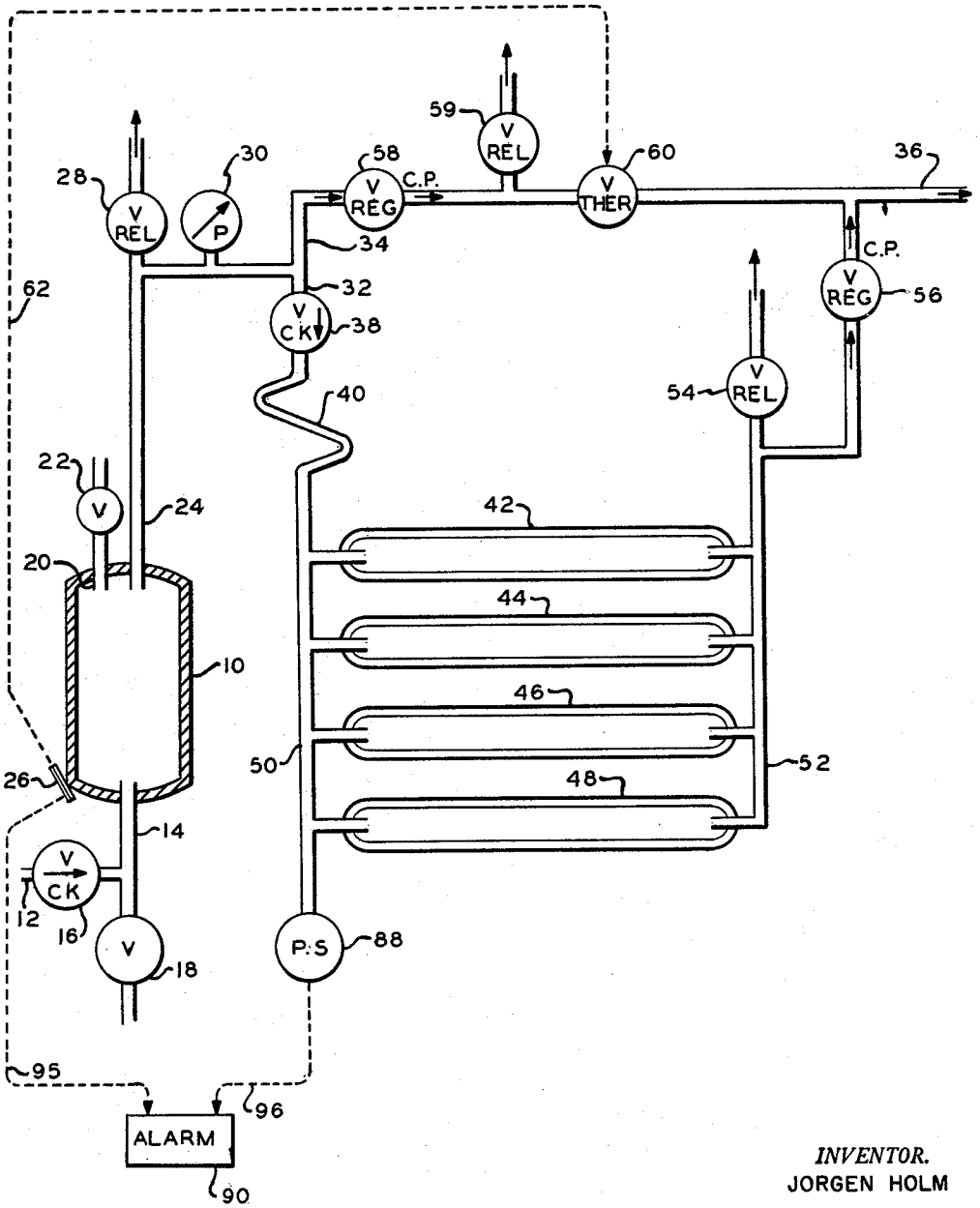
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VAPORIZING STATION FOR LIQUEFIED GAS

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VAPORIZING STATION FOR LIQUEFIED GAS

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This invention relates to automatic stations for vaporizing liquefied gas and dispensing the vaporized material at a temperature and pressure suitable for a desired use.

An object is to make such a station fully automatic with a minimum of complicated or expensive equipment.

A particular object is to facilitate refilling of a vaporizing vessel at the station from a portable supply of liquefied gas without requiring that the portable supply container or the attendant or operator thereof shall remain at the station until the liquefied gas delivered to the vaporizing vessel has completely evaporated in order to insure the initiation of automatic dispensing of gaseous material in response to a customer's demand for such material.

A feature of the invention is the use of a thermostatic control that is sensitive to the temperature of the vaporizing chamber automatically to initiate a change in operation when the liquid in the chamber has entirely evaporated and the chamber or a connection therefrom has warmed up to a predetermined temperature at which the gas is suited to its intended use. Before this change in operation occurs, however, vapor evolved from the liquefied gas is withdrawn from the vaporizing chamber and warmed to the usable temperature. It is then self-pressurized, stored at high pressure and supplied through a pressure regulating valve to a pipe line as needed. When the change in operation occurs, gas is supplied directly from the vaporizing chamber to the pipe line through another pressure regulating valve. The operating pressures of the two valves are made such that gas is fed to the pipe line from the vaporizing chamber in preference to gas from the high pressure receptacles until the vaporizing chamber has been bled down nearly to the pipe line pressure. Thereafter gas is supplied to the pipe line from the high pressure receptacles alone. When the high pressure receptacles are preferably nearly depleted, as indicated by a sufficiently low pressure in the receptacles, and at the same time the vaporizing vessel is empty, the vaporizing chamber may be recharged.

Other objects, features and advantages will appear from the following more detailed description of an illustrative embodiment of the invention, which will now be given in conjunction with the accompanying drawing.

The single figure of the drawing is a schematic view of a liquefied gas vaporizing station embodying the automatic features of applicant's invention.

In the single figure of the drawing, an uninsulated vaporizing chamber 10 is shown for vaporizing liquefied gas which may be supplied thereto at intervals through a filling conduit 12. The chamber 10 is shown as further provided with a fill pipe 14, a check valve 16, a drain valve 18, a vent pipe 20, a vent valve 22, a vapor outlet pipe 24 and a thermo-sensitive element 26 in contact with the wall of the chamber.

The vapor outlet pipe 24 is equipped with a pressure relief or safety valve 28 and a pressure gauge 30 and leads to parallel branch conduits 32 and 34. These conduits lead through separate paths to a pipe line 36 through which gas of suitable pressure and temperature is to be furnished for use as needed.

The path through conduit 32 leads to a check valve 38 and thence through a heating coil 40 to a bank of high pressure gas receptacles, of which four are shown by way of example, at 42, 44, 46 and 48. Each receptacle has an inlet pipe supplied from an input manifold 50, and an outlet pipe connected to an output manifold 52. The manifold 52 is provided with a pressure relief valve 54 and connects through a pressure regulated valve 56 with the pipe line 36. The valve 56 is of conventional type arranged to remain open as long as the pressure at its outlet is less than or equal to a predetermined pressure and to close when that pressure is reached or exceeded.

The path through conduit 34 leads through a pressure regulated valve 58 and thence through a temperature controlled valve 60 to the pipe line 36. The valve 58 is of the same type as valve 56 but works at a somewhat higher limiting pressure in order that when valve 60 is open, the pipe line will be supplied from conduit 34 in preference to conduit 32 as long as there is sufficient pressure in conduit 34. A pressure relief valve 59 is provided in the line between valves 58 and 60.

The temperature controlled valve 60 is controlled by the thermo-sensitive element 26 as is indicated schematically in the drawing by means of the broken line 62. The valve 60 is closed when the temperature at the element 26 is lower than a predetermined value and is open when the temperature equals or exceeds that value.

A pressure operated switch 88 is provided upon the input manifold 50. This switch may be set to operate at a predetermined minimum pressure associated with the need to refill the chamber 10. A refill alarm 90 may be provided under the joint control of the element 26 and the switch 88. These controls are indicated schematically in the drawing by the broken lines 95 and 96, respectively. The alarm 90 will be set off when the temperature at the element 26 is at or above its set value and at the same time the pressure at the switch 88 is at or below its set value.

The operation of the system illustrated with regard to vaporizing stored liquefied gas and dispensing the gaseous product will first be described.

Assuming the vaporizing chamber 10 to be fully charged with liquefied gas, for example liquid oxygen, vaporization proceeds due to leakage of heat from the ambient atmosphere through the walls of the chamber 10. Valves 18, 22, 28, 54 and 59 being closed, evolving vapor flows through check valve 38, heater 40, manifold 50 into gas storage receptacles 42, 44, 46, 48 and thence through manifold 52 to pressure controlled valve 56. Assuming that valve 56 is closed, vapor pressure will build up in the receptacles 42, etc., until all the liquefied gas has been vaporized. In the heater 40, the vapor is exposed to atmospheric heat or to any suitable supplemental heat in order to render the stored material suitable for its intended use in the pipe line 36.

The evolving vapor also enters the regulating valve 58 which will soon close, provided pressure relief valve 59 and thermally controlled valve 60 are closed. The limiting pressure above described will eventually be built up at the inlet side of valve 58.

If an outlet for gas is opened up anywhere along the pipe line 36 while the temperature controlled valve 60 is closed, gas will pass through the valve 56 to meet the demand of the pipe line.

The period of time required to vaporize all the liquid in the chamber 10 after refilling may possibly be several hours. When that time has elapsed, the temperature of the chamber, which meanwhile has been held to the temperature of the contained cryogenic liquid, will start to rise. When a predetermined temperature is attained, the thermal switch 26 operates to open the temperature controlled valve 60. Ordinarily the operating temperature of the switch 26 will be so chosen that the vapor at the valve 60 will have been warmed up to a temperature suitable for use in the pipe line 36. This operating temperature at switch 26 will be intermediate between the temperature of the cryogenic liquid and the operating

temperature of the pipe line because the piping, valves, etc. in the lines 24 and 34 will have a certain capacity for heating the vapor in transit therethrough.

Valve 58 should be set to operate at a slightly higher pressure than valve 56, so that when valve 60 is open, and the pipe line pressure falls due to demand for gas, the demand will first be supplied through valve 58. In this way it is provided that the chamber 10 will be bled down to approximately the pipe line pressure before any further drain is made upon the high pressure gas stored in the receptacles 42, etc.

When the chamber 10 has thus been bled down, the pipe line pressure will, upon further demand, fall slightly to the operating pressure of the valve 56, whereupon gas will be served to the pipe line from the receptacles 42, etc., as needed.

When the pressure in the input manifold 50 as measured by the pressure switch 88 is low enough to permit recharging of the chamber, and at the same time the vaporizing vessel 10 is empty as indicated by the operation of the thermo-sensitive element 26, the alarm 90 is actuated. The chamber 10 may then be recharged in conventional manner from any available supply of the desired liquefied gas.

The operating pressure of the switch 88 may be set high enough so that normal pipe line pressure is readily maintained over any reasonable interval of time which may elapse between actuation of the alarm and the actual recharging in due course of routine delivery service of liquefied gas. Whatever the setting of switch 88, the vaporizing chamber will be at minimum pressure upon actuation of the alarm and therefore ready for recharging at any time thereafter.

It will be evident that, whether the chamber 10 is refilled from a tank truck or otherwise, the station operates automatically to control the filling of the high pressure receptacles, the blowing down of the vaporizing chamber after the liquid is all evaporated, and the delivery of gas from the vaporizing chamber in preference to the delivery of gas from the receptacles while the vaporizing chamber is being blown down. There is no need for the truck operator or other attendant to remain at the installation after recharging the vaporizing chamber in order to await the evaporation of the last of the liquid.

It is preferable that the combined volume of the receptacles 42, etc., be sufficient to contain the whole of the charge of liquefied gas which the chamber 10 accommodates, after the charge has been completely vaporized, warmed to the desired temperature and pressurized to a predetermined maximum storage pressure corresponding to the full charge of liquefied gas. Under normal operating conditions, the relief valves 28 and 54, are set to open at some pressure in excess of the desired maximum storage pressure. These valves together with relief valve 59 are provided according to customary practice to act as safety valves in case any abnormal and dangerous condition should develop. Consequently, the relief valves 28, 54 and 59 will remain closed under all normal operating conditions.

While an illustrative form of apparatus and illustrative methods in accordance with the invention have been described and shown herein, it will be understood that numerous changes may be made without departing from the general principles and scope of the invention.

What is claimed is:

1. In a system for vaporizing and dispensing a liquefied gas, in combination, a vaporizing container for such liquefied gas, first transfer means including first pressure responsive regulating valve means set to be closed by a given limiting pressure at the outlet side of said valve means for transferring gaseous material directly from said vaporizing container to a utilization device at a relatively low pressure, means for storing gaseous material evolved from said vaporizing container at a relatively high pressure, second transfer means including second pressure responsive regulating valve means controlled to be closed by a lower limiting pressure at the outlet side of said valve means than said first pressure responsive valve means for transferring gaseous material from said storage means to said utilization device when gaseous material is not being transferred through said first transfer means, and temperature controlled means responsive to the temperature of said vaporizing container which serves to control flow in said first transfer means.

2. In a system for vaporizing and dispensing a liquefied gas, in combination, a vaporizing container for such liquefied gas, first gas phase transmission means to deliver a portion of vaporized material from said vaporizing container directly to a utilization device, means to store another portion of such vaporized material at high pressure, second gas phase transmission means to deliver vaporized material from said high pressure storage means to the utilization device, temperature controlled means responsive to the temperature of said vaporizing container to block said first gas phase transmission means while the said temperature is below a predetermined value, first pressure valve means in said first gas phase transmission means, said first pressure valve means being controlled to be closed by a given limiting pressure at the outlet side, and second pressure valve means in said second gas phase transmission means, said second pressure valve means being controlled to be closed by a lower limiting pressure at the outlet side than said first pressure valve means whereby material is supplied to the utilization device through said first gas phase transmission means in preference to said second gas phase transmission means as long as the back pressure from the utilization device exceeds the said limiting pressure at the outlet side of said second pressure valve means and said first gas phase transmission means is in unblocked condition.

3. In a system for vaporizing and dispensing a liquefied gas, in combination, a vaporizing chamber for containing and vaporizing such liquefied gas, a check valve, high pressure gas phase storage means connected to said vaporizing chamber by way of said check valve, first pressure regulated valve means connecting said high pressure storage means to a service pipe line, a by-pass including second pressure regulated valve means connecting said vaporizing chamber to said service pipe line, said first and second pressure regulated valve means being each controlled to limit maximum pressure at the respective outlet, said second pressure regulated valve means being set for a higher pressure limit than said first pressure regulated valve means, a temperature controlled valve in said by-pass downstream from said second pressure regulated valve means, and a thermostatic control element in thermal contact with said vaporizing chamber and coupled to said temperature controlled valve for maintaining said valve open at temperatures above a predetermined limiting temperature, whereby gas is fed to said service pipe line through said second pressure regulated valve means in preference to said first pressure regulated valve means whenever said temperature controlled valve is open and the pressure in said service pipe line exceeds the said pressure limit of said first pressure regulated valve means.

4. In a system for vaporizing and dispensing a liquefied gas, in combination, a vaporizing vessel, parallel branched conduits connecting said vessel to a utilization device, a first of said conduits including a check valve, means for heating gaseous material, means for storing gaseous material, and a pressure controlled valve which remains open as long as the pressure at the outlet of the valve is below a first predetermined maximum value; the second of said conduits including a pressure controlled valve which remains open as long as the pressure at the outlet of the valve is below a second predetermined maximum value that is greater than said first predetermined maximum value, a temperature control device responsive to the

temperature of said vaporizing vessel, and a temperature controlled valve in said second conduit between said pressure controlled valve and said utilization device, said last mentioned valve being controlled by said temperature control device to be open whenever the temperature of the said vaporizing vessel is above a predetermined value.

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