Sept. 26, 1961 C. B. TAUSCHER 3,001,375

OXYGEN DISTRIBUTION SYSTEM

Filed Aug. 14, 1959 2 Sheets-Sheet 1

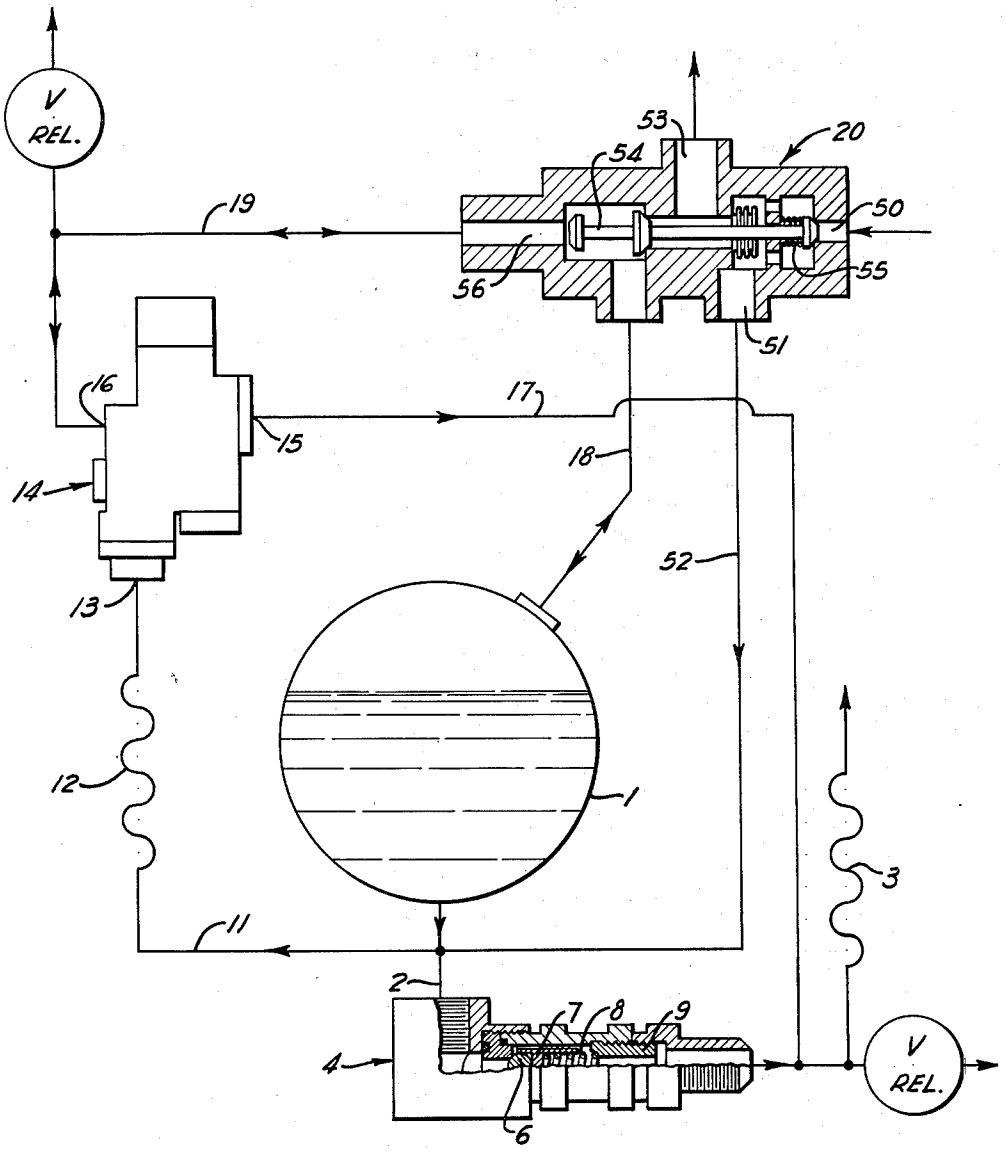


Fig. 1

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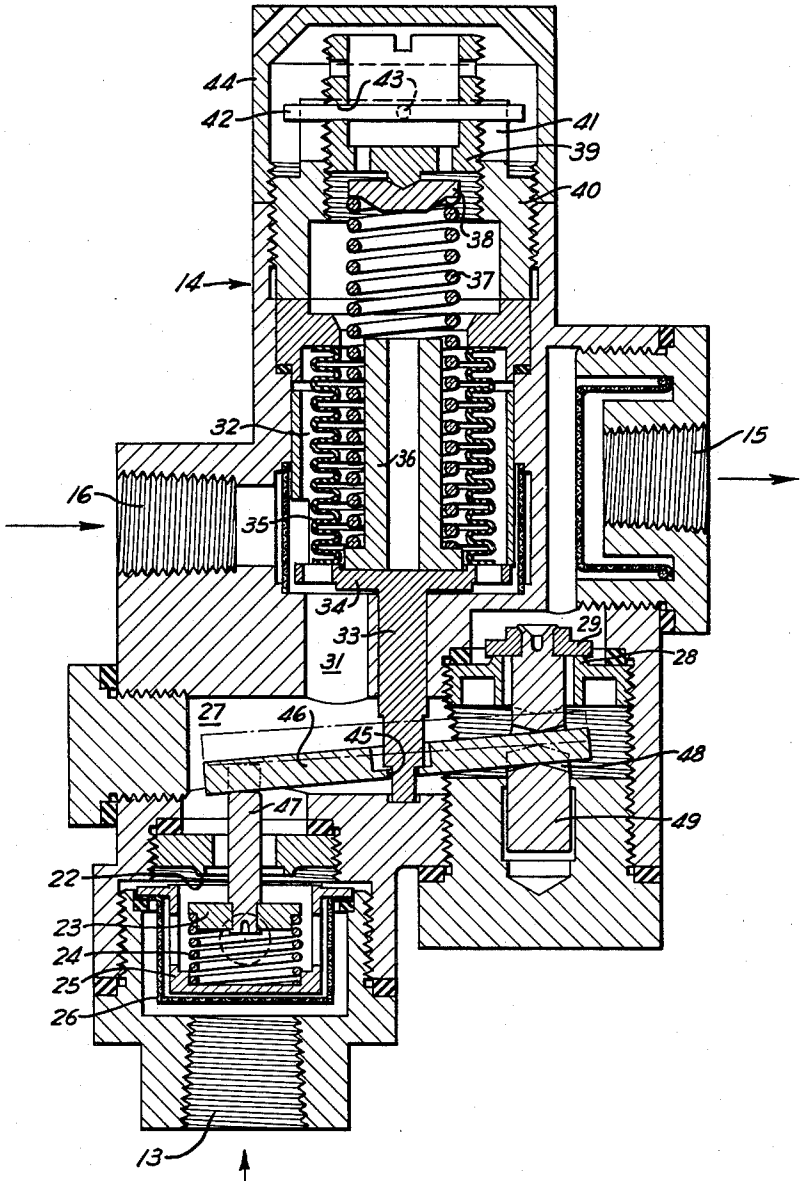


Fig. 2

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OXYGEN DISTRIBUTION SYSTEM

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This invention relates to apparatus for converting liquid oxygen into gaseous oxygen for delivery to a point of consumption.

Such systems are old, of course, but they need improving. A typical system includes a liquid oxygen tank, from which liquid oxygen is withdrawn and warmed in order to vaporize it or convert it into gaesous oxygen, which is then delivered to the location where it is to be used. To keep the desired pressure on the liquid oxygen in the tank, some of it is led through a pressure build-up circuit where it is vaporized and returned to the top of the tank. When the pressure in the tank reaches a predetermined maximum, the build-up circuit is shut off and the top of the tank is connected through a thrift circuit with the point of consumption of the gas, so that any excess gas in the tank will be utilized. The customary way of controlling the build-up and htrift circuits is by means of two valves, each independent of the other. Since it is highly desirable that the build-up circuit be closed before the thrift circuit is opened, each valve must be separately adjusted to the desired operating range. If, through maladjustment or slipping of adjustment, the build-up circuit is not shut off before the thrift circuit is opened, the result is undesirable.

It is among the objects of this invention to provide an oxygen distribution system, in which the same valve unit controls both build-up and thrift circuits, in which it is impossible for the thrift circuit to open before the build-up circuit is closed, and in which adjustment of the pressure at which the circuits are opened and closed does not change the sequence of operation.

In accordance with this invention, a first warming conduit is connected with the bottom outlet of a liquid oxygen tank for vaporizing liquid oxygen from the tank and delivering the resulting gas to a point of consumption. A second warming conduit, forming part of a build-up circuit, will vaporize some of the liquid oxygen from the tank and connect its bottom outlet with the inlet of a valve unit that also has an outlet and a combined inlet and outlet. The combined inlet and outlet is connected by a first gas conduit with the top opening of the tank. The valve unit contains a normally open valve for the inlet and a normally closed valve for the outlet, and also means responsive to a predetermined gas pressure in the valve unit for closing the inlet valve and opening the outlet valve in succession. A second gas conduit, connected with the valve outlet and forming part of a thrift circuit, delivers gas from the top of the tank to the point of consumption.

The preferred embodiment of the invention is illustrated in the accompanying drawings, in which—

FIG. 1 is a diagram of my oxygen distribution system; and

FIG. 2 is an enlarged longitudinal section through the control valve unit.

Referring to FIG. 1 of the drawings, a tank 1, of any well-known construction suitable for storing liquid oxygen, has a gas opening near its top and a liquid opening at its bottom. The bottom opening is connected by a pipe 2 with a heat exchanger 3 of any desired type, illustrated schematically, which will warm the liquid enough to vaporize it. The gas leaving the heat exchanger is delivered to the point where it is to be used. Preferably,

in pipe 2 there is a check valve 4 that will prevent gas between that valve and the point of consumption from flowing backwards into the bottom of the tank. This valve also has another purpose, which will be referred to later. The check valve may include a ball check 6 that normally is held on its seat by a cup 7 pressed toward the seat by a coil spring 8 compressed between the cup and a stationary bushing 9 inside the valve. However, as long as the pressure of the liquid against the ball is greater than the pressure in the opposite direction, the valve will remain open and liquid oxygen will enter the heat exchanger. Pipe 2, the check valve and the heat exchanger form a warming conduit for the liquid oxygen to convert it into gas.

Another warming conduit, which forms part of a pressure build-up circuit and consists of a pipe 11 and a suitable heat exchanger 12, extends from the bottom of the tank to the inlet 13 of a control valve unit 14 that also is provided with an outlet 15 and with a combined inlet and outlet 16. The outlet of this valve unit is connected by a conduit 17, forming part of a thrift circuit, to the point of gas consumption. Preferably, conduit 17 is connected to pipe 2 between the first heat exchanger 3 and check valve 4. The top opening of the tank is connected with the combined inlet and outlet 16 of the control valve unit by means of a conduit that alternately serves as part of the build-up and thrift circuits. This conduit includes pipes 18 and 19 connected by a combined filling, pressure build-up and vent valve 20, which will be described later.

Referring to FIG. 2 of the drawings, the housing of the control valve unit 14 is provided above its bottom inlet 13 with an inlet valve seat 22 facing upstream and with a disc valve 23 for engagement with the seat. The valve is pressed up toward the seat by a coil spring 24 held in a cage 25, which may be enclosed in a filter 26. The valve housing includes a transverse passage 27 connecting the downstream side of the inlet valve with the upstream side of an outlet valve, which has a seat 28 facing the outlet 15 and closed by a disc valve 29 resting on top of the seat. The transverse passage is connected by a short vertical passage 31 with a pressure chamber 32 that also is connected with one combined inlet and outlet 16. The vertical passage is at one side of an opening, in which a vertical stem 33 is slidably mounted. The upper end of the stem inside the pressure chamber has a large head 34, to which the closed lower end of a bellows 35 is secured. The upper end of the bellows is secured to the inside of the valve housing. Mounted on the head of the stem inside the bellows is a flanged sleeve 36 that is pressed downward by a coil spring 37 encircling it and pressing up against a disc 38 that engages the lower end of an adjusting screw 39 threaded in the upper part of a nut 40. This nut is screwed into the upper end of housing 14 and has a pair of vertical slots 41 in its upper end. The adjusting screw is locked in position by a pin 42 slipped through the slots and through radial holes 43 in the screw before the cap 44 is applied.

The lower end of bellows stem 33 is reduced in diameter and extends loosely through a hole 45 in the central part of a lever 46 that extends lengthwise of transverse passage 27. One end of the lever rests on top of the stem 47 of inlet valve 23. The other end of the lever extends through a slot 48 in the stem 49 of outlet valve 29. That slot flares outward in opposite directions from its center so that the lever can tilt in the valve stem. The pressure of spring 37 in the bellows is great enough to overcome the weak spring 24 that urges the inlet valve closed, so that normally the downward pressure of bellows stem 33 against lever 46 swings its free end down while its opposite end fulcrums in valve stem slot 48. That holds the inlet valve open and the outlet valve

closed. Consequently, gas entering inlet 13 of the control valve unit will flow through it and out through the combined inlet and outlet 16 and then around through pipe 19, the combined valve 20 and pipe 18 to the top of the tank to build up pressure in the tank.

As the pressure in the tank reaches a predetermined maximum, above which it is not desired to go, the pressure inside the control valve unit chamber 32 compresses the bellows upwardly so much that stem 33 will be raised far enough to permit the inlet valve to close under the influence of spring 24 and the gas pressure at inlet 13. Further retraction of the bellows stem will allow the right-hand end of lever 46 to rise to the dotted line position, so the gas pressure in passage 27 will be able to raise outlet valve 29 from its seat and connect the combined inlet and outlet 16 with outlet 15. It will be seen that the outlet valve cannot open until after the inlet valve has closed. This sequence of operation is always followed, regardless of the amount of gas pressure required to compress the bellows, which is determined by adjusting screw 39. As soon as the inlet valve closes, delivery of gas to the top of the tank is stopped and then, upon opening the outlet valve, gas can flow in the reverse direction from the tank through pipes 18 and 19 and the control valve unit and then out of the valve outlet through conduit 17. An important function of check valve 4 is to create sufficient pressure drop in pipe 2 from the tank in order to make sure that while outlet valve 29 is open gas from conduit 17, instead of liquid from the bottom of the tank, will preferentially flow to heat exchanger 3 and on to the user. When the pressure in the tank starts to fall, the control valve bellows can expand again. As its stem descends, it pushes down on lever 46, which first compels the outlet valve to close and then the inlet valve to open in order to establish the pressure build-up circuit again.

The combined valve 20 may take various forms. The one illustrated has an inlet 50 and an outlet 51 connected by a filler pipe 52 with the bottom opening in the tank. This valve also has a vent 53. Both the vent and the inlet normally are closed by an axially movable valve element 54 inside the valve and urged to the right by a coil spring 55. This valve also has a normally open passage 56 through it connecting pipes 18 and 19. When it is desired to fill the tank with liquid oxygen, liquid is supplied to the valve inlet under pressure, which forces element 54 to the left to thereby close passage 56 and simultaneously open inlet 51 and vent 53. The valve thus connects its inlet with filler pipe 52 and connects the vent with pipe 18 from the top of the tank. Of course, pipe 19 leading from the valve to the control valve unit 14 is closed. After the tank has been filled, the liquid oxygen supply is shut off, which permits element 54 to move back to its normal position where it closes inlet 51 and the vent and again connects pipes 18 and 19 with each other.

According to the provisions of the patent statutes, I have explained the principle of my invention and have described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. An oxygen system for supplying oxygen gas to a point of consumption, comprising a liquid oxygen tank having an opening in its bottom and an opening in its top, a first warming conduit connected with said bottom opening for vaporizing liquid oxygen from the tank and delivering the resulting gas to said point, a valve unit having an inlet and an outlet and a combined inlet and outlet, a second warming conduit for vaporizing some of the liquid oxygen from the tank and connecting its bottom opening with the valve inlet, a first gas conduit connecting said tank top opening with said combined inlet and outlet, a normally open valve for said inlet, a normally closed valve for said outlet, means responsive to a predetermined gas pressure in said valve unit for closing the inlet valve and opening the outlet valve in succession, and a second gas conduit connected with said valve outlet for delivering gas from said top opening to said point of consumption.

2. An oxygen system for supplying oxygen gas to a point of consumption, comprising a liquid oxygen tank having an opening in its bottom and an opening in its top, a first warming conduit connected with said bottom opening for vaporizing liquid oxygen from the tank and delivering the resulting gas to said point, a valve unit having an inlet and an outlet and a combined inlet and outlet, a second warming conduit for vaporizing some of the liquid oxygen from the tank and connecting its bottom opening with the valve inlet, a first gas conduit connecting said tank top opening with said combined inlet and outlet, a normally open valve for said inlet, a normally closed valve for said outlet, means responsive to a predetermined gas pressure in said valve unit for closing the inlet valve and opening the outlet valve in succession, a second gas conduit connecting said valve outlet with said first warming conduit, and a check valve in said first warming conduit between the tank and said second gas conduit.

3. An oxygen system for supplying oxygen gas to a point of consumption, comprising a liquid oxygen tank having an opening in its bottom and an opening in its top, a first warming conduit connected with said bottom opening for vaporizing liquid oxygen from the tank and delivering the resulting gas to said point, a valve unit having an inlet and an outlet and a combined inlet and outlet, a second warming conduit for vaporizing some of the liquid oxygen from the tank and connecting its bottom opening with the valve inlet, a first gas conduit connecting said tank top opening with said combined inlet and outlet, a normally open valve for said inlet, a normally closed valve for said outlet, means responsive to a predetermined gas pressure in said valve unit for closing the inlet valve and opening the outlet valve in succession, a second gas conduit connected with said valve outlet for delivering gas from said top opening to said point of consumption, a normally closed filling conduit connected with the tank bottom opening, a normally closed vent for said first gas conduit, and means for opening the vent and closing the first gas conduit between the vent and said combined inlet and outlet when said filling conduit is opened.

4. An oxygen system for supplying oxygen gas to a point of consumption, comprising a liquid oxygen tank having an opening in its bottom and an opening in its top, a first warming conduit connected with said bottom opening for vaporizing liquid oxygen from the tank and delivering the resulting gas to said point, a valve unit having an inlet and an outlet and a combined inlet and outlet, a second warming conduit for vaporizing some of the liquid oxygen from the tank and connecting its bottom opening with the valve inlet, a first gas conduit connecting said tank top opening with said combined inlet and outlet, valves for said inlet and said outlet, a spring normally holding said inlet valve open and said outlet valve closed, means in said valve unit responsive to a predetermined gas pressure therein for flexing said spring to close the inlet valve and open the outlet valve in succession, and a second gas conduit connected with said valve outlet for delivering gas from said top opening to said point of consumption.

5. An oxygen system for supplying oxygen gas to a point of consumption, comprising a liquid oxygen tank having an opening in its bottom and an opening in its top, a first warming conduit connected with said bottom opening for vaporizing liquid oxygen from the tank and delivering the resulting gas to said point, a valve unit having an inlet and an outlet and a combined inlet and outlet, a second warming conduit for vaporizing some of the liquid oxygen from the tank and

connecting its bottom opening with the valve inlet, a first gas conduit connecting said tank top opening with said combined inlet and outlet, valves for said inlet and said outlet, a lever engaging said valves, spring-biased means pressing against the lever to normally hold the inlet valve open and the outlet valve closed, movable means responsive to predetermined gas pressure in said valve inlet for flexing said spring to reduce its pressure against said lever to permit the inlet valve to close and the outlet valve to open in succession, and a second gas conduit connected with said valve outlet for delivering gas from said top opening to said point of consumption.

6. An oxygen system for supplying oxygen gas to a point of consumption, comprising a liquid oxygen tank having an opening in its bottom and an opening in its top, a first warming conduit connected with said bottom opening for vaporizing liquid oxygen from the tank and delivering the resulting gas to said point, a valve unit having an inlet and an outlet and a combined inlet and outlet, a second warming conduit for vaporizing some of the liquid oxygen from the tank and connecting its bottom opening with the valve inlet, a first gas conduit connecting said tank top opening with said combined inlet and outlet, a valve for said inlet movable upstream to open it, a valve for said outlet movable downstream to open it, a lever having one end urging the inlet valve open and another end urging the outlet valve closed, a

spring-biased stem pressing against the central portion of the lever to normally hold the inlet valve open and the outlet valve closed, means for moving said stem in the opposite direction ,said means being movable by a predetermined fluid pressure in said valve unit, and a second gas conduit connected with said valve outlet for delivering gas from said top opening to said point of consumption.

7. An oxygen system according to claim 6, in which said outlet valve has a stem provided with a transverse opening receiving said other end of the lever, the lever being tiltable in said valve stem and relative to said spring-biased stem.

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