

Oct. 31, 1961

W. H. SMITH

3,006,339

OXYGEN TENTS

Filed Oct. 6, 1958

3 Sheets-Sheet 1

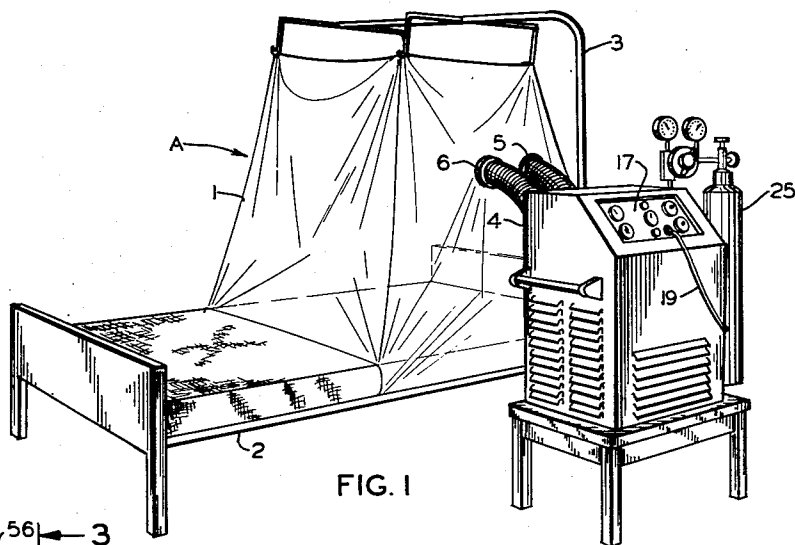


FIG. 1

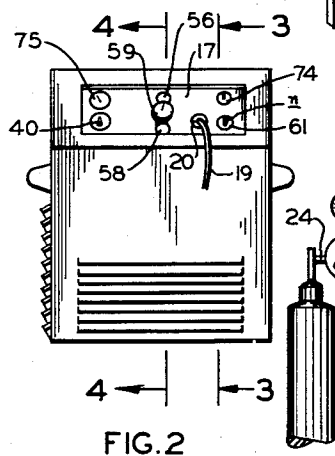


FIG. 2

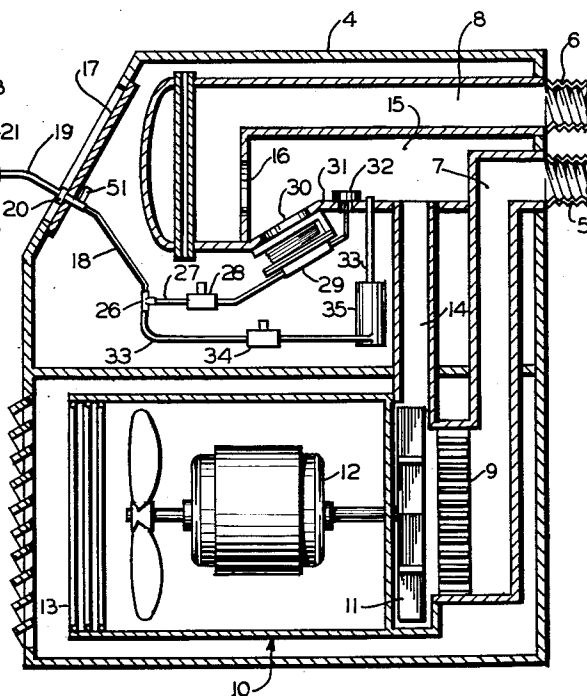


FIG. 3

INVENTOR.  
WILLIAM HAROLD SMITH

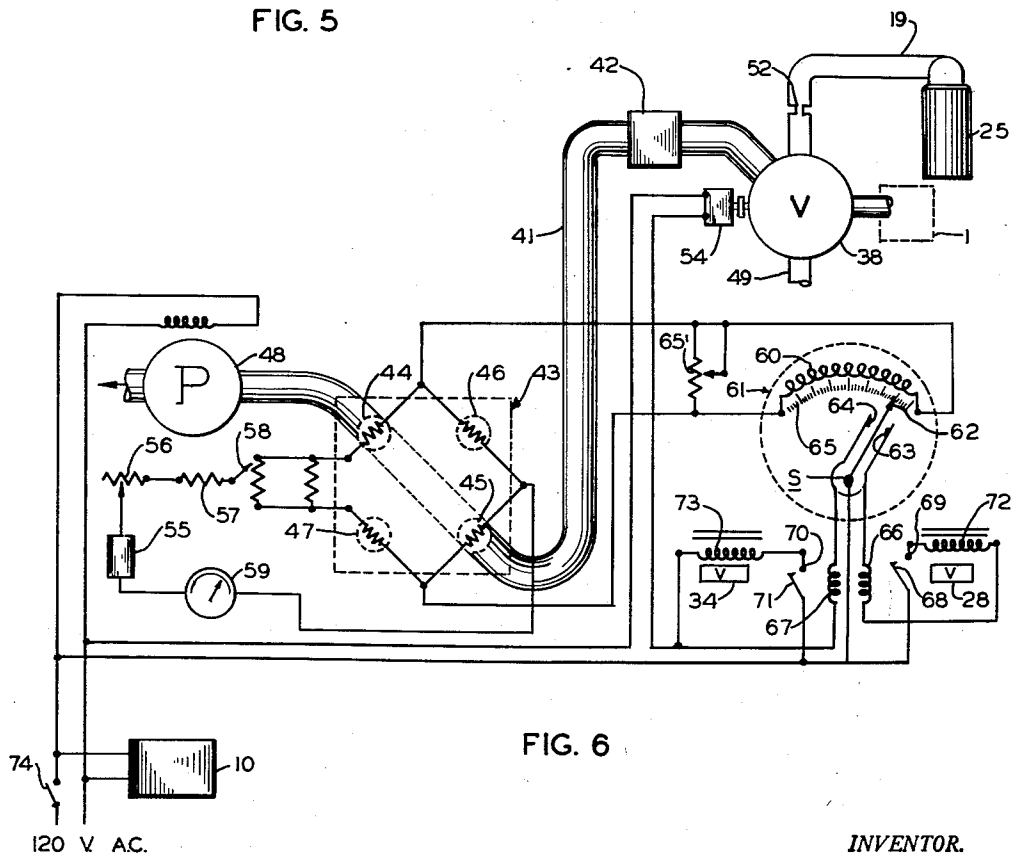
BY  
*Alfred W. Hetcher*

ATT'Y.

**W. H. SMITH**  
**OXYGEN TENTS**

Filed Oct. 6, 1958

3 Sheets-Sheet 2



INVENTOR.  
WILLIAM HAROLD SMITH  
BY  
*Alfred W. Hitchcraft*  
ATT'Y.

Oct. 31, 1961

W. H. SMITH

3,006,339

OXYGEN TENTS

Filed Oct. 6, 1958

3 Sheets-Sheet 3

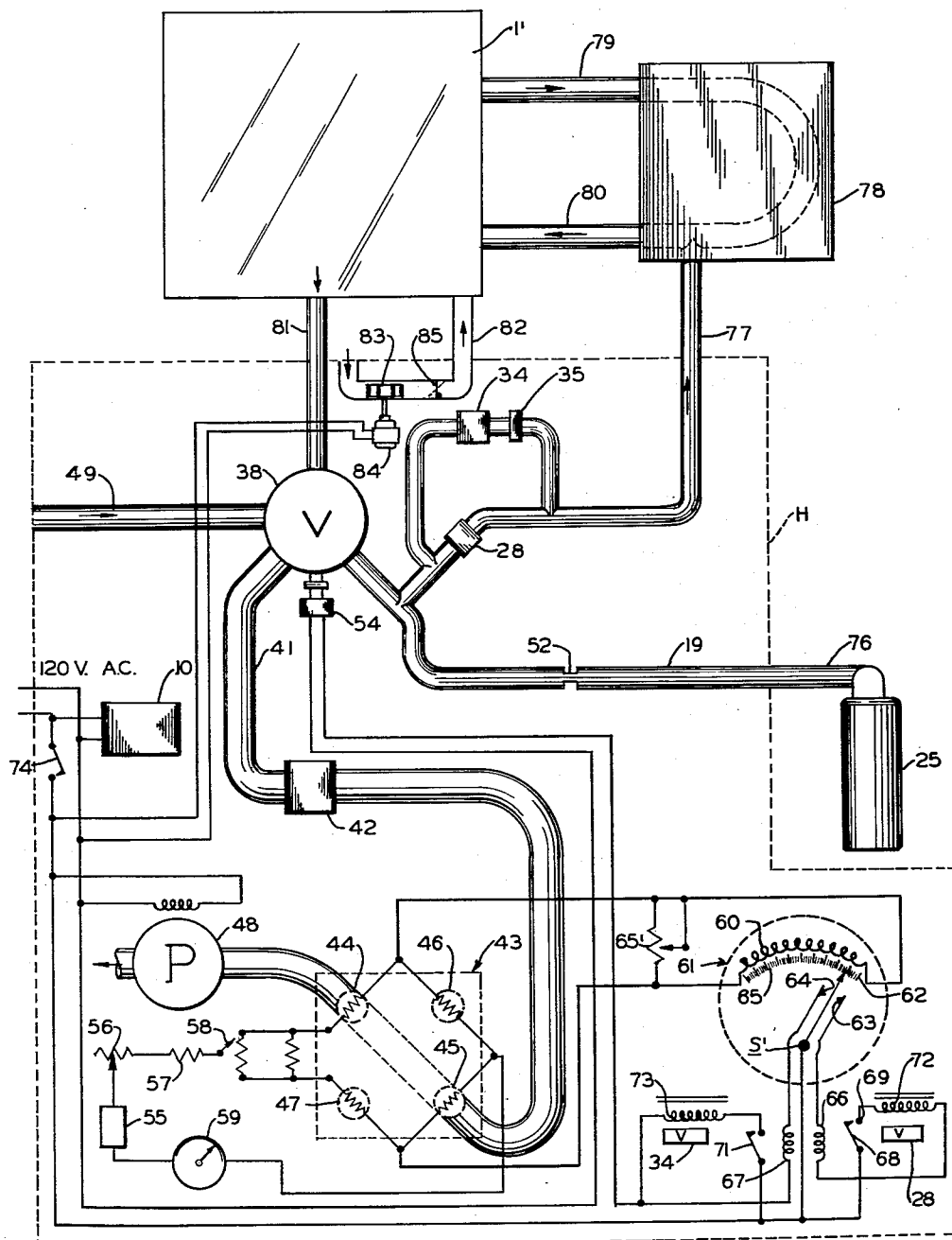


FIG. 7

INVENTOR.

WILLIAM HAROLD SMITH

BY

*Alfred W. Letcher*

ATT'Y.

1

3,006,339

## OXYGEN TENTS

William Harold Smith, Norwalk, Conn., assignor, by mesne assignments, to Shampaine Industries, Inc., St. Louis, Mo., a corporation of Missouri  
Filed Oct. 6, 1958, Ser. No. 765,645  
12 Claims. (Cl. 128—191)

This invention relates to certain new and useful improvements in oxygen tents.

It is the primary object of the present invention to provide an oxygen tent embodying a control system which automatically maintains preset oxygen concentrations within the atmosphere maintained around the patient.

It is also an object of the present invention to provide an oxygen tent of the type stated in which the oxygen concentrations may be preset over a relatively wide range and closely controlled within such setting.

It is an additional object of the present invention to provide an oxygen tent of the type stated which may be tested, calibrated, and adjusted without interrupting the use of the oxygen tent in the treatment of patients.

It is a further object of the present invention to provide an oxygen tent of the type stated which "fails safe" in that room air will be admitted into the canopy should the oxygen supply or electrical system fail.

It is another object of the present invention to provide a control system which can be adapted for use with a wide variety of oxygen tents.

With the above and other objects in view, my invention resides in the novel features of form, construction, arrangement, and combination of parts presently described and pointed out in the claims.

In the accompanying drawings (three sheets):

FIG. 1 is a perspective view of an oxygen tent constructed in accordance with and embodying the present invention;

FIG. 2 is a front elevational view of the cabinet which houses a control mechanism forming part of the present invention;

FIGS. 3 and 4 are fragmentary sectional views taken along lines 3—3 and 4—4, respectively, of FIG. 2;

FIG. 5 is a fragmentary elevational view of a portion of the control panel on the cabinet;

FIG. 6 is a schematic illustration of the testing and control system forming part of the present invention; and

FIG. 7 is a schematic illustration of a modified form of the present invention.

Referring now in more detail and by reference characters to the drawings which illustrate a practical embodiment of the present invention, A designates an oxygen tent comprising a canopy 1 which is arranged over a hospital bed 2 and is supported at its upper end by a boom 3 which is, in turn, mounted on a cabinet or housing 4. Mounted at one end in the canopy 1 are flexible intake and exhaust ducts 5, 6, which are connected at their other ends to ducts 7, 8, in the cabinet 4. The duct 7 terminates adjacent evaporator coils 9 which form part of the air-conditioning unit 10, the latter also conventionally including a circulating fan 11, a motor-compressor 12, and condensor coils 13. Also within the cabinet 4 and having one end adjacent the discharge side of the fan 11 is a duct 14 which communicates with a chamber 15 having a hole 16 at one end thereof whereby the chamber 15 communicates with the cabinet discharge duct 8. Consequently, the air from within the canopy 1 is withdrawn into the conduit 5 whereupon the air passes into the duct 7 and across the evaporator coils 9 and is thereafter discharged into the conduit 14, chamber 15 and

2

then into the duct 8 and conduit 6 for return to the canopy 1.

Mounted within the cabinet 4 and terminating at the control panel 17 thereof is an oxygen supply line 18 which is connected to a flexible pressure hose 19 by means of a fitting 20. The other end of the hose 19 is also provided with a fitting 21 which is connected to the outlet side of an oxygen pressure-regulator valve 22, the latter being suitably provided with a pressure gauge 23. The inlet line 24 of the pressure regulator valve 22 is connected in the conventional manner to an oxygen cylinder 25. Connected to the oxygen supply line 18 by means of a T-fitting 26 is a branch line 27 having a normally open solenoid-operated shut-off valve 28 therein, and also in the line 27 is a control valve 29, the latter being mounted over an aperture 30 formed in the bottom wall 31 of the chamber 15. The valve 29 permits room air to enter the chamber 15 in the event of failure or substantial reduction of the oxygen supply, and since this valve is of the type shown in U.S. Patent 2,687,741, it is not shown or described in detail herein. The branch line 27, furthermore, terminates at the wall 31 in a fixed orifice 32 which communicates with the interior of the chamber 15. Also connected to the oxygen supply line 18 through the fitting 26 is a by-pass line 33 which also communicates with the interior of the chamber 15 and is provided with a normally closed, solenoid-operated, low-limit valve 34 and a silencer or muffler 35.

Mounted within the cabinet 4 is a conduit 36 which extends into the chamber 15 and is provided at its end therein with an air filter 37. The other end of the conduit 36 is connected to a three-way selector valve 38 which is mounted beneath the control panel 17 and is provided with a rotatable shaft 39 terminating in a pointer knob 40. Also connected at one end to the valve 38 is a sensing-element conduit 41 which is provided with a drying unit 42, preferably of a type containing a silica-gel drying agent. Interposed in the conduit 41 is a thermal conductivity analyzer 43 which preferably contains four symmetrically arranged bridge-forming resistance elements 44, 45, 46, 47, the cells 44, 45, being the analyzing elements and the resistance elements 46, 47, being the reference elements. Since the resistance elements 44, 45, 46, 47, are thermally sensitive, analyzers of this type are conventionally manufactured with automatic temperature compensation controls therein so that the reference and sample gas each remain at a constant temperature at the analyzer. Furthermore, the analyzing elements 44, 45, are exposed to the gas sample while the reference elements 46, 47, are exposed to stagnant room air. Similarly disposed in the conduit 41 is a vacuum pump 48 which draws the gas sample through the analyzer 43. In this connection, it should be noted that the thermal conductivity cell 43 is flow sensitive and, therefore, the vacuum pump 48 should provide a constant flow of sample gas across the analyzing elements 44, 45. Alternatively, if desired, the analyzing elements 44, 45, may be shielded from the actual flow stream with the gas sample being circulated therethrough by means of convection currents which will be created by the heat from the resistance elements. Connected to the valve 38 is a room-air inlet 49 which is provided at its outer end with an air filter 50, and, similarly, an oxygen line 51 is connected at one end to the valve 38 and at its other end to the fitting 20. Internally thereof the line 51 is preferably provided with a fixed orifice 52 (FIG. 6) so that the rate of gas flow through the line 51 will be equal to the rate of flow through the vacuum pump 48. It will, therefore, be apparent that the three-way selector valve 38 can be moved to any one of three positions so that oxygen, room air, or breathing medium from the chamber 15 can be intro-

duced into the line 41 for passage through the analyzer 43. The valve shaft 39 may be provided with a cam 53 which is adapted to close a switch 54 when the valve is in the "tent" position and for purposes presently more fully appearing.

Referring now to FIG. 6 it will be seen that the analyzer 43 is connected in series with a suitable direct current power supply such as a multi-celled battery 55 or regulated rectifier, a rheostat 56, a fixed resistor 57, and a balancing potentiometer 58. The power supply 55 supplies current for heating the resistance elements 44, 45, 46, 47, this current being controlled by the rheostat 56. A milliammeter 59 is also connected in series with the analyzer and power supply 55 so as to give a continuous indication of the current flowing through the analyzer 43. Since accurate operation of the analyzer 43 is dependent upon a constant fixed flow of current therethrough, by keeping the reading of the milliammeter 59 adjusted to the proper level of current flow, an accurate output signal from the analyzer 43 is assured. The output of the analyzer 43 is connected in series with the actuating coil 60 of a meter-relay 61 which is provided with a contactor-needle 62 movable in response to the current flow through the actuating coil 60. The meter relay 61 is, furthermore, provided with adjustable high and low contacts 63, 64, respectively, and, preferably, the meter scale 65 is calibrated from zero to 100% oxygen. Shunted across the coil 60 is a variable resistor 65' for adjusting the sensitivity of the meter 61. Connected to the contacts 63, 64, are relay coils 66, 67, having contacts 68, 69, 70, 71, which are interposed in series with solenoids 72, 73, the latter being adapted to actuate the valves 28, 34. The solenoids 72, 73, are connected across the alternating current supply line in which the switch 54 is interposed.

It use, the air-conditioning unit 10 is switched on by means of an on-off switch 74 and the desired temperature of the circulated air adjusted by means of a conventional thermostat 75. Since the present invention is not concerned with the thermostatic control system of the air-conditioning unit 10 the latter is not shown or described. After the breathing medium has been circulated by the fan 11 through the canopy 1 for a sufficient length of time so as to assume a "steady state" operating condition, the selector valve 38 may be turned to the "air" position allowing room air to be drawn into the conduit 41 while at the same time keeping the switch 54 in the open position. The vacuum pump 48 will draw room air through the analyzer 43 and by movement of the balancing potentiometer 58 the analyzer 43 can be balanced. The balance point of the analyzer 43 can be determined by adjusting the potentiometer 58 until the needle 62 reads 0%, at which time the zero adjustment screw *s* can be set to move the needle to a 21% oxygen reading, corresponding to the percentage of oxygen found in room air. To test the full range of the system, the selector valve 38 is turned to the "oxygen" position allowing pure oxygen to flow from the cylinder 25 through the analyzer 43. Since pure oxygen is flowing across the thermal conductivity cell 43 the needle 62 should read slightly in excess of 95%. If this does not occur, the resistor 65' may be appropriately set so that full scale meter deflection corresponds to pure oxygen flowing through the analyzing elements 44, 45.

The selector valve 38 may then be turned to the "tent" position, thereby drawing air from the chamber 15 through the analyzer and at the same time closing the switch 54. Oxygen will then be supplied from the cylinder 25 through the supply lines 18, 19, and through the normally open valve 28 to the orifice 32. The meter contacts 63, 64, may then be set by the knob *n* to the range of oxygen content desired within the canopy 1. As long as the needle 62 is between the meter relay contacts 63, 64, oxygen will continue to be delivered through the line 27 to the chamber 15 since the valve 28 is normally

open. However, should the oxygen concentration within the canopy 1 drop the output of the analyzer 43 will correspondingly drop causing the needle 62 to move into engagement with the contact 64 and operate the relay coil

67. Energizing the coil 67 will close the contacts 70, 71, and energize the solenoid 73, which, in turn, opens the low-limit valve 34. When the valve 34 opens a high flow stream of oxygen will pass into the chamber 15 for circulation into the canopy 1. As the oxygen supply within the tent 1 increases the needle contact 62 will move away from the contact 64 de-energizing the relay coil 67 and solenoid 73 so as to close the valve 34. As long as the needle contact 62 is intermediate the relay contacts 63, 64, oxygen will be supplied through the valve 28 and line 27 to the chamber 15. Should the oxygen supply within the canopy 1 increase to a point beyond the maximum preset limit, the increased output current from the analyzer 43 will cause the needle 62 to move into engagement with the relay contact 63 energizing the relay coil 66 and close the contact 69 which, in turn, allows the solenoid 72 to be energized and close the valve 28. When the valve 28 closes the oxygen supply to the chamber 15 will be cut off causing a pressure drop across the valve 29 and allowing it to open and admit room air to the chamber 15 for delivery to the canopy 1. As the oxygen content within the canopy 1 decreases the needle 62 moves away from the relay contact 63, de-energizing the relay coil 66 and opening the valve 28.

It is also possible to provide a modified form of the present invention as schematically shown in FIG. 7 in which corresponding parts are the same as those in FIGS. 1-6, previously described. In this form of the invention, the control system is mounted within a cabinet or other suitable housing H, and oxygen is supplied from the cylinder 25 through the line 76. The oxygen discharge line 77 from the housing H is connected to oxygen input connection of a conventional air circulating system 78 having intake and exhaust ducts 79, 80, which are connected to a canopy 1'.

Connected to the canopy 1' is a sampling line 81 which leads to the valve 38 and also connected to the canopy 1' is an air intake line 82. Provided for delivering air to the canopy 1' through the line 82 is a fan 83 including a motor 84 which is connected across the 120 volt A.C. line, and interposed in the line 82 is a weighted damper-type valve 85. The valve 85 is so constructed that when the valve 28 is open and the valve 34 is closed the pressure within the canopy 1' will cause the valve 85 to remain closed even though the fan 83 is operating. However when the valve 28 closes, the oxygen supply will be cut off from the canopy 1' and cause a pressure drop therein whereupon the valve 85 will open and allow the fan 83 to flush the canopy 1' with air.

It will be apparent that the control of the valves 28, 34, by the meter-relay 61 is the same as that in FIGS. 1-6. Furthermore, the control system of FIG. 7 can be readily adapted to a variety of oxygen tents by simply connecting the line 77 to the oxygen intake thereon and also connecting the secondary sampling line 81 and air intake line 82 to the canopy 1'.

It should be understood that changes and modifications in the form, construction, arrangement, and combination of the several parts of the oxygen tent may be made and substituted for those herein shown and described without departing from the nature and principle of my invention.

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

1. An oxygen tent comprising means for circulating breathing medium, means for supplying oxygen to said breathing medium, means for admitting room air to said breathing medium, and control means for automatically shutting off the supply of oxygen and admitting room air to the breathing medium when the oxygen content of the breathing medium reaches a predetermined maximum level, said control means also being operable auto-

5

matically to open the oxygen supply and shut off the room air when the oxygen content of the breathing medium reaches a predetermined minimum level.

2. An oxygen tent comprising means for circulating breathing medium, means for supplying oxygen to said breathing medium, auxiliary means operable to supply oxygen to the breathing medium, means for admitting room air to said breathing medium, and control means for automatically shutting off the supply of oxygen and admitting room air to the breathing medium when the oxygen content of the breathing medium reaches a predetermined maximum level, said control means also being operable automatically to open the auxiliary means and shut off the room air when the oxygen content of the breathing medium reaches a predetermined minimum level.

3. An oxygen tent comprising means for circulating breathing medium, normally open means for supplying oxygen to said breathing medium, normally closed auxiliary means operable to supply oxygen to the breathing medium, normally closed means for admitting room air to said breathing medium, and control means for automatically shutting off the supply of oxygen and admitting room air to the breathing medium when the oxygen content of the breathing medium reaches a predetermined maximum level, said control means also being operable automatically to open the auxiliary means and shut off the room air when the oxygen content of the breathing medium reaches a predetermined minimum level.

4. An oxygen tent comprising means for circulating breathing medium, means for supplying oxygen to said breathing medium, means for admitting room air to said breathing medium, and control means including a meter-relay for automatically shutting off the supply of oxygen and admitting room air to the breathing medium when the oxygen content of the breathing medium reaches a predetermined maximum level, said control means also being operable automatically to open the oxygen supply and shut off the room air when the oxygen content of the breathing medium reaches a predetermined minimum level.

5. An oxygen tent comprising means for circulating breathing medium through an enclosure, means for supplying oxygen to said breathing medium and including a normally open shut-off valve, auxiliary means by-passing said shut-off valve for supplying oxygen to said breathing medium and including a normally closed by-pass valve, normally closed control valve means for admitting room air to said breathing medium, and control means for automatically closing the shut-off valve when the oxygen content of the breathing medium reaches a predetermined maximum level, thereby allowing said control valve to open, said control means also being operable automatically to open said by-pass valve when the oxygen content of the breathing medium reaches a predetermined minimum value.

6. An oxygen tent comprising means for circulating breathing medium through an enclosure, means for supplying oxygen to said breathing medium and including a normally open shut-off valve, auxiliary means by-passing said shut-off valve for supplying oxygen to said breathing medium and including a normally closed by-pass valve, normally closed control valve means for admitting room air to said breathing medium, an oxygen analyzer operatively associated with the breathing medium and having an output voltage proportional to the oxygen content of the breathing medium, and a meter-relay operatively associated with the shut-off valve and by-pass valve for automatically closing the shut-off valve when the oxygen content of the breathing medium reaches a predetermined maximum value, said meter-relay also being operable automatically to open said by-pass valve when the oxygen content of the breathing medium reaches a predetermined minimum value.

7. An oxygen tent comprising means for circulating

6

breathing medium through an enclosure, means for supplying oxygen to said breathing medium and including a normally open shut-off valve, auxiliary means by-passing said shut-off valve for supplying oxygen to said breathing medium and including a normally closed by-pass valve, normally closed control valve means for admitting room air to said breathing medium, an oxygen analyzer operatively associated with the breathing medium and having an output voltage proportional to the oxygen content of the breathing medium, and a meter-relay electrically connected to the output of said analyzer and having a contactor movable responsive to changes in output voltage of the analyzer, said meter-relay being operatively associated with the shut-off valve and by-pass valve for automatically closing the shut-off valve when the oxygen content of the breathing medium reaches a predetermined maximum value, said meter-relay also being operable automatically to open said by-pass valve when the oxygen content of the breathing medium reaches a predetermined minimum value.

8. An oxygen tent comprising means for circulating breathing medium through an enclosure, means for supplying oxygen to said breathing medium and including a normally open solenoid operated shut-off valve, auxiliary means by-passing said shut-off valve for supplying oxygen to said breathing medium and including a normally closed solenoid operated by-pass valve, normally closed control valve means for admitting room air to said breathing medium, an oxygen analyzer operatively associated with the breathing medium and having an output voltage proportional to the oxygen content of the breathing medium, and a meter-relay electrically connected to the output of said analyzer and having a contactor movable responsive to changes in output voltage of the analyzer, said meter-relay having high and low contacts engageable with said movable contactor, said low contact and contactor being operable to energize the solenoid of said by-pass valve and open same, said high contact and contactor being operable to energize the solenoid of said shut-off valve and open same.

9. An oxygen tent comprising means for circulating breathing medium through an enclosure, means for supplying oxygen to said breathing medium and including a normally open solenoid operated shut-off valve, auxiliary means by-passing said shut-off valve for supplying oxygen to said breathing medium and including a normally closed solenoid operated by-pass valve, normally closed control valve means for admitting room air to said breathing medium, an oxygen analyzer operatively associated with the breathing medium and having an output voltage proportional to the oxygen content of the breathing medium, and a meter-relay electrically connected to the output of said analyzer and having a contactor movable responsive to changes in output voltage of the analyzer, said meter-relay having high and low contacts engageable with said movable contactor, said low contact and contactor being operable to energize the solenoid of said by-pass valve and open same to allow a surge of oxygen into the breathing medium, said high contact and contactor being operable to energize the solenoid of said shut-off valve and open same, allowing the control valve means to open and admit room air to the breathing medium.

10. For use with an oxygen tent; a device comprising an enclosure having a breathing medium circulating therein normally open valve means for admitting oxygen to the breathing medium in said tent, normally closed valve means operable to admit a stream of oxygen to the breathing medium, normally closed control valve means for admitting room air to said breathing medium, said normally closed control valve means being adapted for automatic opening when the normally open valve means and the normally closed valve means have both been closed for a period of time while the tent is in use, and automatic control means for closing the normally open valve means and retaining the normally closed valve

7

means in a closed position whereby to allow the control valve means to open and thereby admit room air to the breathing medium when the oxygen content thereof reaches a predetermined maximum level, said control means also being operable to open the normally closed valve when the oxygen content of the breathing medium reaches a predetermined minimum level.

11. For use with an oxygen tent; a device comprising an enclosure having a breathing medium circulating therein means for supplying oxygen to the breathing medium in said tent and including a normally open shut-off valve, means by-passing said shut-off valve for supplying oxygen to the breathing medium and including a normally closed by-pass valve, normally closed valve means for permitting room air to be admitted to said breathing medium, an oxygen analyzer operatively associated with the breathing medium and having an output voltage proportional to the oxygen content of the breathing medium, and a meter-relay electrically connected to the output of said analyzer and having a contactor movable responsive to changes in output voltage in the analyzer, said meter-relay being operatively associated with the shut-off valve and by-pass valve for automatically closing the shut-off valve when the oxygen content of the breathing medium reaches a

8

predetermined maximum value, thereby allowing said normally closed valve means to open and admit room air to the breathing medium, said meter-relay also being operable automatically to open said by-pass valve when the oxygen content of the breathing medium reaches a predetermined minimum value.

12. An oxygen tent comprising an enclosure having a breathing medium circulating therein and being adapted to accept air and oxygen from separate supply sources, analyzing means for determining the amount of oxygen in said breathing medium, first automatic control means for adding oxygen to the breathing medium, second automatic control means for adding air to the breathing medium, and regulating means operatively connected to the analyzing means and the first and second control means for retaining the oxygen content of the breathing medium within a predetermined range.

#### References Cited in the file of this patent

##### UNITED STATES PATENTS

|           |        |               |
|-----------|--------|---------------|
| 2,099,954 | Cook   | Nov. 23, 1937 |
| 2,818,860 | Holm   | Jan. 7, 1958  |
| 2,830,583 | Finney | Apr. 15, 1958 |

20