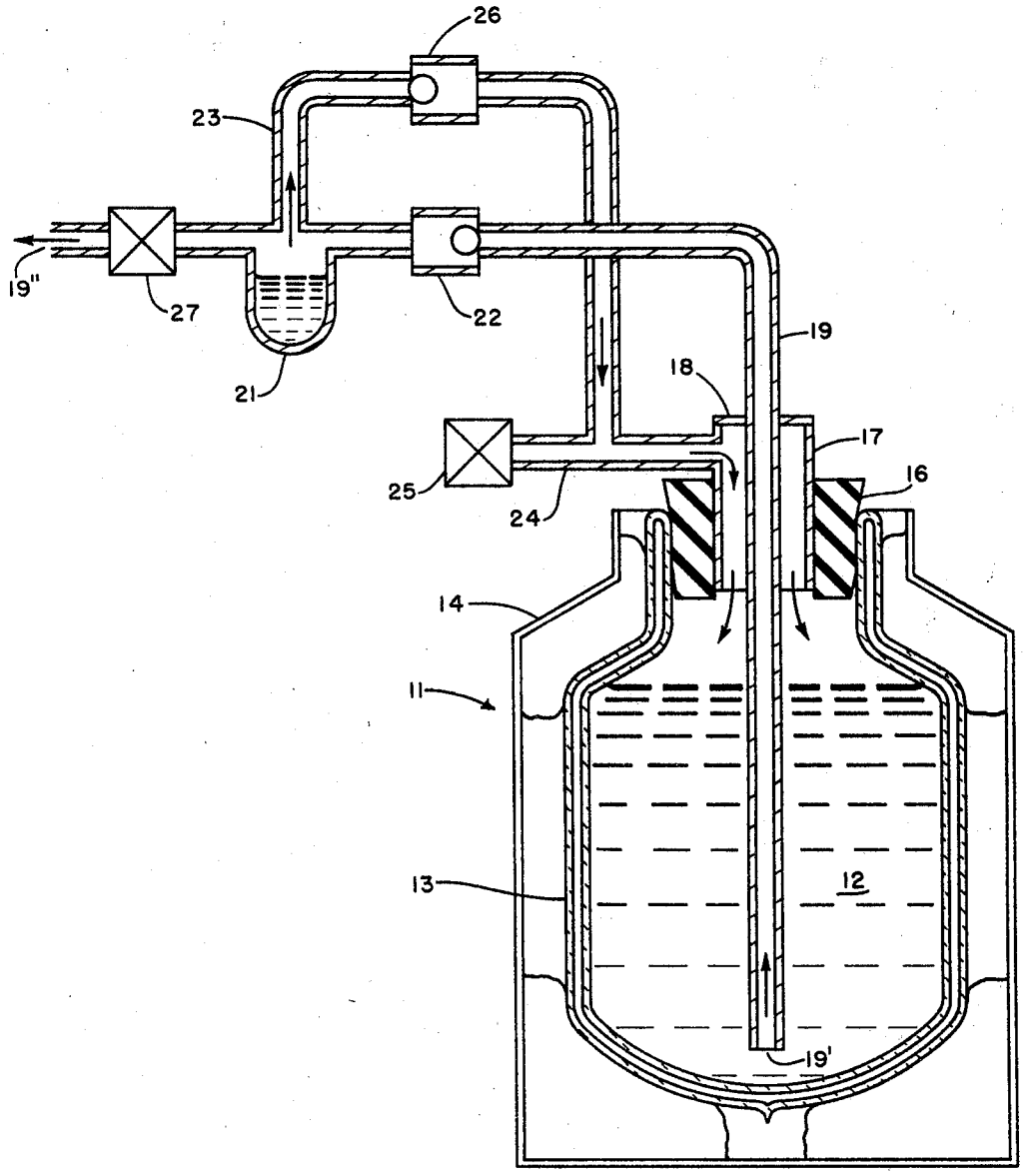
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LIQUIFIED GAS DELIVERY SYSTEM

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LIQUIFIED GAS DELIVERY SYSTEM

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ABSTRACT OF THE DISCLOSURE

What is disclosed is a liquified gas delivery system for use with a Dewar flask. The system includes an auxiliary reservoir coupled to the supply line such that each time liquid is delivered to a utilization device a portion of it is trapped by the reservoir. During standby, the liquid in the reservoir evaporates and creates gas under pressure. The gas is conducted to an inlet point above the level of the liquid in the flask. This pressurizes the liquid and readies the system for delivery of an additional supply on demand.

This invention relates generally to liquified gas delivery systems and, more particularly, it is concerned with the controlled withdrawal of a liquified gas from an insulated storage vessel.

Customarily, liquified gases, such as liquid nitrogen, are stored in insulated containers known as Dewar flasks so as to minimize wastage due to evaporation. That is to say, as the liquid evaporates, it creates considerable pressure, and in order to limit this pressure to a safe value, some of the liquid which has evaporated must be released by venting. If the demand for the liquid is constant and precisely known, a fixed rate of evaporation can be established consistent with the pressure limiting effect of deplenishing the supply so that the pressure seldom, if ever becomes excessive. The difficulty, however, is that there are many applications for liquified gases where the demand is unpredictable and inconstant. Moreover, a fixed rate of evaporation is oftentimes difficult to establish because it depends so much on ambient temperature and pressure conditions.

Hitherto, a common practice has been to try to minimize, so far as possible, the rate of evaporation during the intervals when the liquid is not being used, and to pressurize the container or vessel with a like gas obtained from an external source in order to boost the pressure in the container to the level needed to force out the liquid whenever its use is called for. This requires the attention of an operator and, of course, a separate vessel to contain the gas which is used for pressurizing. Another common practice which avoids this disadvantage is to provide a heating coil for heating the liquified gas in the storage vessel and thereby accelerate the process of evaporation whenever a demand for the liquid exists. The problem with this device is that the amount of heat provided must be closely controlled in accordance with the rate at which the liquid is withdrawn, and if the latter is inconstant, such control may be difficult to implement as a practical matter.

An object of the present invention, therefore, is to provide an improved liquified gas delivery system which is adapted to ensure the discharge of an adequate amount of liquid to meet current demands irrespective of the rate at which the demand is made.

Another object is to accomplish the foregoing object without appreciable wastage due to venting for pressure relief.

Still another object of the invention is to provide a liquified gas delivery system which is relatively simple to construct in that it does not depend on the use of controls which are functionally related to the utilization device for the gaseous liquid.

A further object is to provide a liquified gas delivery system which is reliable and safe to operate.

The novel features of the invention, together with further objects and advantages, will become apparent from the following detailed description of a preferred embodiment and from the drawing to which the description refers.

In the drawing the liquified gas delivery system of the invention is shown schematically.

With reference now to the drawing, it will be observed that the numeral **11** designates a vacuum flask containing a liquified gas **12**, such as liquid nitrogen. Although the invention is not limited to use with any special type of container or flask, a Dewar flask is most commonly used for this purpose both in the laboratory and by commercial suppliers, and the delivery system of the invention is specifically designed to be used with this type of flask. As shown, a Dewar flask is characterized by a double-walled liner 13 which is coated with heat reflective material and which is evacuated so that the interspace between the walls acts as a good heat insulator. Access to the interior of the flask is had through a neck portion at the top, and the fact that this is the only opening in the flask minimizes the problem of evaporation due to the transfer of heat from outside the flask. Most commonly the liner is mounted in a metal bell **14** which protects it from damage.

To couple the delivery system of the invention to the flask, an apertured stopper **16** is fitted to the mouth and a hollow cylindrical member **17** is in turn fitted to the aperture in the stopper. Member **17** extends above the stopper for a short distance and at the top is capped by a cover disc **18**. The supply line is designated **19** in the drawing and has its inlet end **19'** located near the bottom of the flask. To admit the supply line, to the interior of the flask, a central aperture is provided in the disc **18**.

Exteriorly of the flask, the supply line undergoes a right angle bend so as to afford a horizontal run to its outlet end **19''**. A cup **21** is suspended from this horizontal run of the supply line and a check valve **22** is provided between the cup and the bend. Check valve **22** prevents pressure fluid from flowing backward into the flask, as will be explained more fully in connection with the operation of the system.

Coupled to line **19** at a point directly above the cup is an auxiliary line **23** which leads back to the mouth of the flask. More specifically, an aperture is provided in the wall of member **17** to receive a line **24** terminating the auxiliary line. At the outlet end of line **24** there is a safety valve **25**. Also a check valve **26** is disposed in the auxiliary line **23** to prevent the flow of pressure fluid out of the flask by way of the auxiliary line and a control valve **27** is provided between cup **21** and the outlet end of the supply line to control the discharge of the liquid from the system.

In operation, when a charge of liquified gas is called for, control valve **27** is opened permitting gas to flow out of the flask by way of the supply line. There is no flow through the auxiliary line because the sense of check valve **26** is opposite to that of check valve **22**. In the first instance, it will be assumed that the pressure in the flask resulting from the normal evaporative process is sufficient to produce an adequate charge of liquified gas to satisfy the demand of the utilization device to which the outlet end of the supply line is connected. The latter may be a cold chamber, for example, and the valve **27** may be

automatically controlled by a thermostat in the cold chamber.

After the required amount of liquid has been withdrawn from the flask and the control valve is closed, a small quantity of the liquid will have been trapped in the cup **21**. The cup liquid absorbs heat from the surrounding atmosphere a good deal faster than does the liquid in the flask because the cup is not insulated. In fact, it is preferred to form the cup from a relatively good heat conductor, such as copper, so that the cup liquid evaporates and builds up vapor pressure at a relatively rapid rate. The vapor or gaseous phase fluid from the cup is prevented from entering the flask by way of the supply line because of the action of check valve **22**. Instead, it flows through the auxiliary line **23** into the space above the level of the liquid in the flask where it creates additional pressure on the surface of the liquid. When the utilization device again calls for liquid and control valve **27** is again opened, therefore, a sufficient pressure will exist to force the required amount of liquid out of the flask to meet the additional demand. Also, the liquid in the cup **21** will be replenished in the course of the liquid flow through the supply line so that the process can be repeated. In other words, the pressure in the flask is maintained according to the invention without the need for any external pressurizing procedure or adjustments by an attendant.

Should the demand of the utilization device temporarily become lower than normal or cease to exist, permitting the pressure to continue to increase, relief is provided by the safety valve **25**. It should be noted, however, that under these circumstances, only a relatively small amount of the liquid will be lost because the cup **21** is not replenished and as soon as all the cup liquid has evaporated, no further pressure build up will take place according to the invention. Furthermore, by appropriate design of the cup, the rate of evaporation can be established at any desired value consistent with the normal demand of the utilization device.

Although the invention has been described in connection with a single preferred embodiment, it will be appreciated that many variants of this embodiment are possible that are within the spirit and scope of the invention. Therefore, the invention should not be deemed to be limited to the details of what has been described herein by way of illustration, but rather it should be deemed to be limited only to the scope of the appended claims.

What is claimed is:

1. A system for delivering liquified gas from an insulated flask to a utilization device, said system comprising a supply line leading from a first inlet point in the flask to a discharge point outside the flask, said first inlet point being located below the level of the liquid in the flask, said discharge point communicating with said utilization device, and said supply line serving to conduct the gas from said one point to the other while maintaining it in an essentially liquid state, means coupled to said supply line at a point outside the flask in advance of said delivery point for trapping and collecting a small portion of the liquified gas whenever the same is caused to flow from said first inlet point through said supply line to said delivery point, said liquified gas collection means being adapted to permit heat from the surrounding atmosphere to raise the temperature of the liquified gas collected therein at a substantially more rapid rate than the rate at which the temperature of the liquified gas in the flask is raised, thereby causing the liquified gas in said collection means to evaporate and create pressure to act upon the liquified gas in the flask, and said collection means being further adapted to be replenished by trapping of the liquified gas each time the same is caused to flow through said supply line and past the point where said collection means is coupled, a check valve disposed in said supply line in advance of said collection means such that the liquified gas being supplied to said utilization device must first pass through said check valve and then past said collection means, said check valve preventing gas under pressure created by evaporation in said collection means from acting on the liquefied gas surrounding said first inlet point in the flask, a control valve disposed in said supply line immediately preceding said discharge point to control the discharge of liquified gas from said discharge point to said utilization device, an auxiliary line coupled to said supply line at a point located between said control valve and said check valve for conducting gas under pressure from said collection means to a second inlet point in the flask located above the level of the liquified gas therein, and a second check valve disposed in said auxiliary line, said second check valve acting to prevent the gas under pressure above the level of the liquified gas in the flask from escaping to said supply line and discharging through said control valve whenever the same is open, and the opening of said control valve causing a reduction in the pressure in said supply line on the discharge side of said first check valve, thereby permitting a limited supply of liquified gas to flow out of said flask to said utilization device, said flow being terminated by the resulting reduction in the pressure of the gas in the flask above the level of the liquified gas until said control valve again closes permitting a further build-up of the pressure of the gas due to evaporation of the liquified gas trapped by said collection means.

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