Oct. 7, 1941. G. H. ZENNER ET AL 2,257,897

METHOD AND APPARATUS FOR DISPENSING GAS MATERIAL

Filed Feb. 28, 1939

Fig. 1.

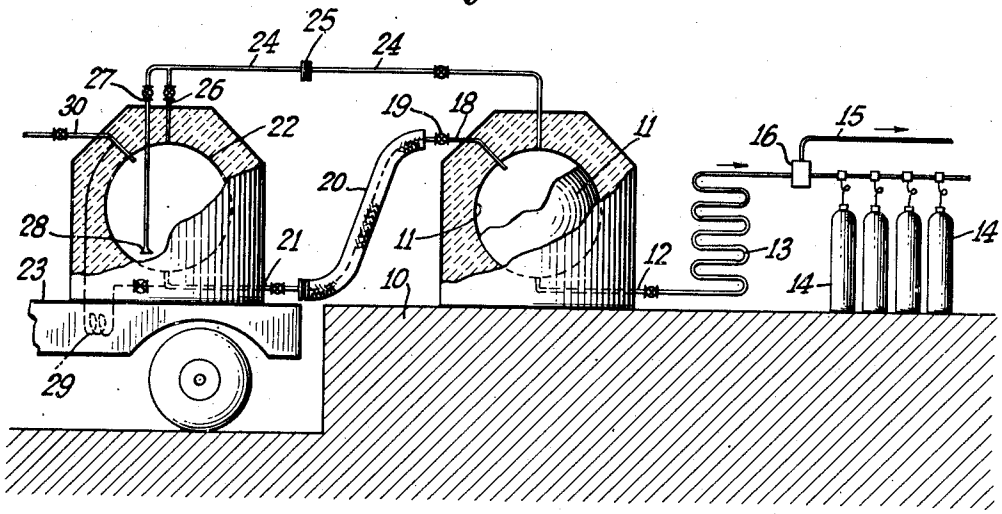
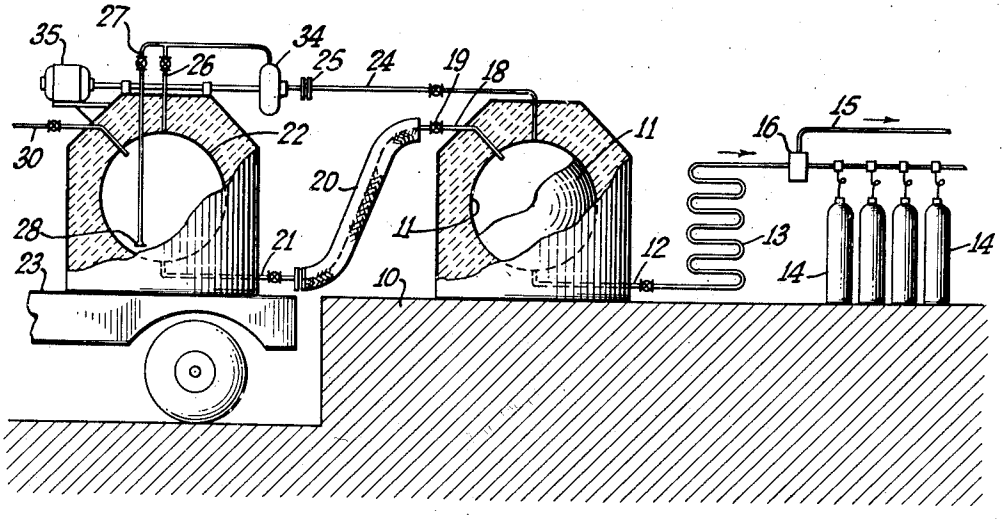


Fig. 2.



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Patented Oct. 7, 1941

2,257,897

UNITED STATES PATENT OFFICE

2,257,897

METHOD AND APPARATUS FOR DISPENSING GAS MATERIAL

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Application February 28, 1939, Serial No. 258,902

8 Claims. (Cl. 62—1)

This invention relates to a method and apparatus for dispensing a gas material having a boiling point below 233° K., and particularly to a method and apparatus for dispensing gas material in the liquid phase, such as liquid oxygen, in a manner involving relatively little loss.

The invention has for its object generally the provision of an improved method together with suitable apparatus for dispensing valuable gas material of the character indicated in a manner which conserves substantially all the so-called "blowdown" and residual gas material in the gas phase.

More particularly, the invention has for its object the provision of procedural steps and suitable apparatus for carrying out the same in such a manner that consumer systems which incorporate receiving vessels or containers may be serviced and supplied with gas material in the liquid phase while at the same time providing for the reliquefaction of all or a substantial part of the gas material in the gas phase which has heretofore been vented to the atmosphere.

Another object is to provide an arrangement of apparatus for supplying consumer systems with gas material of the character indicated in the liquid phase in a manner which employs a relatively small number of so-called cascaded vessels, i. e., vessels arranged to discharge one into another at different or increased pressures, for effecting the transfer of the gas material from a vessel or container which transports the material to a vessel or container which receives the material at the consuming installation and generally contains gas material in the gas phase at a relatively high pressure.

Another object is to provide an arrangement for supplying consumer systems with gas material of the character indicated in the liquid phase from transport containers which are closed or hermetically sealed while in transit in a manner which satisfies present-day regulations governing such transportation.

Still another object is to provide an arrangements of apparatus for filling containers on the consumer premises, for example, containers of the so-called "cold converter" type, with gas material in the liquid phase, such as liquid oxygen, from a sealed transport container with minimum loss by blowdown, by equipping the containers with separable means for effecting cascade connections whereby material in the gas phase in the consumer container may be transferred to the transport container for reliquefaction.

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 invention 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 drawing, in which:

Fig. 1 is a view, mainly schematic but partly in section, showing an arrangement of containers with separable cascaded connections for servicing a consumer installation in accordance with the invention; and

Fig. 2 is a similar view showing a modification.

In consumer installations which utilize low boiling point liquefied gases for industrial purposes, such as liquid oxygen, a vaporizing device is generally provided, which converts gas material from the liquid phase to the vapor phase and elevates it to a pressure suitable for industrial applications. A storage container for receiving periodically supplies of the gas material in the liquid phase for the vaporizer is generally incorporated and the servicing of such installations comprises delivering suitable charges to the receiving container from a transport container whenever required.

In order that such an installation or system may be operated economically, losses of gas material should first be reduced to the lowest practical amount, and, second, deliveries of gas material to the system should be made in the largest practical amounts. There are, of course, present limits to the amount of the charge which may be transported and delivered to the receivers at consumer installations. It is desirable, therefore, to provide servicing arrangements for filling the receivers at the consumer installations in a manner reducing losses of material in the gas phase as nearly as practical to zero.

The transport container is usually moved from the production plant to the consumer installation by truck and is hence subject to governmental regulations. Materials coming in the category of liquefied gases of the character indicated may be transported on the highways at a pressure not higher than 25 lbs./sq. in.-gauge

unless certain rigid specifications for the construction of the container are adopted. As a consequence, containers for transport service under pressure have heretofore been prohibitorily expensive, and shipments as a rule are made in containers open to the atmosphere. By far the largest losses of gas material are those occasioned by the escape of material in the gas phase from the transport container while in transit.

In accordance with the practice of the present invention, in order to approach the ideal "zero" losses, provision is made for transporting the gas material in a substantially closed transport container, where precaution has been taken to prevent the internal pressure from exceeding 25 lbs./sq. in.-gauge.

The step of transferring the gas material in the liquid phase from the transport container to a receiving vessel, such as a cold converter at the consumer installation, is effected under the acceleration of pressure from material in the gas phase withdrawn from the consumer system, the whole charge being delivered at one time from the transport container to the receiver. The original charge of gas material in the transport container as a result is completely displaced and replaced by material in the gas phase. This discharging step may be practiced in connection with two or more containers that are to be filled.

The transfer of the gas phase to the transport container is preferably practiced in a manner which effects a reliquefaction of at least a portion of the gas phase transferred, although it may be practiced merely as a step effecting gas pressure equalization. Accordingly, there is provided, in addition to the usual liquid phase transfer connection, a gas phase equalization connection, which connects the gas space in the receiving container to the interior of the transport container. The portion of this connection entering the transport container is preferably provided with a gas diffuser that is adapted to be submerged below the lowest substantial liquid surface in the transport container. Another portion or branch may be provided which communicates with the normal gas space when desired. The gas phase transfer may be effected under the difference of pressure normally existing between the gas spaces respectively in the receiving container and in the transport container. Power means, however, may be provided in association with the gas phase transfer connection for effecting the transfer at any desired rate. Such power means advantageously has the form of a power-driven gas pump in the gas transfer line.

Referring now to the drawing, and particularly to Fig. 1, 10 denotes the base of a consumer installation on which is disposed a liquid receiving container 11 that has a liquid withdrawal connection 12 leading to a liquid vaporizing device 13. The gas material in the gas phase from this vaporizing device may be fed into gas storage receiving cylinders 14 or into a service pipeline 15 which is regulated by means of a pressure regulating valve, shown diagrammatically at 16. Any suitable connections of this character may be employed to this end, for example, as shown in the U. S. patent to Smith, 1,942,944.

The liquid phase transfer connection is shown as having an inlet 18 leading into the receiving container 11 and has a controlling valve 19. This connection also preferably includes a heat insulated pressure filling hose 20 that is detachably connected to the inlet 18 at one end and at the other to a liquid withdrawal connection 21 of a transport container shown at 22 mounted on a truck chassis 23. These containers may be of any suitable size, for example, a capacity for liquid which when converted into gas occupies 50,000 cubic feet at atmospheric pressure.

The gas phase transfer connection is shown at 24 consisting of a suitable pipe leading from the gas space of the receiving container 11 to the interior of the transport container 22; there being included a separable coupling 25. A valved branch 26 depends from the connection into the gas space of the container 22, a second valved branch 27 being provided with a gas diffuser, as shown at 28, which is connected at a point such as to be normally below the ordinary working levels of the liquid in the container 22. To build initial pressure in the container to effect the discharge of liquid, the container 22 is also provided with suitable pressure building means, for example, an air-heated pressure building coil, as shown at 29 and taught in U. S. patent to Heylandt, Reissue No. 18,876. A filling and evaporation escape connection is also provided for the transport container, as shown at 30.

In normal operation, the invention is practiced with the apparatus described, and a service delivery of liquefied gas, for example, of liquid oxygen is effected to the container 11, by delivering a transported charge to the consumer installation in the transport container 22, the transportation being carried out with the evaporation connection 30 closed. This connection is, of course, closed at all times except when the transport container is being filled at the production plant.

When it is desired to effect transfer of the charge from the container 22 to the container 11, the liquid phase transfer connections are established by coupling the hose 20 in place, and the gas phase transfer connections established by similarly coupling the parts of connection 24 at 25. When these connections are established, the latter is first opened and the material in the gas phase, which is at high pressure, allowed to pass from container 11 into container 22 in order to equalize the pressures. For this purpose, only the valve in the branch 27 is opened. This allows the material in the gas phase to pass through the liquid phase in container 22 and to condense at least in part. This results in a relatively low equalization pressure in the connected containers and dissipates the original high gas pressure that initially obtained in container 11 without loss. The valved branch 26, in this arrangement, is used only in the event that it is desirable or necessary to introduce the gaseous material directly into the gas space of the container 22.

When this gas phase transfer step is completed, the valves in line 24 being closed, a non-equilibrium pressure may be and preferably is built in the transfer container by means of the pressure building coil 29. The liquid phase transfer connection through the hose 20 is opened as soon as a suitable pressure obtains in the container 22.

The transfer of gas material in the liquid phase is continued under the acceleration of the pressure thus provided until the transfer of all the liquid phase has been completed. It is thus seen that the liquid phase is replaced by material in the gas phase at a relatively low pressure. When the liquid phase transfer connections are disconnected, the liquid phase withdrawal outlet 21 is closed.

The container 22 is now returned to the production plant where the returned charge of material in the gas phase is withdrawn. The returned material may then be reliquefied in any suitable manner, for example, by the steps of the process disclosed in U. S. patent to Heylandt, Reissue No. 19,031. Metering of the material returned is advantageously accomplished by weighing.

In the modification shown in Fig. 2, the gas phase transfer connection includes power means for effecting the gas phase transfer. Such means are here shown as comprising a power-driven turbine gas pump 34, disposed in the gas phase transfer connection 24 on the transport container. The power for operating the same is advantageously supplied from the truck which effects the transportation of the container 22. This is illustrated in the form of an electric motor 35 coupled to drive the pump 34; the motor, in such instance, being preferably connected to be supplied with electric current from a battery or generator on the truck. In this arrangement, the pressure building means, such as coil 29 in Fig. 1, may advantageously be dispensed with. Accordingly, none is shown in this modification. Otherwise, the construction and arrangement of apparatus is the same as that shown in Fig. 1.

In the operation of this form of the invention, the charge of liquefied gas to be delivered to the consumer receiver is transported to the place of use in container 22 with its inlet 30 closed, as in the form shown in Fig. 1. When at the place of use, the liquid phase transfer connections are established along with the gas phase transfer connections, and then a gas phase equalization is practiced, as was described in connection with the form shown in Fig. 1. In this case, however, the pump 34 is started and the valved branch 27 first opened. The material in the gas phase blown through the liquid phase in the container 22 as a result is partly condensed. This is continued until a desired low pressure is attained in the container 11, when the valve in branch 26 is opened and that in branch 27 closed. Pressure is now built in the gas space of the container 22 to a desired value by the vapor transferring action of pump 34 and the valves in the liquid phase transfer connection opened. The discharge of liquid consequently takes place under the acceleration provided by gas pressure thus built in the container 22, the conduit 24 being closed until substantially all the liquid is forced out. The liquid withdrawal connection 21 is thereupon closed, the transfer connections uncoupled, and the truck with a charge of material in the gas phase in container 22 returned to the production plant.

While the step of discharging at one time has been here described as taking place continuously, transferring liquid from the container 22 to container 11, it is obvious that container 11 might well have comprised two or more smaller containers of such size as to receive completely the discharge from the container 22 when thus sent out on a servicing trip.

Since certain changes in carrying out the above method and in the construction 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 drawing shall be interpreted as illustrative and not in a limiting sense.

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

1. The method of dispensing a gas material having a boiling point temperature at atmospheric pressure less than 233° K. to a consumer system having a liquid phase receiver and means for storing and delivering material in the gas phase at a desired high pressure, which comprises the steps, in combination, of transporting to such system a charge of gas material in the liquid phase in a transport container which is closable to the atmosphere, transferring gas phase along a desired path for equalizing purposes from said receiver to said transport container when closed to the atmosphere preparatory to discharge, effecting reliquefaction of at least a portion of said transferred gas phase in said container by causing the same to enter said container at a point below the liquid level therein, and then discharging liquid phase from said container while substituting gas phase.

2. The method of dispensing a gas material having a boiling point temperature at atmospheric pressure less than 233° K. to a consumer system having a liquid phase receiver and means for storing and delivering material in the gas phase at a desired high pressure, which comprises the steps, in combination, of transporting to such system a charge of gas material in the liquid phase in a transport container which is closable to the atmosphere, transferring gas phase along a desired path for equalizing purposes from said receiver to said transport container when closed to the atmosphere preparatory to discharge, applying the refrigeration of the liquid phase in said container to said transferred gas phase by causing the same to enter said container at a point below the liquid level therein in order to reliquefy at least a portion of the gas phase transferred, and then discharging liquid phase from said container while substituting gas phase.

3. The method of dispensing a gas material having a boiling point temperature at atmospheric pressure less than 233° K. to a consumer system having a liquid phase receiver and means for storing and delivering material in the gas phase at a desired high pressure, which comprises the steps, in combination, of transporting to such system a charge of gas material in the liquid phase in a transport container which is closable to the atmosphere, transferring gas phase along a desired path for equalizing purposes from said receiver to said transport container when closed to the atmosphere preparatory to discharge, applying the refrigeration of the liquid phase in said container to said transferred gas phase by passing at least a portion of the gas drawn from said path into said liquid container at a point below the liquid level therein in order to liquefy in said container at least a portion of the gas phase so transferred, building a non-equilibrium pressure in said container, effecting a discharge of liquid phase while substituting gas phase, and returning the substituted gas phase to the production plant for reliquefaction.

4. In apparatus for dispensing gas material having a boiling point temperature at atmospheric pressure below 233° K., the combination with a consumer system having a container for receiving and storing a charge of such gas material in the liquid phase and means for distributing gas material in the gas phase at a desired high pressure of a heat insulated transport container for servicing said system provid-

ed with means for closing the same to the atmosphere at will, means for establishing liquid phase transfer communication between said receiving container and said transport container, and additional means for establishing gas phase transfer communication between said system and said containers, said last-named means including a connection leading to the gas space of said transport container and a gas phase condensing means in said transport container and extending below the normal liquid level therein; whereby at least a portion of the gas phase transferred from said system to said transport container may be liquefied therein and conserved thereby avoiding the necessity for blowdown to the atmosphere preparatory to transfer of liquid phase.

5. In apparatus for dispensing gas material having a boiling point temperature at atmospheric pressure below 233° K., the combination with a consumer system having means for distributing gas material in the gas phase at a desired high pressure and incorporating a receiving container for liquid phase, of a heat insulated transport container for servicing said system provided with means for closing the same to the atmosphere at will, said transport container being of a capacity such that it may be completely discharged into said receiving container during a servicing period, means comprising a connection for establishing liquid phase transfer communication between said receiving container and said transport container, and additional means comprising another connection for establishing gas phase transfer communication between said containers, said last-named connection comprising a branch leading to the gas space of said transport container and an independent portion having a gas diffusing device in said transport container and extending below the normal liquid level therein; whereby at least a portion of the gas phase transferred from said system to said transport container may be liquefied therein and conserved.

6. In apparatus for dispensing gas material having a boiling point temperature at atmospheric pressure below 233° K., the combination with a consumer system having means for distributing gas material in the gas phase at a desired high pressure and incorporating a receiver for liquid phase, of a heat insulated transport container for servicing said system provided with means for closing the same to the atmosphere at will, means for building a non-equilibrium pressure in said container, means comprising a connection for establishing liquid phase transfer communication between said system and said container, and additional means comprising another connection for establishing gas phase transfer communication between said system and said container, said last-named connection being provided with branches, one of which communicates with the gas space in said container, the other including a gas diffusing device in said container and extending below the normal liquid level therein; whereby at least a portion of the gas phase transferred from said system to said container may be liquefied therein.

7. In apparatus for dispensing gas material having a boiling point temperature at atmospheric pressure below 233° K., the combination with a consumer system having means for distributing gas material in the gas phase at a desired high pressure and incorporating a receiver for liquid phase, of a heat insulated transport container for servicing said system provided with means for closing the same to the atmosphere at will, means for building a non-equilibrium pressure in said container, means comprising a connection for establishing liquid phase transfer communication between said system and said container, additional means comprising another connection for establishing gas phase transfer communication between said system and said container, said last-named connection being provided with a gas phase transfer pump and formed with branches, one of which communicates with the gas space of said container and another extending below the normal liquid level therein and terminating with a gas diffusing device; whereby at least a portion of the gas phase transferred from said system to said container may be transferred quickly and liquefied therein.

8. The method of dispensing a gas material having a boiling point temperature at atmospheric pressure less than 233° K. to a consumer system having a liquid phase receiver and means for storing and delivering material in the gas phase at a desired high pressure, which comprises the steps, in combination, of transporting to such system a charge of gas material in the liquid phase in a transport container which is closable to the atmosphere, transferring gas phase from said receiver to said transport container when closed to the atmosphere, transferring by the aid of mechanical force an additional quantity of gas from said receiver to said transport container, applying the refrigeration of the liquid phase to at least a portion of the transferred gas phase by causing the same to pass into said container at a point below the level of the liquid therein, and discharging liquid phase from said container while substituting gas phase.

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