

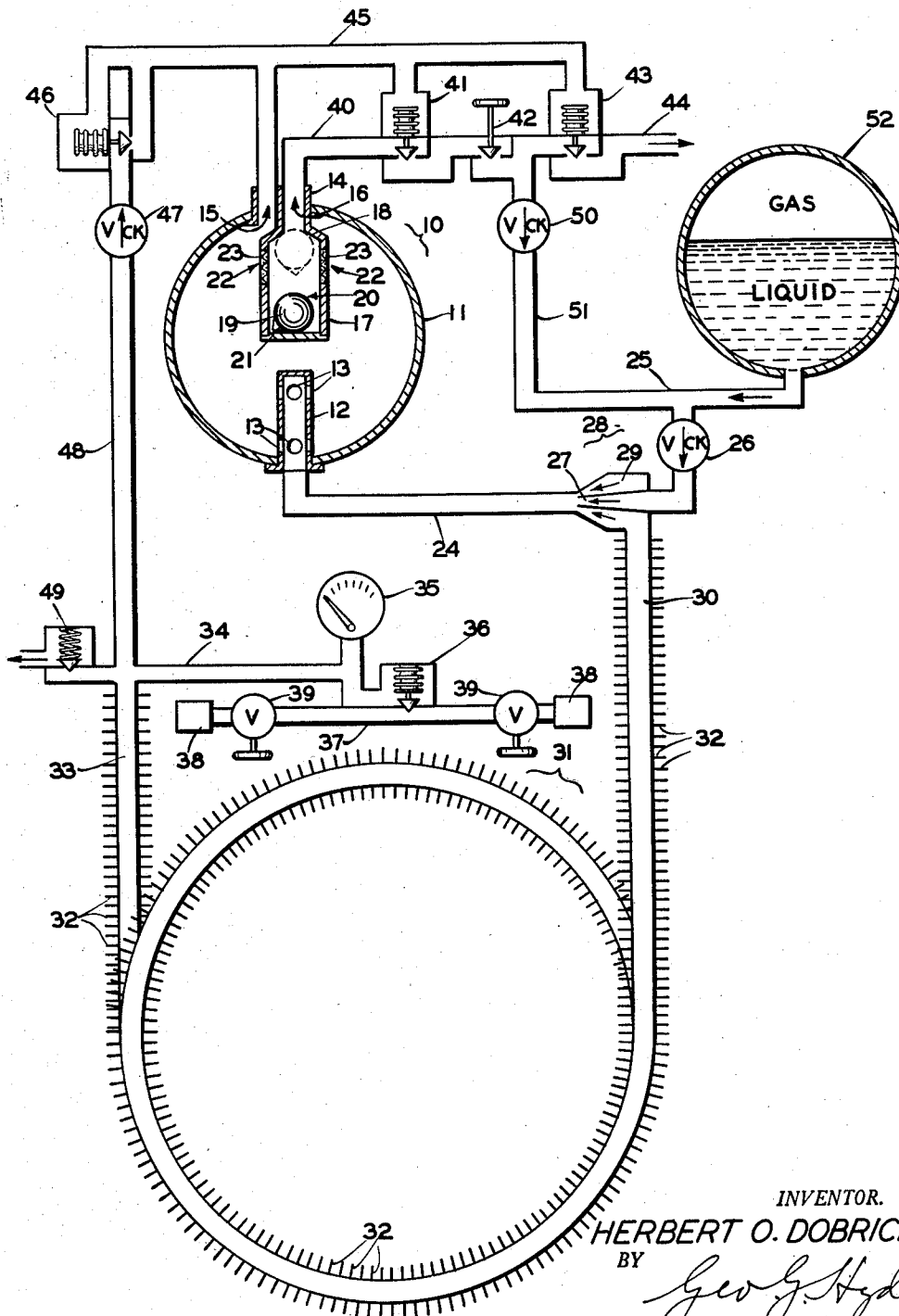
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LIQUID-GAS CONVERTER SYSTEM

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LIQUID-GAS CONVERTER SYSTEM

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6 Claims. (Cl. 137—202)

This invention relates to gas supply systems, and particularly to systems in which gas under pressure is dispensed from a supply of liquefied gas, as well as to a method of operating such systems. It is especially effective in systems for filling containers or otherwise dispensing gaseous oxygen under pressure from a supply of liquid oxygen.

An object of the invention is to provide an improved system of this type in which a liquid container is automatically refilled as required.

Another object is to provide a novel arrangement for building up and maintaining gas dispensing pressure from gasified liquid at lower pressure.

A further object is to provide a new container filling system for volatile liquid, and more specifically a system for supplying such liquid under pressure to a system in which gas pressure from volatilized liquid higher than that of the liquid is developed. A related object is to supply volatile liquid to a container while it is maintained in open communication with a system for gasifying liquid from the container; and a specific object is to utilize an injector arrangement for this purpose.

An object is to provide an improved arrangement in which gas pressure from volatilized liquid is employed to operate system control valves. Another purpose is to utilize such pressure to actuate pressure-stabilizing means.

An additional object is to provide a novel container construction. Related specific objects are to provide an improved liquid feed to the container, novel arrangements for gas discharged therefrom, a new float-actuated sealing construction, means for minimizing the effect of gas flow on such float construction, and separate arrangements for gas discharge and gas pressure.

A purpose of the invention is also to provide an arrangement for returning gas under pressure to a liquid source.

The foregoing and other objects and advantages of the invention will appear more fully from consideration of the detailed description which follows, in conjunction with the accompanying drawing in which one embodiment of the invention is illustrated. It is to be expressly understood, however, that the drawing is for the purposes of illustration and description, and is not to be construed as defining the limits of the invention.

The drawing is a diagram of a system embodying the invention, with the container shown in central longitudinal section.

In the illustrated embodiment the dispensing container 10 for the highly volatile liquid, such as oxygen, comprises a body 11, preferably spherical in shape, having an inlet for liquid opening into the lower part, and a gas outlet arrangement at the top. As shown, the inlet comprises a closed axial vertical tubular feed nozzle 12 having a series of lateral openings 13. The outlet arrangement is formed in cap 14, extending axially through the top of container 10 and provided with a gas pres-

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sure passage 15 communicating directly with the top of container 10, as well as a gas discharge outlet 16.

An arrangement is provided for closing discharge outlet 16 when the liquid in container 10 reaches the proper level adjacent to the top. As shown, cylindrical float well 17 with a closed bottom has a laterally extending top 18 connected to discharge outlet 16. A float 19 caged in well 17 has a convex, preferably spherical seating face 20 and a depending central weight 21 on the opposite side, arranged to keep face 20 uppermost when floating. The float 19 may advantageously be a hollow ball, as shown, with the weight 21 attached at any point. The lower frusto-conical face of well top 17, extending around outlet 16 and forming the seat for float 19, should have a sufficiently obtuse angle between opposite elements to prevent the float 19 from wedging and sticking, an angle of not less than 120° having been found to be satisfactory. The float 19 may be a glass ball, exhausted through a tubular extension which when sealed off in the usual way forms a pip or projection that constitutes the positioning weight 21.

An arrangement is provided to prevent violent and turbulent gas flow from interfering with proper closure of outlet 16 by float 19. For this purpose the well 17 is connected to the interior of container body 11 through ports 22 located in the sides of the well near its top substantially above the float 19 when resting on the well bottom. Ports 22 are advantageously covered with fine wire screens 23, which reduce turbulence in the well to a minimum.

For filling container 10 with liquid, nozzle 12 is connected by a liquid supply circuit and refilling means to a source of liquid under pressure. In the form illustrated, liquid inlet pipe 25 is connected through check valve 26 to a liquid supply circuit comprising the jet 27 of an injector 28 directed into an aligned section of supply pipe 24 which is connected to nozzle 12.

An arrangement is provided for dispensing under pressure gas vaporized from the liquid in container 10. As shown, the outer compartment 29 of injector 28, surrounding jet 27, is connected with the inlet end 30 of a vaporizing coil 31, preferably provided with heat-collecting fins 32. The outlet end 33 of the coil is connected through gas feed pipe 34 to gas pressure gauge 35 and to gas supply control valve 36. This valve is of the type which opens at a selected pressure, a bellows-operated valve being indicated. The valve connects feed pipe 34 with gas dispensing pipe 37 having the requisite outlet arrangements for the desired type of dispensing. The illustrated embodiment is designed for filling portable containers with gas under pressure, and includes outlet couplings 38 connected by hand-operated valves 39 to pipe 37.

An arrangement is provided for building up and maintaining gas under the requisite pressure in dispensing pipe 37 by vaporizing liquid from container 10, and for automatically refilling the container when empty. As illustrated, the outlet 16 from container 10 connects with gas discharge passage 40, which passes through container sealing valve 41, hand-operated shut-off valve 42 and vent closing valve 43 to gas vent 44. Passages 16 and 40, vent 44, and valves 41, 42 and 43 form a gas outlet or discharge circuit. Valves 41 and 43 are of the fluid-operated pressure-closed type, actuated by gas pressure on bellows. Their bellows-operating compartments are connected to gas pressure pipe 45, which is in turn connected to gas pressure outlet 15 of container 10. Pipe 45 is also connected through pressure limiting valve 46, check valve 47 and pressure supply pipe 48 to the outlet end 33 of vaporizing coil 31. Valve 46 is of a similar pressure-closed type, and its bellows-operating compart-

ment is connected to pressure pipe 45. Valves 41, 43 and 46 may be of the type disclosed in detail in the patent application of this inventor filed April 22, 1954, Serial No. 424,959. A relief valve 49 venting to the atmosphere is connected to pressure supply pipe 48.

Gas discharge passage 40 may be connected at a point between shut-off valve 42 and vent closing valve 43 through a gas return circuit, here shown to comprise check valve 50 and return pipe 51, to liquid inlet pipe 25.

In operation, starting with shut-off valve 42 open, dispensing valves 39 closed and no liquid oxygen in container 10, the pressure-controlled valves 41, 43 and 46 will be open, with valves 36 and 39 closed and no gas pressure in the system. The liquid oxygen supply at inlet pipe 25 is under pressure, 70 p.s.i. being employed in a type of installation that will be used as an example. Under these conditions the liquid oxygen will be projected through injector 28 into supply pipe 24, the aspirating action in chamber 29 preventing flow of the liquid into the vaporizing coil 31, connected to said chamber and will pass through lateral openings 13 in nozzle 12 into the lower part of container 10.

The liquid entering the container will be vigorously gasified at first by the higher temperature of the container, and will rush out through ports 22, outlet 16 and discharge passage 40 to vent 44. Check valve 47 prevents gas generated during container filling from exerting back pressure on the gas-generating and pressure build-up portion of the system. When the container body 11 is sufficiently chilled, the liquid oxygen will begin to fill container 10, and when it reaches ports 22, will flow into well 17, lifting float 19, which will be oriented by weight 21 with spherical face 20 upward. As the liquid level rises in container 10, face 20 of the float will be seated against the frusto-conical seat on well top 18, closing outlet 16.

It is pointed out that this arrangement avoids the difficulties previously encountered in providing effective float closures for liquid oxygen containers because of the turbulence of the gas discharged during filling, as the indicated construction minimizes turbulence in the float seating region. The float is not exposed to the gas flow until the container is nearly filled and the turbulence has substantially subsided; screens 22 smooth out the gas flow and the spherical seating face of the float, engaging a frusto-conical seat, permits considerable axial deviation of the float without affecting the seal.

When outlet 16 is closed by float 19, the liquid flow through injector 28 is arrested, and liquid oxygen from container 10 and supply pipe 24 starts to flow through chamber 29 into the inlet end 30 of vaporizing coil 31, where it gasifies and steadily builds up gas pressure which is transmitted through pressure supply pipe 48 to pressure pipe 45 and through passage 15 to container 10. This circuit is known as a pressure build-up circuit. It comprises a means for generating gas, here coil 31, and a pressure or pressure return circuit which here comprises pipe 48, check valve 47, pressure-closed valve 46, pipe 45, and passage 15. When the gas pressure reaches a value slightly above that of the liquid supply, 85 p.s.i. in the example selected, valve 43 closes, providing a more effective closure of vent 44, than that produced by float 19, which therefore need not form a perfect seal. This makes it possible to construct the float of glass, which will inevitably have a certain amount of surface irregularity and allow slight leakage. When the increasing build-up circuit pressure, shown on indicator 35, reaches the minimum dispensing value, 300 p.s.i. in said example, supply control valve 36 opens, and gas can be dispensed through couplings 38 by operating hand valves 39. At the same build-up circuit pressure, or at a pressure somewhat lower, such as 200 p.s.i., container outlet sealing valve 41 is closed by the pressure, cutting off the connection between container outlet 16 and return pipe 51, and permitting the slight leakage past float 19 to build up

pressure above the float to the point where it equals the gas pressure below the float, so that the latter can descend as the liquid level falls below the pre-determined level at which the float closes the outlet.

When the gas pressure reaches the desired dispensing value, 400 p.s.i. in the example, pressure limiting valve 46 closes in response to the pressure and holds the pressure in pipe 45 to that value. As pipe 45 is connected to the space above the liquid in container 10, higher pressure developed in coil 30 will be applied to the bottom only of the liquid through supply pipe 24, and will prevent the liquid from flowing into coil 30 and gasifying until the withdrawal of gas through couplings 38 lowers the gas pressure, opens limiting valve 46 and allows the liquid oxygen to flow again from container 10 into coil 31. If, however, the pressure should build up through improper functioning of the system to an excessive value, such as 475 p.s.i. in the example, relief valve 49 will open.

When all of the liquid oxygen from container 10 has been gasified, the pressure will drop, closing control valve 36 and opening sealing valve 41, allowing the residual gas in the system to pass check valve 50, which limits the flow of liquid oxygen from inlet pipe 25, and travel through return pipe 51 to the oxygen supply tank 52 connected to pipe 25. Tank 52 is of course much larger than container 10, being shown disproportionately small for convenience. It is maintained at 70 p.s.i. and kept at the low temperature required to maintain the oxygen in liquid condition at this pressure, by well-known means, so that the gas returned to tank 52 through line 51 is salvaged for reuse.

When the pressure drops to the refill value, 85 p.s.i. in the example, valve 43 opens, allowing the residual gas in the system to pass out through vent 44, so that the system drops to atmospheric pressure. Liquid oxygen will start to flow through injector 28 and will refill container 10, repeating the described cycle of operation. When the system is not in use, shut-off valve 42 is closed, retaining the gas under pressure in the system. Under these conditions the gas pressure will prevent liquid oxygen flow from jet 27, so the system will remain inactive until further gas dispensing is desired. Upon opening shut-off valve 42 the cycle of operation already described will be in effect.

Although but one embodiment of the invention has been illustrated and described in detail, it is to be expressly understood that the invention is not limited thereto. Various changes can be made in the design and arrangement of the parts without departing from the spirit and scope of the invention as the same will now be understood by those skilled in the art.

I claim:

1. A liquid-gas converter system, comprising a container for volatile liquid, a liquid phase circuit connected to the container, means for filling the container with said liquid, comprising an injector unit including an aspirating chamber and a jet in the chamber connected to a source of said liquid under pressure and directed into the liquid phase circuit, means for cutting off the liquid supply from said source to said jet when the container is filled with liquid, and a gas pressure build-up circuit having a liquid inlet connected to said aspirating chamber, arranged for the flow of liquid into the inlet through said chamber when the liquid supply is cut off.

2. A liquid-gas converter system, comprising a container for volatile liquid, a gas outlet connected to the top of the container, a float-operated valve in said outlet arranged to close the outlet when the liquid in the container reaches a predetermined level, a liquid phase circuit connected to the container, means for filling the container with said liquid, comprising an injector unit including an aspirating chamber and a jet in the chamber connected to a source of said liquid under pressure and directed into the liquid phase circuit, means for cutting off the liquid from said source when the container is

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filled to said level with liquid, including a check valve between the source and the jet closed by back pressure when said gas outlet is closed, and a gas pressure build-up circuit having a liquid inlet connected to said aspirating chamber, arranged to receive liquid through said chamber when the check valve is closed.

3. A liquid-gas converter system, comprising a container for volatile liquid, a gas outlet connected to the top of the container, valve means in said outlet for substantially closing said outlet when the liquid in the container reaches a predetermined level, a liquid supply circuit connected to the container, a pressure build-up circuit connected from the bottom to the top of the container, and means comprising a pressure-closed valve in the outlet responsive to pressure in the build-up circuit for maintaining said outlet closed when the liquid falls below said predetermined level.

4. The invention defined in claim 3 including means for preventing excessive pressure build-up in said container comprising a pressure-closed pressure limiting valve in said build-up circuit responsive to pressure in the container.

5. The invention defined in claim 3 including means for connecting said supply circuit to a liquid source, and a gas return circuit connecting said last-mentioned means to said outlet between said pressure-closed valve and the container.

6. A liquid-gas converter system, comprising a container for volatile liquid, a gas outlet connected to the

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top of the container, first valve means in said outlet for substantially closing said outlet when the liquid in the container reaches a predetermined level and for maintaining said outlet substantially closed in response to gas pressure in said container when the liquid falls below said predetermined level, and means for opening said first valve means while maintaining said outlet closed until gas pressure in said container falls below a predetermined value comprising second pressure-closed valve means in said outlet downstream from said first valve means for completely closing said outlet in response to container pressures exceeding said predetermined value.

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