March 13, 1945. T H DUFF 2,371,231

LIQUEFIED HYDROCARBON GAS STORAGE AND DISPENSING SYSTEM

Filed Oct. 23, 1941 2 Sheets-Sheet 1

FIG. 1

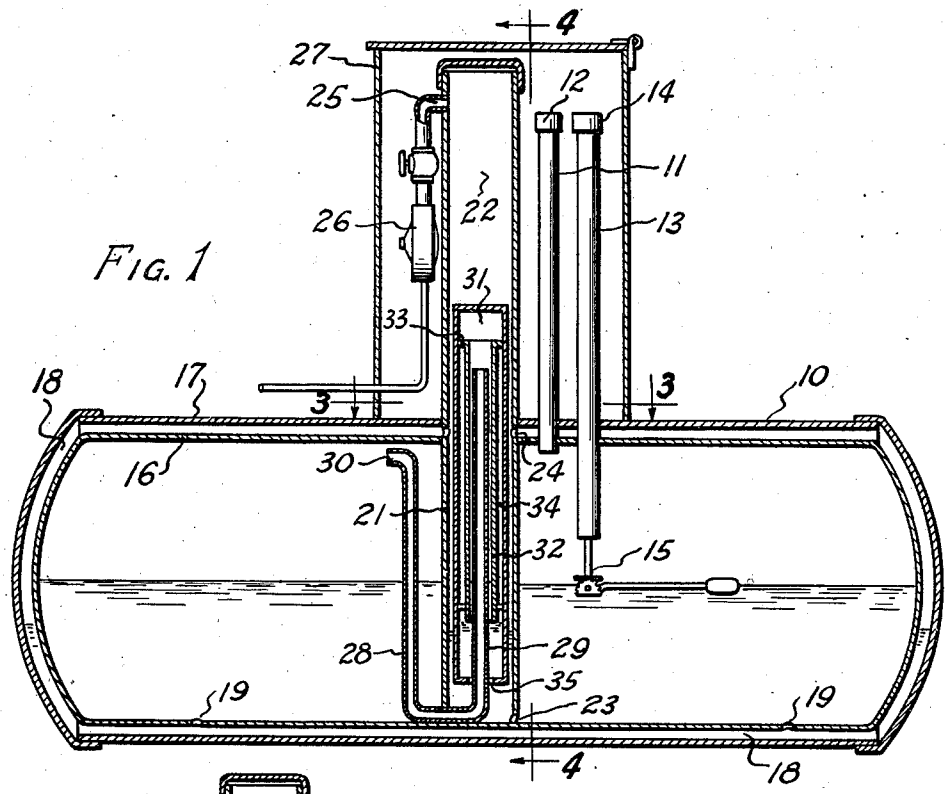
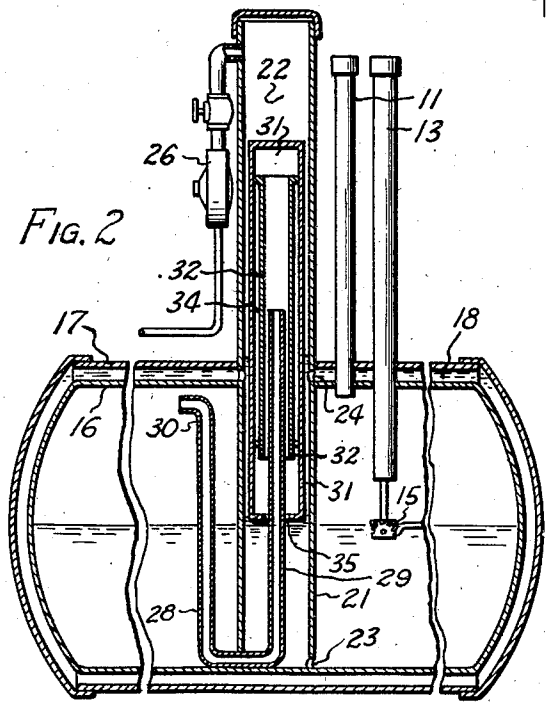


FIG. 2



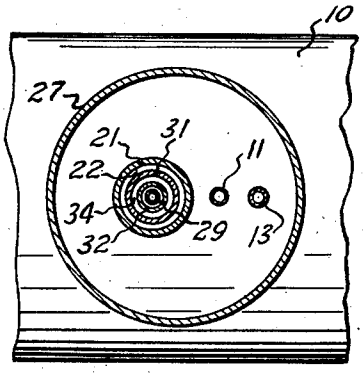


FIG. 3

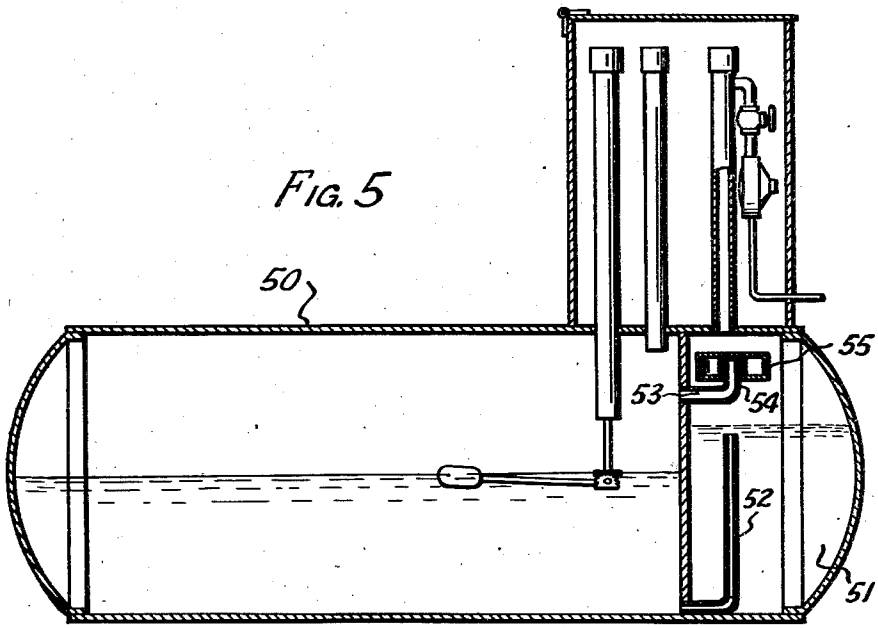
INVENTOR
T. H. DUFF
BY E. Hastings Ackley
ATTORNEY

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FIG. 5



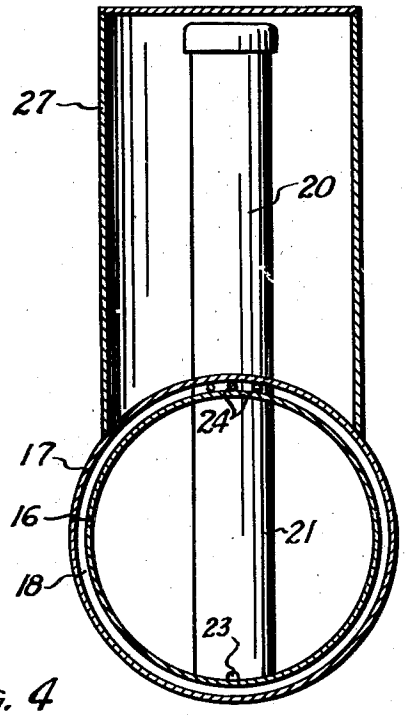


FIG. 4

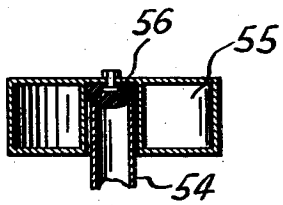


FIG. 6

INVENTOR
T. H. DUFF
BY Kerr Hastings Ackley
ATTORNEY

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LIQUEFIED HYDROCARBON GAS STORAGE AND DISPENSING SYSTEM

T H Duff, Plainview, Tex.

Application October 23, 1941, Serial No. 416,190

9 Claims. (Cl. 62—1)

This invention relates to new and useful improvements in liquefied hydrocarbon gas dispensing systems.

One object of the invention is to provide an improved system for controlling the vaporization and flow of gas from a liquefied hydrocarbon storage system.

An important object of the invention is to provide a novel means for controlling the flow of vaporized hydrocarbon gas from a liquefied gas storage tank to the service outlets of the system.

Another object of the invention is to provide, in a device of the character described, a valve utilizing a liquid seal for its sealing element whereby positive sealing action is assured, and the necessity of replacement of worn parts is substantially eliminated.

A further object of the invention is to provide an improved heat exchanging device for use in conjunction with a device of the character described, wherein the area of liquefied hydrocarbons which is exposed to the heating action of the surrounding elements such as earth, air, water, steam, exhaust gases, or other heat sources, is greatly amplified, and the rate of vaporization of such liquefied gas is thereby increased.

A particular object of the invention is to provide a system of the character described wherein the liquefied gas is withdrawn from storage and vaporized, whereby the mixture of propane and butane which is usually in the customary commercial mixtures of hydrocarbon gas will be vaporized in substantially the same proportions as it was mixed, thereby providing a fuel having a more uniform heat value.

Still another object of the invention is to provide, in a system of the character described, means for preventing the liquefied hydrocarbons from entering the service line to the house or other place of consumption.

A still further object of the invention is to provide a system of the character described which is simple and economical of structure, and which is economical to operate and repair, and which has few parts to wear and need replacement, whereby safe, trouble-free service is afforded.

Additional objects and advantages of the invention will be apparent from a reading of the following description of a device constructed in accordance with the invention, and reference to the accompanying drawings thereof, wherein:

Figure 1 is a view, partly in elevation and partly in section, of a device constructed in accordance with the invention, and showing the same in normal operating position,

Figure 2 is a view, similar to Figure 1, showing the operating portion of the device in the position it assumes when excessive withdrawals of gas are being made,

Figure 3 is an enlarged horizontal cross-sectional view taken on the line 3—3 of Figure 1,

Figure 4 is a transverse vertical sectional view taken on the line 4—4 of Figure 1,

Figure 5 is a view partly in elevation and partly in section, of a modified form of the device, and

Figure 6 is an enlarged view of the valve element of Figure 5.

In the drawings, the numeral 10 designates an elongate cylindrical storage tank which is adapted to be buried in the ground for receiving, and holding in heat exchanging relationship with the earth, liquefied hydrocarbon gases such as butane, propane and the like and mixtures or combinations thereof. The tank is adapted to be substantially filled with liquefied hydrocarbon gas under pressure through a filler pipe 11 having the customary inlet valve 12 at its upper end, and an escape pipe 13 having an outlet valve 14 at its upper end permits the vaporized gas to flow from the tank as it is filled, preferably into the filling tank truck (not shown) or other supply source. A float gauge element 15 extends downwardly through the escape pipe, in the usual manner, for indicating the liquid level in the tank.

The tank includes an inner shell 16, forming the main storage, and an outer shell 17 spaced from the inner shell so as to form a secondary chamber 18 therebetween. This secondary chamber communicates with the main storage through restrictive orifices 19 formed in the bottom wall of the inner shell.

For controlling the flow of gas from the tank, a control device 20, which includes a housing 21 forming an elongate vertical cylindrical valve chamber 22, is shown as mounted in the central portion of the tank. The valve chamber housing extends from the lower surface of the inner shell upwardly through the upper portion of the tank and above said tank for a distance substantially equal to the diameter of the tank. This valve chamber communicates with the lower portion of the tank storage space by means of a port 23 formed at the lower end of the housing, and also has communication with the secondary chamber 18 by means of openings 24 provided in the mid-portion of the housing, as is clearly shown in Figure 1. An outlet 25 is provided at the upper end of the valve chamber housing for connection with the usual pressure regulator 26 and the other customary control devices which are included in

the service line leading from the tank to the house or other place of consumption of the vaporized gas.

While the housing 21 has been shown as a single member, it will readily be seen that said housing may also be made in two sections, one section being secured to the outer shell 17 and extending upwardly therefrom, and the other section being located in the inner shell 16 and aligned with the first section. It is also to be noted that the housing may be located near the end of the tank 10 to facilitate fabrication of the plan.

The usual curb-box or housing 27 may be installed for protecting the control devices and other connections extending above the tank, if desired.

A U-shaped vent tube 28 has one arm 29 extending upwardly axially within the valve chamber 22 to a point above the top of the tank 10, while its other arm 30 extends upwardly within the inner shell 16 to a point near its top, as is clearly shown in Figure 1. This vent tube provides communication between the vapor area of the storage tank and the valve chamber 22 for a purpose which will be hereinafter explained.

An elongate float body 31, closed at its upper end, is freely slidable within the valve chamber. The float body has an axially disposed reduced sleeve 32 secured therein and spaced from the inner wall of said body. The sleeve terminates short of the upper end of the float body and an annular closure plate 33 is secured, by welding or otherwise, between the upper end of this sleeve and the inner wall of the float body, whereby an annular float chamber 34 is formed thereby.

The lower end of the sleeve 32 is also terminated short of the lower end of the float body, and the lower end portion of the float body has an inwardly directed flange forming a reduced opening 35 at the lower end of the bore of said body.

As is clearly shown in Figure 1, the float sleeve 32 is freely slidable over the arm 29 of the vent tube, and is spaced therefrom to form a flow passage therebetween. Thus, vaporized gas entering the arm 30 of the vent tube may flow through the tube into the bore of the float body and downwardly within said body between the outer surface of the tube arm 29 and the bore of the sleeve 32 to the opening 35 at the lower end of the float body, through which it will enter the valve chamber 22.

In operation, the tank is filled with liquefied hydrocarbon gas in the usual manner through the filler inlet pipe 11. The liquid level within the tank will rise and the liquefied gas will flow through the orifices 19 into the secondary chamber between the inner and outer shells of the tank, and will also enter through the opening or port 23 into the lower portion of the valve chamber 22, and will find a level in all three chambers.

Due to the fact that the liquefied gas in the secondary chamber 18 is in close heat exchanging relationship with the surrounding earth, vaporization of such gas will take place more rapidly than in the other chambers, and as a result, the space above the liquid in the secondary chamber and the valve chamber will be filled with the vaporized gas under increased pressure. The liquid in these chambers will, therefore, be forced back through the openings or port 23 and the orifices 19 into the main storage space in the inner shell 16, since the vaporized gas cannot pass from the secondary chamber and the valve chamber into the inner shell.

As the vaporized gas is drawn off through the service line, more liquefied gas enters the secondary chamber through the orifices 19 and is quickly vaporized due to the amplified area of contact and relatively thin volume which the liquid takes in the secondary chamber.

It is pointed out that the float body 31 is buoyantly supported upon the liquefied gas which is present in the lower portion of the valve chamber 22, since the float chamber 34 together with the vaporized gas, which has travelled through the vent tube 28 into the upper end of the float body and the float sleeve 32, are trapped in the float body by liquefied gas which has entered the lower end of the float body through the opening 35. Due to this liquid seal formed around the lower end of the float body, the vaporized gas which is in the inner shell 16 cannot pass through the vent tube into the valve chamber, so long as the lower end of the float body is below the liquid level within the inner shell.

In the event that the supply of heat which, transferred from the surrounding earth, is vaporizing the gas in the secondary chamber is lessened for any reason, or if the rate of withdrawal of the vaporized gas through the outlet 25 is sufficiently increased, the level of the liquefied gas in the secondary chamber will be raised. As the liquefied gas rises in the secondary chamber, more surface of the liquid is exposed to the heat of the earth, due to the shape of the chamber, and, consequently, there is an increase in the rate of vaporization. Such increase in the vaporization rate will ordinarily be ample to take care of the increased demand for vaporized gas.

If, however, the rate of vaporization of the gas in the secondary chamber is not sufficient to take care of the large withdrawal of the gas through the outlet, then the liquefied gas level in the said secondary chamber will rise until such liquefied gas flows through the openings 24 to join the liquefied gas which has risen equally in the valve chamber 22. When this occurs, the float body 31 will naturally be elevated with the increased liquid level in the valve chamber, and, when the lower end of the body is raised above the liquid level in the inner shell 16, the gas which is trapped in the upper portion of said inner shell will travel through the U-shaped vent tube 28 and downwardly through the float sleeve 32 and outwardly through the opening 35 at the lower end of the float body into the valve chamber, from which it will be withdrawn through the outlet 25 into the service line to the house.

Thus it will be seen that vaporized gas from the main storage space within the inner shell is being utilized to supply the heavy demand and is supplementing the supply from the secondary chamber 18, thereby considerably increasing the supply.

When the period of heavy withdrawal has passed, or when the temperature condition which caused the loss of heat application to its outer shell has passed, the vaporized gas in the valve chamber will force the liquefied gas level downwardly in the secondary chamber and in the valve chamber. As the level is lowered, the float body 31 will follow the liquid level downwardly in the valve chamber, whereupon the gas vapor which has been flowing out of the inner shell through the vent tube will be again sealed off by the formation of a liquid seal around the lower end of the float body as the body's lower

end moves below the liquid level in the inner shell.

The system will then operate in the usual manner first described until another period of heavy withdrawal or loss of heat energy causes the repetition of the cycle just described.

It is to be noted that the large space within the float body below the lower end of the sleeve 32 prevents liquefied gas from rushing into the float body and upwardly through the sleeve into the vent tube before such liquefied gas could flow outwardly from the valve chamber through the opening or port 23 at the lower end of the housing. Also, the enlarged space within the float body above the upper end of the sleeve serves the same purpose when the float body is in its completely lowered position. Presence of liquefied gas in the vent tube would inhibit the functioning of the device until such liquefied gas had vaporized. The location of the bend in the vent tube at the lower portion of the tank serves to expose any liquefied gas which might accumulate in the tube to the higher temperature present at that depth, and thus to assure vaporization of such accumulated liquefied gas.

It will be seen that I have provided, in the above system, a secondary chamber for presenting the liquefied gas to the action of the heat of the surrounding earth over an amplified area of contact, thereby increasing the rate of vaporization in a simple, readily manufactured heat exchanger, that I have also provided a system wherein the liquefied hydrocarbon gas is drawn from storage into the heat exchanger in a liquid form, and that I have provided means for positively controlling the flow therefrom, so that no liquefied gas can get into the service lines. Thus, I have provided a system which utilizes the mixed butane and propane of the ordinary commercial mixtures rather than drawing off the lighter propane faster than the heavier butane is drawn off, providing a more uniform heat value fuel by withdrawing the liquid mixture and vaporizing it. I have also provided a means of utilizing the gas from above the liquefied gas in the main storage in case of heavy withdrawal to supplement the regularly vaporized supply from the secondary chamber. This system is also a safer system because none of the liquid can enter the service line leading to the house.

It is to be noted that I have provided an improved control device for the gas which is vaporized, wherein there is formed a liquid seal for excluding the gas vapor from the main storage tank until the use of such gas is desired. Thus, the valve is simple and easily and cheaply manufactured, and wear which would be present in valves having material forming contacting seats in the usual manner is substantially eliminated.

The cap at the upper end of the valve housing 21 may be secured by screw-threads or other releasable means so as to permit its removal, whereby the float body may be inspected, repaired and replaced, if desired.

Obviously, the bouyancy of the float 31 may be changed by varying the size of the element or of the float chamber 34 therein. Also, the weight and length of the float body may be altered to effect opening of the vent tube 28 to permit withdrawal of vaporized gas from the main storage or inner shell, if desired.

Of course, many variations of the invention are possible. I have, however, illustrated in Figures 5 and 6 a modified form of the invention.

In Figure 5, I have provided a storage tank 50 with a secondary chamber 51 at one end. A liquefied gas inlet pipe 52 provides communication between the lower portion of the main tank 50 and the secondary tank, and this pipe may extend to any suitable elevation within the said secondary chamber to control the liquid level therein so as to maintain a large amount of liquid in contact with the heat exchanging walls of the secondary chamber. A vapor inlet tube 53 is mounted in the upper portion of the secondary chamber and has an upwardly directed arm 54, for the same purpose as the arm 29 of the vent tube 28 of the first form. This tube serves the same purpose as the aforesaid vent tube 28, in that it provides communication between the vapor space of the main storage tank and the secondary chamber. A valve float 55 having a sealing element 56 of Neoprene or other suitable material is positioned on the upper end of the arm 54 for controlling the admission of the vaporized gas from the tank 50 into the secondary chamber and acts in substantially the same manner as the valve or float body 31 of the first form of the invention.

Ordinarily, gas is formed from the liquefied gas in the secondary chamber 51 and is withdrawn through an outlet 56 at the upper end of the chamber into the service line. When, however, there is a heat loss or an extremely heavy withdrawal of vaporized gas through the outlet, the level of the liquefied gas will rise in the secondary chamber until it floats the valve 55. When the valve is lifted, the vapor in the main storage tank 50 is permitted to flow from the tank into the secondary chamber through the inlet tube 53, to supplement the gas vaporized in the secondary chamber and thus to satisfy the demand.

It will be readily observed that this form of the invention is very much like that first described, and that it has the same advantages except that the heat exchanging secondary chamber is not as extensive as that of the first form. In this form there is not the delicate control which is possible with the first form, but other of the advantages of such first form are present.

While the tanks have been described as adapted to be buried in the earth, they may obviously be placed in the house cellar or in other special buildings or housings above ground. In every case, the housing or building for the tank may utilize earth, air, water, steam, or any other suitable substance as the heat source for causing vaporization of the liquefied gas.

The above description of the invention is explanatory only, and changes in details of the constructions illustrated may be made by those skilled in the art, within the scope of the appended claims, without departing from the spirit of the invention.

What I claim and desire to secure by Letters Patent is:

1. A liquefied gas storage and dispensing system including, a storage tank for holding liquefied gas under pressure, a secondary vaporizing chamber in heat exchanging relationship with the surrounding medium, means for admitting liquefied gas from the storage tank into said secondary chamber for vaporization therein, a valve chamber having communication with the secondary chamber for receiving vaporized gas therefrom and having a service outlet, and means establishing communication between the vapor space of the storage tank and said valve chamber normally closed by a liquid column of the stored liquefied gas to prevent admission of vaporized

gas from the vapor space of said storage tank to said valve chamber, said last-named means being operable to admit such vaporized gas under predetermined conditions of withdrawal of vaporized gas from the secondary chamber in excess of its vaporizing capacity.

2. A liquefied gas storage and dispensing system including, a storage tank for holding liquefied gas under pressure, a secondary vaporizing chamber in heat exchanging relationship with the surrounding medium, means for admitting liquefied gas from the storage tank into said secondary chamber for vaporization therein, a valve chamber having communication with the secondary chamber for receiving vaporized gas therefrom and having a service outlet, means establishing communication between the vapor space of the storage tank and said valve chamber, means for admitting liquefied gas from the storage tank to said valve chamber, and a float valve in the valve chamber and actuated by the liquefied gas in said valve chamber for controlling the admission of vaporized gas from the vapor space of said storage tank to said valve chamber.

3. A liquefied gas storage and dispensing system including, a storage tank for holding gas under pressure, a secondary vaporizing chamber surrounding said tank and in heat exchanging relationship with the surrounding medium, means for admitting liquefied gas from the storage tank into said secondary chamber for vaporization therein, a valve chamber having communication with the secondary chamber for receiving vaporized gas therefrom and having a service outlet, a U-shaped tube establishing communication between the vapor space of the storage tank and said valve chamber, means for admitting liquefied gas from the storage tank to said valve chamber, and a float valve in the valve chamber and actuated by the liquefied gas in said chamber for controlling admission of the vaporized gas from the vapor space of said storage tank to said valve chamber, said U-shaped tube having its base portion in the area of greatest heat whereby liquefied gas which may accumulate therein is vaporized by said heat to assure flow of vaporized gas through said tube.

4. A liquefied gas storage and dispensing system including, a storage tank for holding liquefied gas under pressure, a secondary vaporizing chamber surrounding said tank and in heat exchanging relationship with the surrounding medium, means for admitting liquefied gas from the storage tank into said secondary chamber for vaporization therein, a valve chamber having communication with the secondary chamber for receiving vaporized gas therefrom and having a service outlet, a U-shaped tube establishing communication between the vapor space of the storage tank and said valve chamber, means for admitting liquefied gas from the storage tank to said valve chamber, and a float valve in the valve chamber and actuated by the liquefied gas in said chamber for controlling admission of the vaporized gas from the vapor space of said storage tank to said valve chamber, the liquefied gas in the valve chamber forming a liquid seal between said float valve and U-shaped tube.

5. A liquefied gas storage and dispensing system including, a storage tank for holding liquefied gas under pressure, a secondary vaporizing chamber surrounding said tank and in heat exchanging relationship with the surrounding medium, means for admitting liquefied gas from the storage tank into said secondary chamber for vaporization therein, a valve chamber having communication with the secondary chamber for receiving vaporized gas therefrom and having a service outlet, a U-shaped tube having one arm extending upwardly into the vapor space in the storage tank and its other arm extending axially upward within the valve chamber for establishing communication between the vapor space of the storage tank and said valve chamber, means for admitting liquefied gas from the storage tank to said valve chamber, and a float valve in the valve chamber telescoping the upwardly extending arm of the U-shaped tube and actuated by the liquefied gas in said chamber for controlling admission of the vaporized gas from the vapor space of said storage tank to said valve chamber.

6. A liquefied gas storage and dispensing system including, a storage tank for holding liquefied gas under pressure, a secondary chamber surrounding said tank and in heat exchanging relationship with the surrounding medium, means for admitting liquefied gas from the storage tank into said secondary chamber for vaporization therein, a valve chamber having communication with the secondary chamber for receiving vaporized gas therefrom and having a service outlet, a U-shaped tube having one arm extending upwardly into the vapor space in the storage tank and its other arm extending axially upward within the valve chamber for establishing communication between the vapor space of the storage tank and said valve chamber, means for admitting liquefied gas from the storage tank to said valve chamber, a float valve in said chamber telescoping the upwardly extending arm of the U-shaped tube and actuated b ythe liquefied gas in said chamber for controlling admission of the vaporized gas from the vapor space of the storage tank to said valve chamber, the liquified gas in the valve chamber forming a liquid seal between the float valve and the U-shaped tube, and a service line having a gas pressure regulator connected to the service outlet from said valve chamber.

7. A liquefied gas storage and dispensing system including, a storage tank for holding liquefied gas under pressure, a vaporizing chamber in heat exchanging relationship with the surrounding medium, means for admitting liquefied gas from the storage tank into said vaporizing chamber for vaporization therein, a valve chamber having communication with the vaporizing chamber for receiving vaporized gas therefrom and having a service outlet, means for establishing communication between the vapor space of the storage tank and said valve chamber, means for admitting liquefied gas from the storage tank to said valve chamber, and valve means in the valve chamber and actuated by the liquefied gas in said chamber for controlling the admission of vaporized gas from the vapor space of said storage tank to said valve chamber, said valve means being operable to admit such vaporized gas from the storage tank to prevent liquefied gas from entering the service outlet from the valve chamber.

8. In a liquefied gas storage and dispensing system, a storage tank for holding liquefied gas under pressure, a gas vaporizing chamber, a valve housing having an inlet for admitting liquefied gas from the storage tank and an inlet for vaporized gas from the vaporizing chamber, an upright conductor in the housing for conducting vaporized gas from the storage tank into said housing, and a floating closure telescoping said upright con-

ductor and floating on the liquefied gas in said housing, the contact of the liquefied gas with the floating closure forming a liquid seal to normally prevent admission of vaporized gas into the housing through the conductor and admitting vaporized gas from the storage tank to said housing when the level of liquified gas in the housing rises to a predetermined point.

9. In a liquefied gas storage and dispensing system, a storage tank for holding liquefied gas under pressure, a secondary chamber in heat exchanging relationship with the surrounding medium and having communication with the liquefied gas in the storage tank, a service outlet from said chamber, a conductor establishing communication between the vapor space in the storage tank and the secondary chamber for admitting vaporized gas from said vapor space into said chamber, and means for utilizing a portion of the liquefied gas to form a seal normally closing off flow of vaporized gas through the conductor but permitting flow of such vaporized gas to prevent liquefied gas from entering the service outlet when the level of liquefied gas in the secondary chamber rises to a predetermined point.

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