Jan. 14, 1936. G. J. BOSHKOFF 2,028,119

METHOD AND APPARATUS FOR DISPENSING GAS MATERIAL

Filed May 29, 1934 2 Sheets-Sheet 1

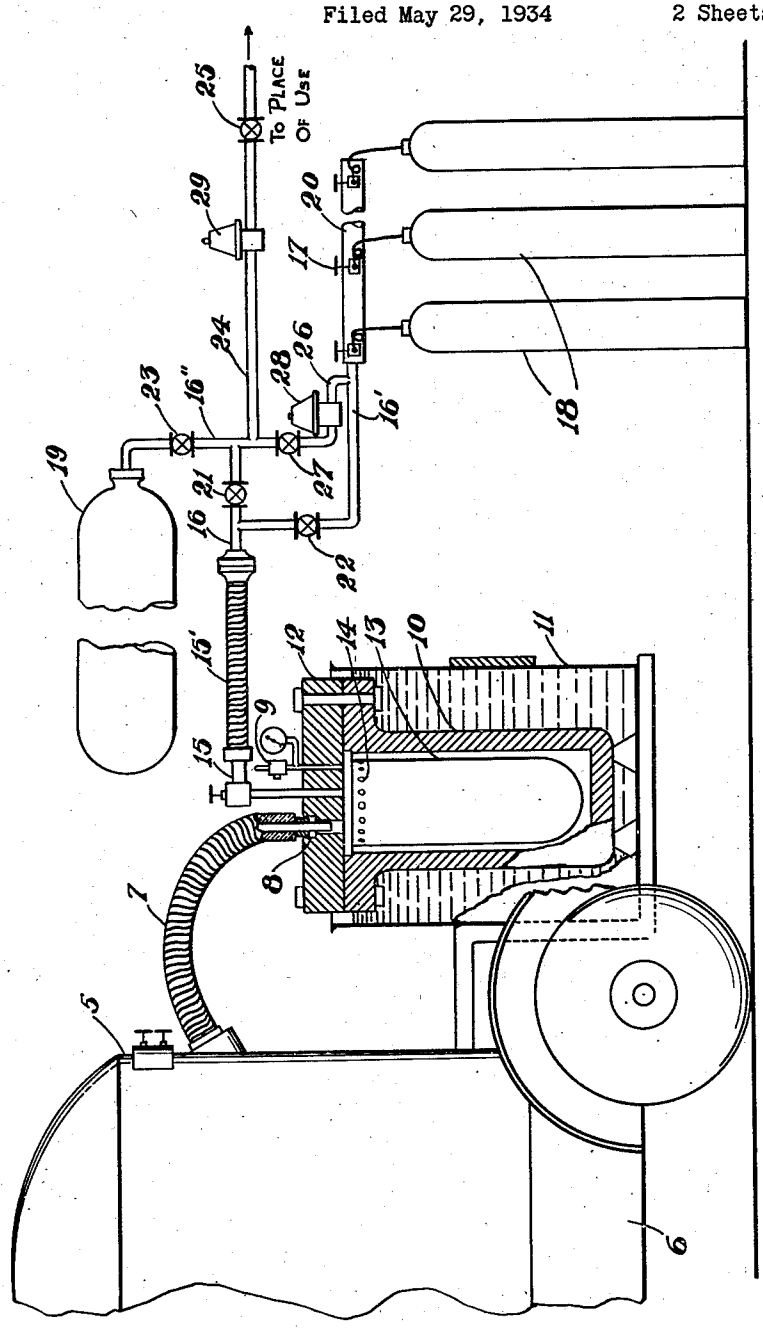


Fig. 1

INVENTOR
George J. Boshkoff
BY
Watson, Bristol, Johnson & Leavenworth
ATTORNEYS

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Fig. 2

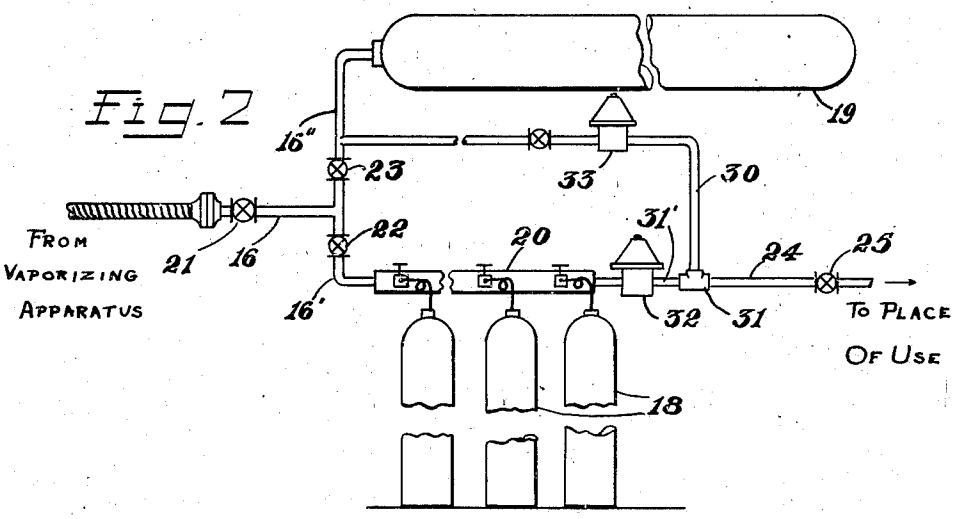
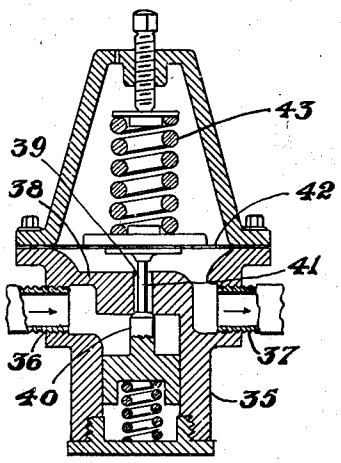


Fig 3



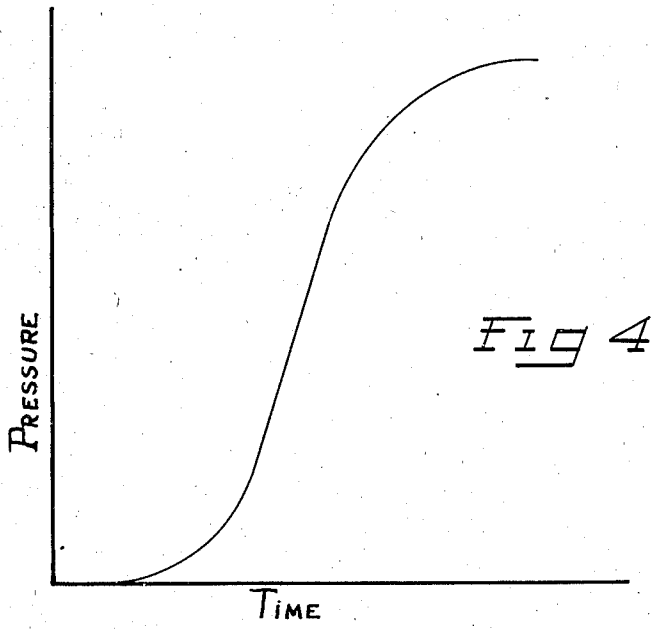


Fig 4

INVENTOR
George J. Boshkoff
BY
Watson, Bristol, Johnson & Leavenworth
ATTORNEYS

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UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR DISPENSING GAS MATERIAL

George J. Boshkoff, Buffalo, N. Y., assignor to The Linde Air Products Company, New York, N. Y., a corporation of Ohio

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12 Claims. (Cl. 62—1)

This invention relates to a method and apparatus for dispensing gas material, particularly gas material which is stored and transferred in the liquid phase at a temperature below 273° K. and converted into the gas phase when supplied to consuming apparatus.

The invention has for its object generally an improved procedure for dispensing gas material in the manner indicated and suitable means for carrying out such procedure in an efficient and economical manner.

More specifically, it is an object to provide steps in a method of charging and recharging apparatus for converting gas material in the liquid phase into the gas phase and discharging the same to receiving apparatus with relatively small blow-down losses.

It is also an object to associate a system of gas receivers with a converting or vaporizing device for a liquefied gas in such a manner as to supply gas material in the gas phase in a succession of two or more predetermined pressures, whereby a relatively efficient and economical system results.

It is still another object to associate automatic regulating devices with a system of gas receivers arranged for operation at two or more predetermined pressures for supplying consuming apparatus at a substantially constant service pressure.

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 fragmentary view partly in section and partly in elevation showing a system of gas receivers and liquefied gas converting apparatus arranged in accordance with the invention;

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

Fig. 3 is an enlarged sectional view showing a detail of an automatic valve employed in the arrangements shown in Figs. 1 and 2; and

Fig. 4 is an explanatory diagram.

It has already been proposed to service consumers of highly compressed gases intended for industrial purposes with gas material in the liquid phase in such a manner that the storing and transferring of the gas material in the liquid phase involves handling in apparatus subject to temperatures materially below 273° K. This has been conveniently accomplished by shipping the gas material in the liquid phase in containers having suitable heat insulation and, when at the consumer's plant, delivered to stationary converting apparatus installed at the plant where the gas material in the liquid phase is converted into the gas phase or it may be converted into gas in converters transportable with the containers and supplied to storing devices for subsequent delivery to consuming apparatus at a desired service pressure. Where the converting apparatus whether transportable or stationary is employed to supply a plurality of disconnected storing devices, there are blow-down losses incident to the change of connections between converter and storing device. By means of the present invention these losses are materially reduced.

Any suitable form of converting or vaporizing apparatus may be used in conjunction with the servicing container in the practice of the present invention. It is, however, advantageous to employ a device for this purpose which utilizes, as a source of heat to effect the vaporization of the liquefied gas, a source naturally available since the operation of the device is thereby rendered relatively inexpensive. One form of vaporizing device adapted for converting liquid oxygen into gaseous oxygen by utilizing the heat of the atmosphere or that of water at atmospheric temperature, or slightly higher, is shown in the U. S. patent to Heylandt, Reissue No. 18,476, dated May 17, 1932. In the apparatus shown in this patent, a high pressure vessel having suitable warming means is provided for converting a charge of liquid oxygen into gaseous oxygen, which is then discharged and stored in a high pressure gas receiver until supplied to consuming apparatus. Relatively high gas pressures may be generated in the converting vessel, for example, a pressure of 2100 lbs. gage, the gas material in the gas phase being passed to the high pressure receiver until all the charge is vaporized, after which recharging may take place.

The conversion of gas material from the liquid phase into the gas phase, in such apparatus, takes place relatively quickly after the converting process has once started, as set forth in the said

reissue patent. A pressure-time curve showing a characteristic manner in which pressure is generated is illustrated in Fig. 4, which shows the rise in pressure of a charge of gas material in relation to time when receiving devices of a certain capacity are employed with this type of vaporizing apparatus.

In the pressure-time curve of Fig. 4, time is abscissa, while the ordinates represent pressure. When the converting vessel, which has a thin spaced lining or basket, is charged and closed, pressure begins to build up at first rather slowly, as indicated by the lower left-hand portion of the curve depicted in Fig. 4. The rate of pressure rise increases as the material becomes heated. Then a very rapid rise in pressure ensues, since the liquid expands considerably after the first slow initial rise in pressure and flows into the space in the converting vessel on the outside of the basket. After this overflow has ceased, the final conversion of the liquid into gas is completed and the rate of pressure generation decreases as indicated by the upper right-hand portion of the curve which bends over and asymptotically approaches the horizontal. When the converting vessel is at high pressure, the gas receiving device which may have from four to six times the volume of the converting vessel, is filled. The converting vessel cannot be connected to another receiving device and recharged without releasing pressure therein. Heretofore, there were considerable blow-down losses in connection with the operation of the converting vessel in this manner where the gas receiving devices are operated at a single predetermined pressure level.

In accordance with the present invention, gas receiving devices are provided for operation at two or more predetermined pressure levels, which are connected to the vaporizing apparatus and are arranged to supply gas material in the gas phase successively rather than simultaneously to consuming apparatus at a desired service pressure.

Referring now to the embodiment shown in Fig. 1, 5 denotes a transportable heat-insulated container, which holds a supply of liquid oxygen and which is moved from place to place by means of a suitable vehicle, such as a truck, indicated at 6. The liquid oxygen to be vaporized is withdrawn from the container through a conduit 7 and introduced through a filling opening 8 into a vaporizer 10 of the character shown in the above-noted Heylandt patent. The outer or pressure vessel of the vaporizer is shown in an exterior water-bath 11 that is mounted on the rear of the truck, and has a removable cover 12. Within the pressure vessel is a spaced thin-walled basket 13, about the top of which are perforations 14 which afford communication between the space within the basket and the clearance space about the same. The cover 12 has a connection 15 which is connected by a flexible portion 15' with a supply connection 16 associated permanently with the receiving system. Suitable auxiliary devices may be associated with the vaporizing apparatus as desired, for example, a safety valve and a pressure gage which are shown collectively at 9.

In order to receive the gas supplied through the connection 16 and store the same at a plurality of predetermined operating pressures, this connection is arranged to communicate selectively with a plurality of receivers designed to operate at the desired different pressure levels. The conduit 16 accordingly is shown as provided with a branch 16' leading to a suitable high pressure receiving means 18, for example, a plurality of cylinders, while a second branch 16'' leads to a suitable low pressure receiving means 19, for example, a low pressure vessel. The receivers 18 preferably have a common filling manifold 20, the connection to each cylinder being preferably individually controlled as indicated by the valves shown at 17.

The filling of the receivers 18 and 19 is selectively controlled by suitable means in the connection 16 and its branches. For example, a valve 21 is shown as interposed in the connection 16, and is normally closed when pressure is building in the vaporizing apparatus. A valve 22 is interposed in the branch 16' and a valve 23 in the branch 16''. A service or withdrawal conduit 24 is provided which makes suitable connection with the receivers, and leads to the place of use. The service conduit is preferably independently controlled by means of a valve, as shown at 25.

In order that the system of the present invention may be selectively discharged, one or more by-pass connections are provided to effect communication between any receiver and the withdrawal conduit. In the arrangement shown, conduit 24 communicates with the low pressure branch 16''; accordingly, a by-pass connection 26 is arranged to lead from manifold 20 to the conduit 24 and is controlled by a valve 27. In the event that the gas pressure in the receiver 19 falls to a predetermined pressure level, when supplying gas for industrial use, the receiving means at 18 may be cut in by opening valve 27.

In order that this system may be substantially automatic and the desired sequence in discharge from the receivers may be independent of the personal equation of an attendant, suitable automatic valves are associated with the discharge connections; for example, an automatic pressure regulating valve 28 may be inserted, as shown in the by-pass connection 26 which is set to open upon the drop of pressure on its discharge side (which is the supply side of regulator 29) to a pressure level which exceeds that in the service conduit by a desired pressure differential.

To maintain the service pressure constant a second automatic regulating valve may be inserted in the service conduit 24 ahead of the valve 25, as shown at 29. This latter is set to function, in relation to the pressures described above, to maintain the pressure on the service side of the conduit 24 constantly at, for example, 150 lbs. gage.

Where the cylinders 18 are normally charged to an operating pressure in the neighborhood of 2100 lbs. gage, the receiver 19 may conveniently be charged to an operating pressure in the neighborhood of 300 lbs. gage. The predetermined pressure level to be maintained on the supply side of the service conduit may advantageously exceed that in the service conduit by a differential of 15 lbs. gage; for example, when 150 lbs. gage is to be maintained in the service conduit, the predetermined pressure level, below which the supply is not permitted to go, may be 165 lbs. gage. When this pressure level is desired, the regulator 28 is set to open the by-pass 26 when the supply pressure in the receiver 19 falls to 165 lbs. gage. Communication between the service supply and the cylinders 18 is thus established to maintain the service continuously after the supply of low-pressure gas has been utilized.

In the modified form shown in Fig. 2, the by-

pass connection is shown at 30 and has one end connected to the branch 16'' while the other end is connected to the service conduit 24 through a coupling 31 that has a connection 31' leading directly to the manifold 20. A service pressure regulating valve 32 is preferably inserted in connection 31' as shown. The by-pass is also here controlled by a pressure regulating valve 33 that is normally open but set to close when the pressure in the by-pass drops below a predetermined pressure which is above that maintained by regulator 32 by a predetermined differential; for example, where valve 32 is set to open to maintain the service pressure at 150 lbs. gage, regulator 33 may be set to open at 155 lbs. gage. In consequence, valve 32 is always closed so long as the low pressure receiver is able to supply gas to maintain a pressure of 155 lbs. gage. When this fails, the high pressure supply is automatically cut in.

The regulators 28, 29, 32 and 33 may, of course, have any suitable construction. An example of a suitable construction for these regulators is shown in Fig. 3, where a housing 35 is depicted as having an inlet 36, with which a portion of the conduit 24 communicates, and an outlet 37 with which an exit portion of the conduit communicates. This casing has a partition 38 dividing it into inlet and outlet chambers, the partition having a valve opening 39 with a seat on the under side. Cooperating with this seat is a valve member 40 having a stem 41 connected to a pressure operated diaphragm 42. This diaphragm is shown as having a spring 43 bearing thereon from above and exposed on the under side to the pressure on the outlet side of the partition 38. Thus it is seen that this valve may be set to maintain automatically a desired pressure in the outlet chamber by restricting the orifice at 39 sufficiently to maintain a constant service pressure.

The operation of the system as a whole is as follows: the vessel 10 is filled with a measured quantity of liquid withdrawn from the container 5 through the connection 7. The filling opening at 8 is then closed to the atmosphere, the valves 21 and 22 being also preferably closed, whereupon pressure begins to build in the vessel 10 in the manner above described. Valve 23 is also preferably closed and valve 27 is open. When the desired high pressure is developed or shortly before, valve 22 is opened in order to charge the cylinders at 18 which are put in communication with the manifold 20 by opening valve 17. Valve 23 remains preferably closed during the entire period of charging the cylinders at 18, while the condition of valve 25, whether open or closed, depends on requirements at the place of use. When the receivers at 18 are charged, valve 22 is closed and valves 21 and 23 are opened. The receiver at 19 is now charged, and since it has a volume which is larger by a predetermined ratio than that of the converting vessel, the filling operation will have been completed when the pressure between the receiver at 19 and the converter has been equalized at the desired value, for example, a pressure of 300 lbs. gage. When the equalization of pressures in the vessel 10 and receiver 19 has been accomplished, the valve 21 is closed, after which the converting vessel is disconnected and blown down to be ready for charging another receiving system. By this arrangement, it is seen that by employing a low pressure receiver at 19 the blow-down losses are materially reduced since the volume of gas released from the converting vessel is blown down from the pressure of the low pressure receivers instead of the high pressure of the high pressure receivers as formerly was necessary when it was desired to use the same converting vessel to charge another system of receivers without waiting for the gas remaining therein to be discharged to consuming apparatus.

Gas is withdrawn from the two sets of receivers here provided through the service conduit 24 by having valves 23, 25 and 27 open and valves 21 and 22 closed. It is seen that gas first passes from the low pressure receiver into the service conduit and then from the high pressure receiver manifold which is automatically controlled by the regulator 28. The regulator 28 prevents flow of gas from the receivers 18 so long as the pressure on the outlet side of the last-named regulator is above a predetermined value, to which it is adjusted, i. e., in the example given, 165 lbs. gage. When, therefore, the pressure of the low pressure receiver is reduced to 165 lbs. gage, the regulator 28 automatically connects the high pressure receivers 18 with the service conduit. When the high pressure receivers 18 are empty, the system may be recharged in the manner indicated. The operation of the system shown in Fig. 2 is, of course, similar, except for the functioning of the automatic valves, as explained above.

Systems of the character here set forth having gas receiving means operated at but two pressure levels, may use receivers of such volumetric capacities respectively as to reduce the operating blow-down losses when charging the converter to relatively low values, for example, 3%; it being obvious that such systems are adapted to be operated with receivers at three or more different pressure levels having capacities such as to reduce the operating blow-down losses to any desired value. The use of each additional receiver at another pressure level, however, represents additional capital investment. Hence, a factor in determining the number of receivers to be operated at different pressure levels in any given instance is the ascertaining of that number on which the saving of gas material, represented by the decrement in blow-down losses, makes the desired monetary return on the investment involved.

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. The method of dispensing gas material to consuming apparatus at a desired service pressure which comprises supplying a suitable vaporizing device with liquefied gas, converting the liquefied gas material into gaseous phase, discharging vaporized gas material into a plurality of receivers operating on successively different pressures, and thereafter supplying consuming apparatus from said receivers by discharging the same successively.

2. The method of discharging gas material to consuming apparatus at a desired service pressure which comprises supplying a vaporizing device with liquefied gas, converting said gas material into gas by applying heat, discharging the converted gas material into a plurality of gas re-

ceivers arranged to be operated at a plurality of different pressure levels in a manner such as to pass from the highest to the lowest pressure level, and thereafter supplying consuming apparatus from said receivers by passing successively from the lowest to the higher pressure level.

3. The method of dispensing gas material to consuming apparatus at a desired service pressure which comprises supplying a suitable vaporizing device with liquefied gas, converting the liquefied gas material into gaseous phase, discharging a major portion of the gas material from said vaporizing device into a receiving device at a predetermined high pressure, discharging a remaining portion from said vaporizing device into a low pressure receiving device, and storing said portions in said receiving devices at their respective pressures until desired for use.

4. The method of dispensing gas material to consuming apparatus at a desired service pressure which comprises charging suitable vaporizing apparatus with a desired amount of liquefied gas, converting said charge into gas when said apparatus has been charged, discharging said apparatus into a plurality of gas receivers operating at different pressure levels, the discharge advancing from the high to the low pressure levels, and thereafter supplying consuming apparatus from said receivers which are emptied in an order advancing from low pressure to high pressure, said higher pressure receiver being arranged to be connected automatically to the supply connections when a predetermined pressure value is reached.

5. The method of dispensing oxygen to industrial consuming apparatus at a desired service pressure which comprises charging a vaporizing device with a desired amount of liquid oxygen, vaporizing the charge in said vaporizing device after the same has been charged, withdrawing the gaseous oxygen from said device and storing the same in a plurality of gas receivers arranged to operate at relatively different pressure levels, first supplying consuming apparatus from a receiver operated at the lowest pressure level and thereafter supplying consuming apparatus from a receiver operated at a higher pressure level.

6. The method of dispensing oxygen to industrial consumers at a desired service pressure which comprises charging a vaporizing device with a desired amount of liquid oxygen when the device is vented to the atmosphere, vaporizing the charge in said device when the same has been closed to the atmosphere, discharging a major portion of the gaseous oxygen into a high pressure gas receiver until a predetermined high pressure is reached, thereupon discharging a remaining portion into a low pressure gas receiver, supplying consuming apparatus at a desired service pressure from said low pressure receiver until a predetermined low pressure not greatly in excess of said service pressure is reached, and thereafter supplying consuming apparatus from said high pressure receiver.

7. Apparatus for dispensing gas material to consumers at a desired service pressure comprising, in combination, portable means for receiving gas material in the liquid phase and vaporizing the same, gas withdrawal means leading from said receiving and vaporizing means having a plurality of supply connections, gas receivers connected respectively to said connections and arranged to hold gas at different operating pressures, a service connection associated with said withdrawal means, and control means associated with said connections arranged for the selective charging and discharging of said receivers.

8. Apparatus for dispensing gas material to consumers at a desired service pressure comprising, in combination, means for receiving gas material in the liquid phase and vaporizing the same, a gas withdrawal connection leading from said receiving and vaporizing means having a plurality of supply connections, gas receivers connected respectively to said branches, said receivers being operated at a plurality of different pressure levels, a service connection associated with said withdrawal connection, and control means associated with said connections arranged for charging said receivers by passing from the highest pressure to the lowest pressure and for discharging said receivers by passing from the lowest to the highest pressures.

9. Apparatus for dispensing gas material to consumers at a desired service pressure comprising, in combination, a relatively movable vaporizing apparatus for receiving and vaporizing a charge of liquid oxygen, a gas withdrawal connection leading from said vessel and having a plurality of branches, gas receivers connected respectively to said branches and arranged to receive and hold gas respectively at different operating pressures, a service connection associated with said withdrawal connection, and valves in said connections arranged for selectively charging and discharging said receivers.

10. Apparatus for dispensing gaseous oxygen to consumers at a substantially constant service pressure comprising, in combination, a relatively movable vaporizing apparatus adapted to hold and vaporize a charge of liquid oxygen, a gas withdrawal connection leading from said vessel having a pair of branches, gas receivers connected respectively to said branches and arranged to be operated at two different operating pressures, a service connection leading from one of said branches, valves for controlling said branches and connections, and an automatic regulator associated with said service connection whereby the service pressure may be maintained substantially constant.

11. Apparatus for dispensing gaseous oxygen to consumers at a substantially constant service pressure comprising, in combination, a relatively movable vaporizing apparatus adapted to hold and vaporize a measured charge of liquid oxygen, a gas withdrawal connection leading from said vessel having a pair of branches, a high pressure receiver connected to one of said branches, a low pressure receiver connected to the other branch, a service connection leading from one of said branches, a by-pass connection leading from said service connection to the other branch, and regulating means in said connections and branches.

12. Apparatus for dispensing gaseous oxygen to consumers at a substantially constant service pressure comprising, in combination, a relatively movable warm converter including a pressure vessel adapted to receive and vaporize a charge of liquid oxygen, a gas withdrawal connection leading from said pressure vessel and having a pair of supply branches, gas receivers connected respectively to said branches and arranged to hold gas and be charged respectively to a low and a high operating pressure, a service connection associated with the branch which communicates with the low pressure receiver, a by-pass connection leading from said high pressure receiver

to said withdrawal connection, valves in said branches and connections for selectively controlling the charging and discharging of said receivers, an automatic regulator in said service connection for maintaining the service pressure substantially constant, and a second automatic regulator in said by-pass connection leading to the gas receiver operated at the higher pressure and arranged to connect said receiver for discharging to said service connection only when the pressure in said low pressure receiver has dropped below a predetermined value.

GEORGE J. BOSHKOFF.