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H. C. SMITH

1,942,944

METHOD AND APPARATUS FOR DISPENSING GAS MATERIAL

Filed June 13, 1933

2 Sheets-Sheet 1

Fig. 1

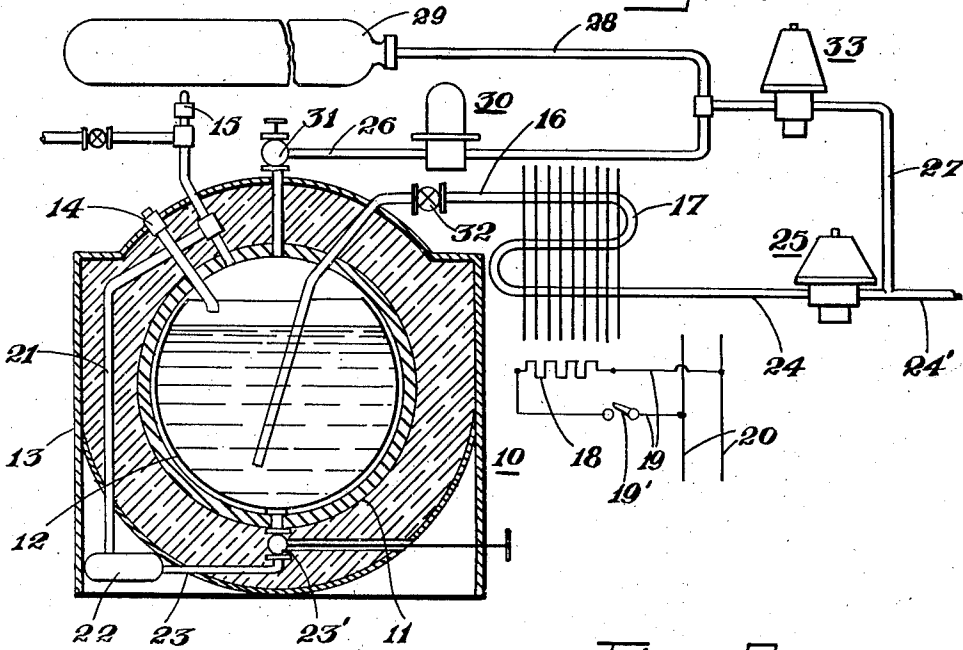
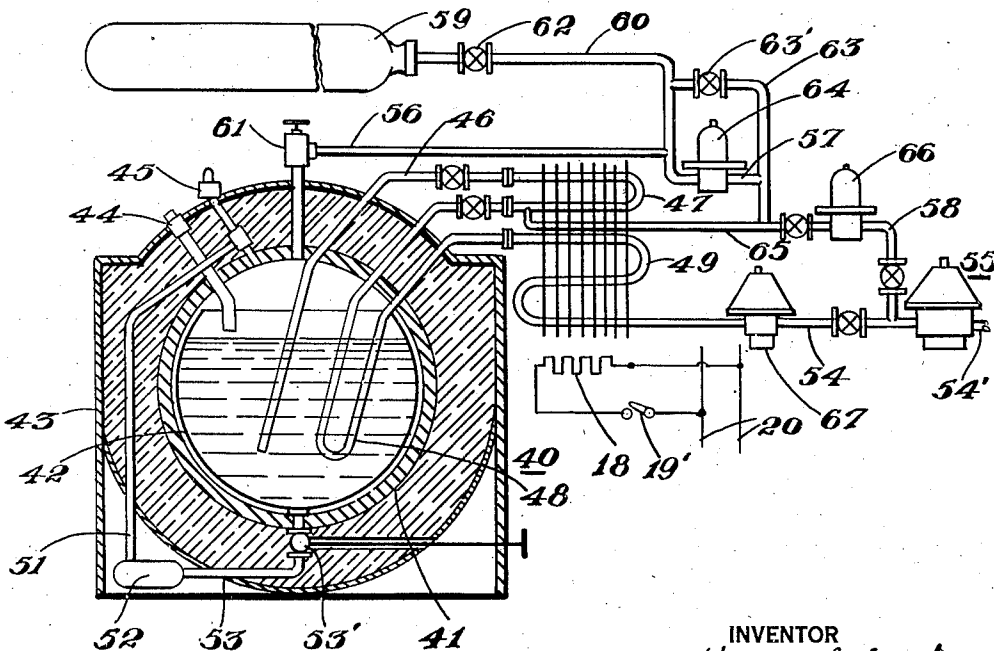


Fig. 2



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Fig. 3

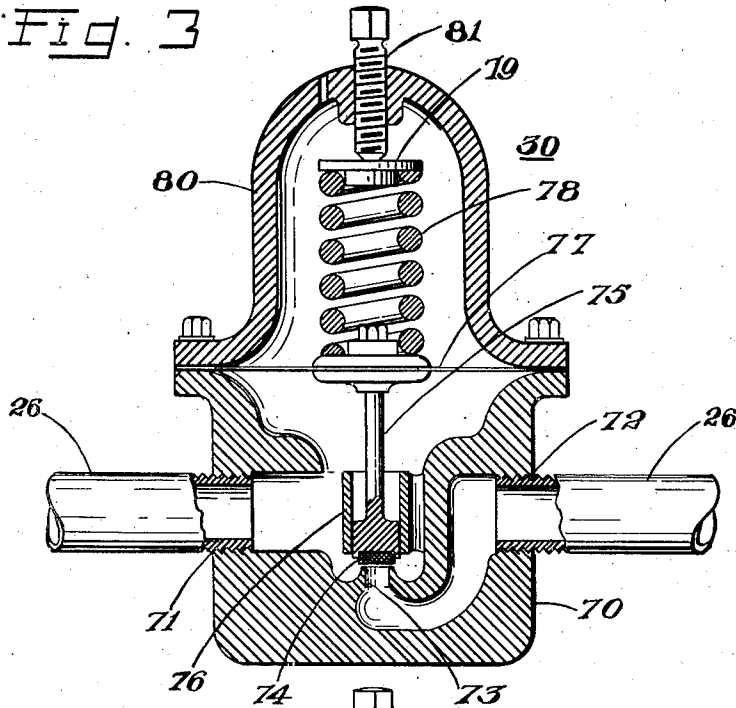
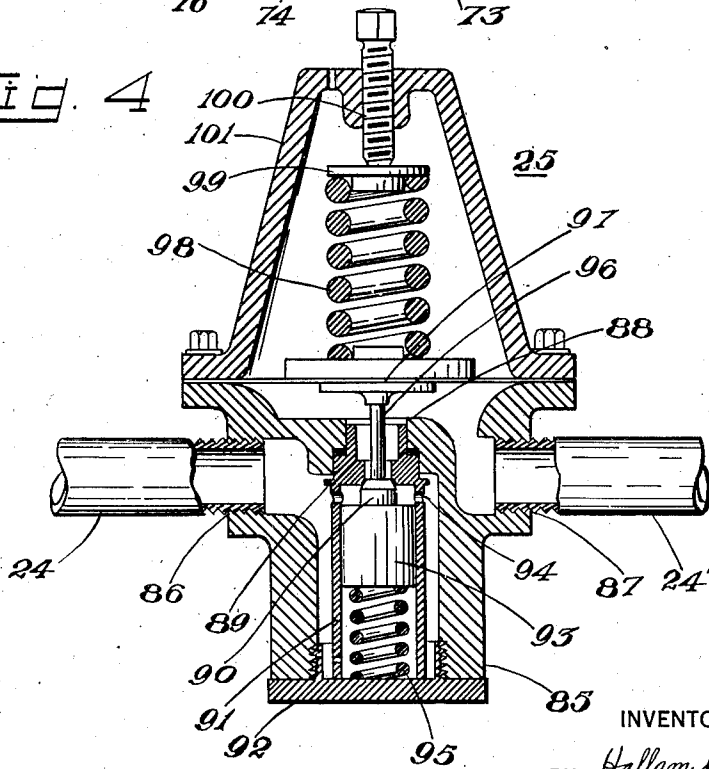


Fig. 4



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METHOD AND APPARATUS FOR DISPENSING GAS MATERIAL

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This invention relates to a method and apparatus for dispensing gas material, particularly gas material which is conveyed and stored in the liquid phase, and has for its object to provide a procedure and suitable means for effecting the discharge of gas to consuming apparatus at a desired substantially constant pressure.

More specifically, it is an object to provide steps and suitable means for effecting withdrawal of gas material from liquid and gas phase storage means in a manner whereby the pressures of the respective discharges are controlled and the consuming apparatus is continuously served with gas material at the desired pressure or pressures. Another object is to provide a system having a relatively great discharge capacity that is capable of conserving the normal evaporation without waste with substantially a minimum of investment in equipment. To this end, the apparatus in the system of the present invention incorporates receiving means for gas material in the gas phase, the whole being arranged to supply gas at a relatively constant high pressure, when desired.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the several steps and the relation of one or more of such steps with respect to each of the others, and the apparatus embodying features of construction, combinations of elements and arrangement of parts which are adapted to effect such steps, all as exemplified in the following detailed disclosure, and the scope of the application of which will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

Fig. 1 is a view partly in section, partly in elevation and partly conventional, showing an arrangement of apparatus adapted for the practice of the invention;

Fig. 2 is a similar view showing a modified form of apparatus;

Fig. 3 is an enlarged sectional view showing the construction of a suitable form of back pressure regulating valve that is employed in the discharge systems illustrated in Figs. 1 and 2; and

Fig. 4 is a similar view of a reducing pressure regulator shown in the systems illustrated in Figs. 1 and 2.

Liquefied gases intended for industrial consumption, such as liquid oxygen, nitrogen, meth-

ane and the like, with which the method of the present invention is practiced, are conveyed in the liquid phase within portable containers of the heat insulated variety to the place where the gas material is to be consumed. As such, liquefied gases may be transferred at the place of use to a second vessel, which is permanently installed at the place of use, or the portable container may be temporarily left at the place of use and withdrawals made as desired therefrom for the purpose of consumption.

According to the present invention, the liquefied gas is transferred to a second vessel which is also a heat insulated container of the storage variety. Economies may be effected in the use of gas material stored in such containers, since gas material may be withdrawn either in the gas phase, or in the liquid phase, provided there is associated therewith suitable means for converting the liquid phase into the gas phase at the desired pressure for use in the consuming apparatus. In the present invention, this is accomplished by providing means for vaporizing the liquefied gas as withdrawn and controlling the pressure of discharge. In order to conserve the normal evaporation from the storage container, one or more gas receivers are arranged to communicate with the discharge system and to hold gas material in the gas phase and store the same under a continually increasing pressure, provision being made in the distributing system to utilize a desired portion of this accumulated gas initially upon demand from the consuming apparatus before withdrawals of gas material in the liquid phase take place.

Referring now to the drawings and particularly to Fig. 1, 10 denotes generally a container for liquefied gas of the insulated type, which has an inner vessel 11 of the pressure variety having a spaced lining or basket 12 adapted to receive and hold a charge of liquefied gas. The whole is enveloped in a suitable outer jacket or casing 13, which is substantially closed except where pierced by conduits that provide filling and withdrawal means for the inner vessel. The filling means is here shown as comprising a short conduit 14 having a closure at the outer end. A safety valve 15 also communicates with the vessel 11 and provides convenient relief for excessive pressure.

A conduit 16 having its open end reaching nearly to the bottom of the vessel 11 comprises the liquid phase withdrawal means which communicates externally of the container with one end of a heating or vaporizing means 17, which

may be of any suitable variety adapted to impart heat relatively rapidly to the liquid traversing the same. This vaporizing means may conveniently comprise a plurality of convolutions or coils arranged in the fashion of a conventional heat radiator. The gas material, if sufficiently heated, may be discharged directly to consuming apparatus.

The heating and vaporizing means 17, may, of course, have any convenient location and may be arranged to absorb heat directly from the atmosphere at normal temperatures. It is preferable, however, to associate with the heating and vaporizing means an agent for imparting heat in order to accelerate the attainment of the heating effect desired. The heat applying agent may be of any suitable character, but as the gas material here being heated is at relatively low temperatures, it is preferable that the heating agent be not one which has a relatively high freezing point and is preferably not of an aqueous nature. Air is a suitable heat applying agent, and when employed for this purpose may preferably be additionally heated by a suitable air heating means. To this end, electric air heating means are conventionally shown by way of example; this electric heating means comprises a resistance heating grid 18 connected through service conductors 19 with supply buses 20, the heating effect being controlled by the control of the heating current which is here indicated as effected by switch means 19'.

In order to produce a discharge of liquid from vessel 11, means for building pressure within the vessel 11, are provided. Such means may conveniently comprise a conduit 21 arranged to communicate with the gas space of the pressure vessel 11 and lead to a vaporizing vessel 22 arranged to absorb heat from the atmosphere and disposed on the exterior of the insulation employed in the container about the vessel 11. A second conduit 23 leads from the vessel 22 to a point below the liquid level in the pressure vessel 11. The admission of liquid to the vessel 22 is controlled by valve 23' which may be hand operated, as shown. By vaporizing liquid in the vaporizer 22, pressure may be built in the vessel 11, as desired.

The heating and vaporizing means 17, under the influence of the pressure generated, discharges into a service conduit or customer's pipe line 24, which has a pressure regulator 25 therein designed automatically to maintain substantially constant the pressure on the customer's side of the pipe line indicated at 24'. This regulator may be of any conventional design, a suitable construction being illustrated in Fig. 4, and hereinafter more fully described.

A gas phase withdrawal conduit is shown at 26 leading from the gas space of the vessel 11 and communicating through a conduit portion 27 with the main discharge conduit 24'. A gas receiver 29 is connected by the conduit portion 28 with the conduit 26, the discharge through this conduit being controlled by suitable means such as a valve. An automatic valve is preferable, a back pressure regulating valve 30 is accordingly shown in the conduit 26; details of the valve 30 being shown in Fig. 3, and hereinafter more fully described. A hand valve may be provided in addition, as shown at 31. Also, a hand valve, as shown at 32, may be provided in the conduit 16.

To insure that the pressure of the gas sup-

plied in the gas phase, for example, from the receiver 29, is reduced to a desired value, a second pressure regulating valve 33, similar to that at 25, is preferably disposed in the conduit portion 27. This valve is advantageously set to reduce the pressure of the gas supplied in the gas phase to a value slightly in excess of that supplied from the pressure regulator 25. In this way, the gas in the gas phase is first employed to supply the demand before the liquid phase withdrawals are utilized.

In operation, the vapors normally generated in the vessel 11 from heat leakage when there is no discharge to consuming apparatus accumulate therein until a predetermined pressure is reached, for example, a pressure of 200 lbs./square inch gage, determined by the setting of the back pressure regulator 30. When this predetermined value is attained, the valve 30 opens automatically and gas passes by way of the conduits 26 and 28 into the receiver 29; the valves 31 and 32 being normally open. The vapors thus generated are stored in the receiver 29 until the limiting high pressure is reached when the safety valve at 15 opens until an excess pressure is blown off; the gas receiver being, of course, of such dimensions as to receive and store without blow off the vapors which are thus generated during an anticipated period of no demand.

If now consuming apparatus be connected to make demand upon the conduit 24', the stored gas material will flow through the conduits 26, 27 and 28, the open back pressure valve 30 and the regulator valve 33, which reduces the pressure of the stored gases to a desired service value, for example, to 145 lbs./square inch gage pressure. It is seen that the consuming apparatus will be supplied with a supply of gas at substantially constant pressure. If the demand continues so long and the stored gas is used up to an extent such that the pressure drops to a value close to the value to be maintained in the supply main 24', the valve 30 closes, while valve 33 remains open. But when the pressure in conduit 24' drops to a predetermined value which is slightly lower than the pressure delivered by regulator 33, then regulator 25 opens. Gas material in the liquid phase will now pass out through the conduit 16 and become vaporized by the heat supplied to the vaporizer 17, this vaporized gas material passing through the connections 22, the reducing regulator 25 and the conduit 24'. The flow of liquefied gas from the vessel 11, is maintained by maintaining a pressure in the vessel 11 at a sufficient value, which may be determined visually from gages (not shown in the interests of clearness in the drawings), and if the pressure falls below the desired value, the valve at 23' is opened to permit a flow of liquid into the vessel 22 at a rate sufficient to build the desired pressure. Upon cessation of demand, the valve 23' is closed; otherwise, pressure accumulates in the vessel 11 at a rate greater than desired.

In the form of the invention illustrated in Fig. 2, the apparatus depicted differs from that shown in Fig. 1 mainly in the provision of means for automatically building pressure within the vessel 11, which are auxiliary to or a substitute for the heating vessel shown in connection with Fig. 1. Referring specifically to Fig. 2, 40 denotes generally a container having an inner vessel 41 of the pressure variety and having a spaced lining 42 for holding the charge of liquefied gas. This container has an outer casing 43 for supporting

the insulation and is provided also with a filling conduit 44. A safety valve 45 communicating with the gas space of the pressure vessel, and a liquid phase withdrawal conduit 46 depending into the liquid within the vessel 41 in a manner similar to that shown at 16 in Fig. 1, are shown. The conduit 46 also communicates with one end of a heating or vaporizing means 47 that is connected to communicate with a heat exchanging means 48 submerged in the liquid within vessel 41. The other end of this latter means connects with a second heating or vaporizing means 49, the two heating means 47 and 49 being external to the container and preferably associated so as to be warmed by a single heating agent, which may be electrical, as indicated in Fig. 1.

In order to build pressure in the vessel 41 at will independently of the heat exchanging means 48, there is provided an exposed vessel 52 with connections 51 and 53 controlled by a valve 53', similar to the arrangement shown in Fig. 1. Gas material vaporized in the heating means 47 and 49 is discharged into a main supply conduit 54, which has a pressure regulator 55, similar to that shown at 25, and in Fig. 4, for the purpose of maintaining a substantially constant pressure on the consumer's side 54' of the main discharge conduit. A gas phase withdrawal conduit 56 is arranged to communicate by way of conduit sections 57 and 58 with the main discharge conduit 54, and a gas receiver 59; the latter being connected to the gas phase withdrawal connection 56 by way of a conduit 60 and has valves 61 and 62 interposed to control the connections 56 and 60, respectively.

This second form of device has automatic back pressure valves at 64 and 66 introduced in the conduit sections 57 and 58. These back pressure valves are designed automatically to open upon the attainment of respectively desired back pressures on the supply side and to close when such back pressures fall below the desired values. In this system, it may be desired to bleed off a certain amount of gas in the gas phase from the receiver 59, even though the pressure is not sufficient to cause the valve at 64 to open. In order to effect this without disturbing its seating, a bypass is preferably provided about this valve, as indicated at 63, a hand valve 63' being preferably provided to control this by-pass.

A connection 65 is provided leading from a point intermediate of the valves 64 and 66 to the heating or vaporizing means 47. In this form of the invention, the discharge from the heating or vaporizing means 47 and 49 is also preferably automatically controlled prior to the discharge into the regulator 55. This is accomplished by introducing a second automatic pressure reducing valve 67 that is set to reduce the pressure to a point slightly above that to which the regulator 55 is intended to reduce the discharge pressure.

In operation, this second form of device is similar to that shown in Fig. 1, except that the additional automatic means, here provided, secure a wider range of automatic operation. The back pressure regulating valve 64 is seen to provide automatic means for cutting in and out the vaporizers 47 and 49 upon the drop of the pressures in the receiver 59 and in the gas space of the vessel 41 below a predetermined value. When this value is reached, flow of gas material in the gas phase through the connection 57 is shut off by the closing of back pressure valve 64 and the vaporiz-

ers 47 and 49 automatically cut in, so that withdrawal of gas material in the liquid phase to be heated in the vaporizers thereafter occurs. The back pressure regulator 66 here functions to cut in the submerged heater 48 when the back pressure in the vapor space in the vessel 41 drops to a predetermined value, the submerged heater when thus cut in functioning to build pressure within the vessel 41, so as to maintain the desired rate of discharge of gas material in the liquid phase. The setting of the back pressure valve at 64 is thus seen to require only a slight advance over that at 66, for example, the regulator at 64 may be set to close at 170 pounds gage pressure, whereas, that at 66 may be set to close at 165 pounds gage pressure. The regulator 55 is set to reduce the gas pressure of the gas material supplied either from the receiver 59, or from the vessel 41 to the desired service value, for example, 150 pounds gage. The regulator at 67 would then be set slightly in advance of the setting for the regulator 55, for example, 155 pounds gage pressure.

In both systems, the automatic regulators of both types may be installed in duplicate sets so arranged that one of the members of each pair may be cut out of service without interrupting the flow of gas through the other when it is desired to effect repairs to the valves. A number of pressure regulators for controlling the pressure of the gas material delivered to various consuming devices may also be used in place of the single regulator on the pipe line shown at 25 and 55.

Fig. 3 illustrates a construction suitable for a back pressure regulator of the character employed at 30, 64 or 66. Here, a main casing 70 is shown as provided with an inlet port 71 and an outlet port 72 which are connected interiorly by means of a valve orifice 73, on which seats a valve member 74, that is actuated and carried by a valve stem 75. The lower end of the stem 75 operates in a guide sleeve 76 which is mounted rigidly on the interior of the casing 70. The upper end of the valve stem 75 is secured to and actuated by a diaphragm 77 that closes the orifice 73. The diaphragm 77 is arranged to be actuated differentially by the pressure existing within the casing 70, communicated through the inlet port 71, and an exterior pressure which is substantially constantly applied, although desirably made adjustable. Any convenient means for providing such exterior pressure may be employed, for example, a coiled spring 78, which acts at its lower end to apply pressure to the upper surface of the diaphragm 77 and reacts at its upper end against a mounting plate 79 that is carried by a cap 80; the latter being secured on top of the casing 70 to protect the diaphragm 77. This cap is preferably provided with an adjusting screw 81 for raising or lowering the plate 79 and thus varying the pressure which is to be applied to the diaphragm 77.

The pressure regulating and reducing valve shown in Fig. 4 differs from the back pressure valve shown in Fig. 3 mainly in the fact that its pressure on the outlet side acts on the diaphragm to determine the flow of gas therethrough instead of the back pressure on the inlet side. A casing 85 is accordingly shown with an inlet port 86 and an outlet port 87, and has a valve orifice 88 providing communication therebetween. This orifice is provided with an adjustable seat member 89, on which a valve element 90 seats when it moves upwardly, the seating member being carried by a sleeve member 91, that is mounted on and ad-

justed by the screw member 92 which has a base closing the bottom of the casing 85. The valve element 90 has rigidly attached thereto a piston element 93 working in the sleeve 91, the upper end of the sleeve being perforated to provide orifices 94 to admit fluid from the inlet of the casing to the space above the piston for passage through the valve when unseated. Reacting against the downward movement of the piston 93 is a spring 95 inserted between the base 92 and the under face of the piston 93. This spring applies a constant upward pressure tending to seat the valve element 90. A valve stem 96 projects upwardly from the valve element 90 through the valve orifice and is arranged to be actuated by a diaphragm 97 closing the top of the valve casing and exposed to the outlet pressure. This outlet pressure tends to seat the valve element upon the attainment of a certain limiting value determined by the exterior pressure on the diaphragm. In order that this exterior pressure may be adjusted, an adjustable spring 98 is arranged to bear downwardly on the diaphragm 97 and react against a plate 99 that is adjustably carried by a screw 100 mounted in a casing top 101 that is secured above the diaphragm on the casing 85. These automatic valves are shown merely as exemplary of varieties of such valves which may be employed in the practice of the invention, but in themselves do not constitute part of my invention.

Since certain changes in carrying out the above process and in the constructions set forth, which embody the invention, may be made without departing from its scope, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

Having described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. A method for dispensing gas material from a storage container for liquefied gas having gas receiving means connected to the discharge passage leading from the container, which method comprises discharging gas material in the gas phase from both said container and said receiving means into said passage while the gas pressure exceeds a desired working value, discharging gas material in the liquid phase when said pressure becomes lower than said working value, and vaporizing the gas material in the liquid phase as discharged.

2. A method for dispensing gas material from a storage container for liquefied gas having gas receiving means connected to the discharge passage leading from the container, which method comprises discharging gas material in the gas phase from both said container and said receiving means into said passage while the gas pressure exceeds a desired working value, discharging gas material in the liquid phase when said pressure becomes lower than said working value, maintaining a desired pressure in said container in order to obtain a discharge of gas material in the liquid phase at a desired rate, and vaporizing the gas material in the liquid phase as discharged.

3. A method for dispensing gas material from a storage container for liquefied gas having gas receiving means connected to the discharge passage leading from the container, which method comprises discharging gas material in the gas phase from both said container and said receiving means into said passage while the pressures within said container and receiving means exceed a desired value, discharging gas material

in the liquid phase from said container when said pressures become lower than said desired value, vaporizing the gas material discharged in the liquid phase, and utilizing gas material thus vaporized to vaporize a portion of the liquid material in said container.

4. A method of supplying oxygen in the gas phase obtained from oxygen in the liquid phase held in an insulated container having a discharge passage leading therefrom and a gas receiver connected thereto, which method comprises collecting normally evaporated oxygen from said container during periods of non-consumption, storing said collected oxygen in said receiver, withdrawing oxygen in the gas phase from both said container and said receiver during periods of consumption while the pressures therein are of predetermined value above a desired value in said discharge passage, withdrawing liquid oxygen from said container when the oxygen in the gas phase fails to be above said predetermined value, vaporizing the withdrawn liquid oxygen, and utilizing oxygen thus vaporized to vaporize a portion of the liquid in said container whereby pressure is built therein for accelerating the withdrawal of liquid oxygen.

5. A method of supplying oxygen in the gas phase obtained from oxygen in the liquid phase held in an insulated container having a discharge passage leading therefrom and a gas receiver connected thereto, which method comprises collecting normally evaporated oxygen from said container during periods of non-consumption, storing said collected oxygen in said receiver, withdrawing oxygen in the gas phase from both said container and said receiver during periods of consumption while the pressures therein are of a predetermined value above a desired value in said discharge passage, withdrawing liquid oxygen from said container when the oxygen in the gas phase fails to be above said predetermined value, vaporizing the withdrawn liquid oxygen, and automatically producing vaporization of a portion of the liquid in the container whenever the pressure therein drops below a second predetermined value.

6. A method of supplying oxygen in the gas phase obtained from oxygen in the liquid phase held in an insulated container having a discharge passage leading therefrom and a gas receiver connected thereto, which method comprises collecting normally evaporated oxygen from said container during periods of non-consumption, storing said collected oxygen in said receiver, withdrawing oxygen in the gas phase from both said container and said receiver during periods of consumption while the pressures therein are of a predetermined value above a desired value in said discharge passage, automatically causing the withdrawal of oxygen in the liquid phase whenever the pressure of the oxygen in the gas phase falls below said predetermined value, and heating the oxygen withdrawn in the liquid phase to vaporize the same and maintain a desired pressure.

7. Apparatus for dispensing gas material comprising, in combination, a container for liquefied gas, gas and liquid phase withdrawal connections associated with said container leading to consuming apparatus, receiving means for storing gas in the gas phase connected to communicate with said container, means for maintaining open the gas phase withdrawal connections when the pressure within said container exceeds a desired value, and means for automatically opening said

liquid phase withdrawal connections when the pressure within said container is lower than said desired value.

8. Apparatus for dispensing gas material comprising, in combination, a container for liquefied gas, gas and liquid phase withdrawal connections associated with said container having a common discharge passage leading to consuming apparatus, receiving means for storing gas in the gas phase connected to communicate with said container, a vaporizing device connected to vaporize the liquid passing in said liquid phase withdrawal connection, and means for automatically closing said gas phase withdrawal connection upon the drop of the pressure in said container below a desired value.

9. Apparatus for dispensing gas material comprising, in combination, a container for liquefied gas, gas and liquid phase withdrawal connections associated with said container having a common discharge passage leading to consuming apparatus, receiving means for storing gas in the gas phase connected to communicate with said container, vaporizing means in said liquid phase withdrawal connections for vaporizing the liquid passing therein, means in said withdrawal connections for maintaining the pressure of the discharged gas material at a desired working value, and means for automatically shutting off the discharge through the gas phase withdrawal connections when the pressure in said container drops below a desired value which is above said working value.

10. Apparatus for dispensing gas material comprising, in combination, a container for liquefied gas, gas and liquid phase withdrawal connections associated with said container having a common discharge passage leading to consuming apparatus, receiving means for storing gas in the gas phase connected to communicate with said container, vaporizing means in said liquid phase withdrawal connections for vaporizing the liquid passing therethrough, and means in said common discharge connection for automatically maintaining the pressure on the outlet side of the system at a substantially constant value.

11. Apparatus for dispensing gas material comprising, in combination, a container for liquefied gas, gas and liquid phase withdrawal connections associated with said container having a common discharge passage leading to consuming apparatus, receiving means for storing gas in the gas phase connected to communicate with said con-

tainer, vaporizing means in said liquid phase withdrawal connections having a portion submerged in the liquid within said container, a by-pass in said liquid phase withdrawal connection about said submerged portion of the vaporizing means, and means for automatically cutting in said submerged portion of the vaporizing means whenever the pressure in said container drops below a predetermined value.

12. Apparatus for dispensing gas material comprising, in combination, a container for liquefied gas, gas and liquid phase withdrawal connections associated with said container having a common discharge passage leading to consuming apparatus, receiving means for storing gas in the gas phase connected to communicate with said container, a vaporizing means in said liquid phase withdrawal connection for vaporizing the liquid passing therethrough and having a portion arranged to heat the liquid within said container, a by-pass connected about said portion which heats the liquid in said container, means for automatically maintaining a discharge of gas material in the gas phase from said container and receiving means when the pressures therein exceed a predetermined value, and means for automatically closing said by-pass whenever the pressure in said container drops below a desired value which is above said predetermined value.

13. Apparatus for dispensing gas material comprising, in combination, a container for liquefied gas, gas and liquid phase withdrawal connections associated with said container having a common discharge passage leading to consuming apparatus, receiving means for storing gas in the gas phase connected to communicate with said container, a vaporizing means in said liquid phase withdrawal connection for vaporizing the liquid passing therethrough and having a portion arranged to heat the liquid within said container, a by-pass connected about said portion which heats the liquid in said container, means for automatically maintaining the discharge of gas material in the gas phase from said container and receiving means when the pressures therein exceed a predetermined value, means for automatically closing said by-pass whenever the pressure in said container drops below a desired value which is above said predetermined value, and means in said common discharge passage for automatically maintaining the discharge pressure substantially constant.

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