

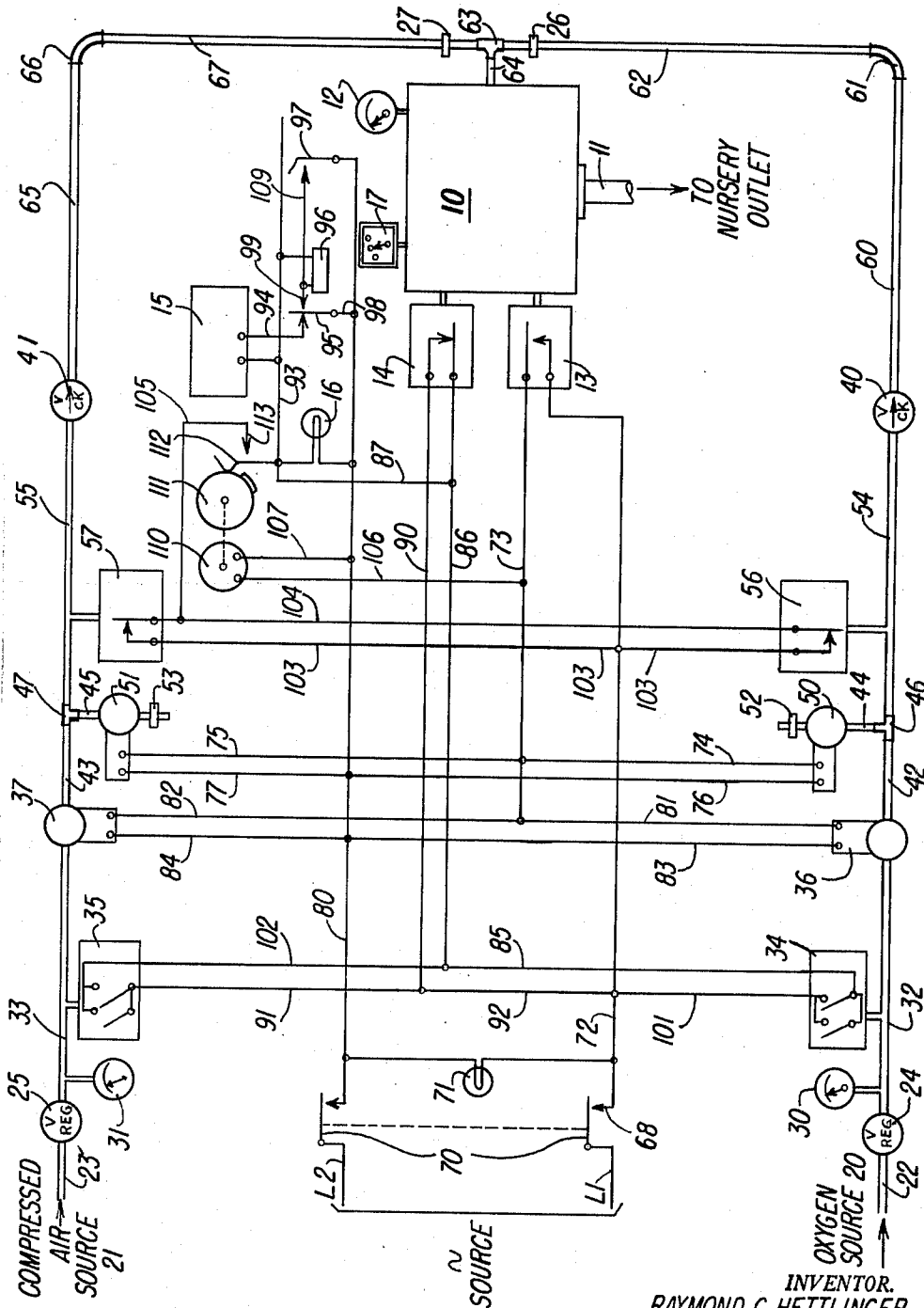
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GAS PROPORTIONER SYSTEM

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GAS PROPORTIONER SYSTEM

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The present invention relates to a gas proportioner system, and more particularly to an oxygen-air proportioner system and apparatus adapted for use in hospitals for supplying a precise mixture of oxygen and air to hospital nurseries.

In the care and treatment of premature babies in hospital nurseries, it is customary to place the premature babies in incubators arranged to provide an atmosphere of oxygen-enriched air. Although a high-oxygen atmosphere is known to be beneficial in the prevention of breathing irregularities in premature babies, it is now known that unless the percentage of oxygen is maintained below what is generally considered a safe level, the babies are subject to a recently discovered disease named retrolental fibroplasia—which means a fibrous growth in back of the lens—the blindness of premature babies. An indication of the seriousness of this disease is the estimate of The National Society for the Prevention of Blindness that retrolental fibroplasia accounts for approximately one half of all blindness among younger children, and that about 8,000 young people in the United States have partial or complete loss of vision as a result of this eye disease.

It is, therefore, a primary object of the present invention to provide an oxygen-enriched air supply system and apparatus in which the oxygen concentration is automatically maintained at what is generally considered by the medical profession a desired safe level.

Another object is to provide in an oxygen-air proportioner system and apparatus, means for continually monitoring pressures in the supply conduits and mixing container of the system to assure proper functioning of the system.

A further object is to provide for use in hospitals for supplying a precise mixture of oxygen and air to nurseries which includes pressure-responsive alarm means for indicating improper functioning of any part of the system.

Still another object of the present invention is to provide in an oxygen-air supply system for hospital nurseries, means for indicating a malfunction in the system.

A still further object is to provide in a gas proportioner system, a container for dispensing a preferred gaseous mixture, supply means for the container including two or more sources of different gases, and a transfer section for transferring gases from the supply means to the container during filling periods, in which the transfer section is effective to isolate the supply means from the container during non-filling periods so that any leakage from the supply means cannot alter the gas mixture once it is formed in the container.

Briefly stated, in accord with the illustrated embodiment of the present invention, there is provided an oxygen-air proportioner system and apparatus adapted for use in hospitals, including a mixing tank or vessel for receiving and dispensing a predetermined mixture of oxygen and air. The system comprises a supply section including oxygen and air sources and means for supplying oxygen and air in the desired proportions to the receiving vessel, and a transfer section for connecting the supply section to the receiving vessel permitting gas transfer only during filling periods. The receiving vessel is provided with pressure-responsive control means for initiating the transfer of oxygen and air from the supply

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section to the receiving vessel when a predetermined low pressure condition is sensed by the pressure-responsive control. The system further includes pressure-responsive alarm signal means for indicating both audibly and visually the detection of pressures below a desired level in the receiving vessel, and outside desired ranges in the conduits of the supply and transfer sections connected to the receiving vessel.

A feature of the system is the provision of means comprising a transfer section for isolating the receiving vessel from gas transfer from the supply section except during filling periods. This ensures that any leakage through valves at the outlets of the supply section is diverted from the receiving vessel so that the oxygen-air mixture once formed in the desired proportions cannot be altered from the desired proportions due to such leakage. The operation of the transfer section is monitored by pressure-responsive alarm signal means to ensure that the system is functioning properly. Timer controlled means is also provided in conjunction with this feature to prevent a premature alarm signal indication if, for example, a valve in the transfer section is slow to operate.

The invention, both as to its organization and method of operation, together with further objects and advantages will best be understood by reference to the following description taken in connection with the accompanying drawing in which the single figure diagrammatically illustrates the gas proportioner system of the present invention including the valves, components, and electrical circuitry used to control the system.

Referring now to the single figure of the drawing, the illustrated gas proportioner system includes a pressure-tight mixing tank or vessel 10, for receiving and dispensing the desired mixture of oxygen and air. The tank or container 10 is provided with outlet means in the form of a conduit 11 for connection to a user of the oxygen-air mixture provided by the system such as, for example, a hospital nursery piping system arranged to supply the oxygen-air mixture to incubators. The vessel 10 may also be provided with a pressure gauge 12 for indicating the pressure of the oxygen-air mixture formed in the vessel 10.

The system of the single figure is provided with automatic control means including a pressure-responsive switch 13 in communication with tank 10, which is arranged to close when a predetermined low pressure, for example, about 41 p.s.i. gauge, is sensed by pressure-responsive switch 13, causing it to close, thus actuating initiation of a "filling period" resulting in replenishment of the oxygen-air mixture in the vessel 10. The switch 13 remains closed until replenishment of the gaseous mixture increases the pressure in vessel 10 to a higher pressure level, for example, about 46 p.s.i. gauge, which when sensed by the switch 13 will cause it to open, terminating the filling period as described more fully below. The pressure-responsive switch 13 is of conventional construction, as are all of the switches described herein.

The automatic controls for the system of the single figure also include means for monitoring pressures at critical locations in the system including the pressure in the tank 10. This monitoring means includes a pressure-responsive switch 14, in communication with vessel 10, for actuating alarm signals including an audible signal produced by a buzzer 15, and a visual signal consisting of a red light provided by a lamp bulb 16, when a predetermined low pressure condition in vessel 10 is sensed by switch 14, for example, any pressure level below about 30 p.s.i. gauge. The provision of this alarm signal feature makes certain that there is ample warning before the pressure in vessel 10 falls to a level at which the supply of oxygen and air in vessel 10 would

be insufficient to take care of the demand so that appropriate remedial action can be taken, if necessary.

If the alarm signals are actuated by closing of switch 14 or any of the other pressure-responsive switches that control them, as described below, on sensing by the switch of any undesirable pressure condition, subsequent restoration of the desired pressure condition will also be sensed by the switch, causing it to open, resulting in termination of the alarm signal due to the opening of the alarm signal circuit.

The system of the single figure may also be provided with a conventional oxygen analyzer 17, in communication with vessel 10, for sensing and indicating the percentage of oxygen concentration in vessel 10.

The receiving and dispensing vessel 10 is supplied with gas from the supply section of the system which includes an oxygen source generally indicated at 20, and a compressed air source generally indicated at 21. The oxygen source indicated at 20 may be of any suitable type such as, for example, a connection to a hospital piped oxygen system, or to a cylinder of oxygen for medical use. The air source indicated at 21, may be of any suitable type such as, for example, a conventional air compressor adopted to provide a supply of oil-free compressed air. The supply section includes oxygen and air conduits 22 and 23 connecting to sources 20 and 21, respectively, in which are disposed conventional pressure regulating valves or regulators 24 and 25, which are both set at approximately 55 p.s.i. gauge in the illustrated embodiment. The pressure regulating valves 24 and 25 provide fixed gas pressures for the system, and function in conjunction with oxygen and air orifices 26 and 27 described below, to regulate the flow of gases from the respective sources whereby the gases are delivered to vessel 10 in the desired proportions.

It is therefore clear that the system of the single figure is such that with proper choice of the pressure regulator settings and the diameters of the restricted openings of the orifices 26 and 27, an oxygen-air mixture of any desired concentration of oxygen may be supplied to the vessel 10. In the illustrated system embodiment the oxygen concentration is maintained at slightly less than 40% within plus or minus 1% of the set point. This is based on the present state of knowledge of the medical profession and current hospital nursery specifications. However, if further research indicates that a somewhat different oxygen concentration is to be preferred it will be recognized that the illustrated system can be readily modified to yield such different concentration merely by adjusting the regulator pressure settings, or the orifice diameters, or both.

The supply section may advantageously include means for indicating gas pressures consisting of pressure gauges 30 and 31, in communication with the conduits 32 and 33, respectively, downstream of pressure regulating valves 24 and 25.

The supply section is provided with pressure-responsive switches 34 and 35, in communication with conduits 32 and 33, respectively, for actuating operation of the alarm signals 15 and 16, described above, when undesirably low or high pressures are sensed in conduits 32 and 33. The switches 34 and 35 are arranged so that they close when they sense low pressures below about 45 p.s.i. gauge, or high pressures above about 64 p.s.i. gauge, and open at intermediate pressures.

Transfer of oxygen and air from the supply section to the vessel 10 is controlled by means including a pair of normally-closed solenoid-operated valves 36 and 37 disposed in conduits 32 and 33, respectively.

The supply section of the system of the single figure is substantially permanently connected to the vessel 10 by means including what may be conveniently referred to as a "transfer" or "spillout" section bounded by the solenoid-operated valves 36 and 37, and check valves 40 and 41 described more fully below. The transfer sec-

tion includes oxygen and air conduits 42 and 43 connected to the valves 36 and 37, respectively. The transfer or spillout section in the illustrated embodiment is opened or vented to atmosphere by means including branch conduits 44 and 45, connected to conduits 42 and 43, respectively, by T connections 46 and 47. Venting of the oxygen and air portions of the transfer section is controlled by means including a pair of normally-open solenoid-operated valves 50 and 51 disposed in the conduits 44 and 45, respectively. The rate of pressure decrease in the spillout section on venting of the oxygen and air portions of the spillout section at the conclusion of a filling period is slowed by the provision of restricted orifices 52 and 53 connected to the outlets of the normally-open valves 50, and 51, respectively. This provision is effective to prevent premature actuation of an alarm signal as described below. Attached, respectively, to the T connections 46 and 47, are conduits 54 and 55, to which are connected conventional check valves 40 and 41, mentioned above, which permit flow of oxygen and air to the vessel 10, but do not permit flow in the reverse direction. The transfer section is also provided with means including pressure-responsive switches 56 and 57, respectively in communication with the conduits 54 and 55, for actuating an alarm signal in the event an undesirable pressure condition exists in the transfer section. The switches 56 and 57 are arranged to close when a low pressure condition is sensed in the transfer section, for example, a pressure of less than about 30 p.s.i. gauge.

The transfer section therefore completely separates the receiving vessel 10 containing the formed oxygen and air mixture, from the gas supply section of the system of the single figure during non-filling periods. Consequently, once the oxygen-air mixture in the desired oxygen concentration is formed in the vessel 10, the mixture proportions cannot be altered by leakage from the supply section caused by defective solenoid-operated valves or check valves. Since it is known that solenoid-operated valves and check valves of even the best workmanship may develop leaks, particularly after long or hard usage, the complete separation of the supply section from receiving vessel 10 by operation of the transfer section on completion of the filling cycle is an important safety feature to preserve the integrity of the oxygen-air mixture in the vessel 10.

Oxygen delivered to the vessel 10 from the transfer section flows through a conduit 60 connected to check valve 40, and via an elbow 61, a conduit 62, a restricted opening provided by an orifice 26, a T connection 63, and a conduit 64, into the vessel 10. Similarly, air delivered to the vessel 10 flows via a conduit 65 connected to check valve 41, an elbow 66, a conduit 67, a restricted opening in the line provided by an orifice 27, T connection 63, and conduit 64, into the vessel 10.

The orifices 26 and 27 are of conventional construction arranged to provide restricted openings of predetermined sizes in the respective oxygen and air conduits which are coordinated with the settings of the pressure regulators 24 and 25 to provide an oxygen concentration in the vessel 10 of slightly less than about 40% oxygen by volume. It will be recognized by those skilled in this art that the orifices 26 and 27, and the orifices 52 and 53 in the outlets of the transfer section could be replaced by other means providing the desired restricted openings, for example, suitable adjustable needle valves.

The control circuit of the oxygen-air proportioner system shown in the single figure is electrically energized via a pair of lines L_1 and L_2 connected to a suitable voltage source, for example, an A.C. source. The lines L_1 and L_2 are connected to the control circuit of the system of FIG. 1 by a double-pole single-throw disconnect switch 70 which is normally in closed condition. A means is provided for indicating that the control circuit is energized consisting of a green lamp 71, connected across the contacts of switch 70 so that it is lighted only when switch

70 is closed. A contact 68 of switch 70 which is energized by closing of switch 70, is connected to a fixed contact of pressure-responsive switch 13 by a line 72. The movable contact of switch 13 is connected to a line 73 which, in turn, is connected to the normally-closed solenoid-operated valves 36 and 37, controlling the flow of oxygen and air from the supply section, by lines 81 and 82. The return circuit from the solenoids 36 and 37 is via lines 83 and 84, which are connected to a line 80 which, in turn, is connected to L_2 via the other fixed contact of switch 70. The normally-open solenoid-operated valves 50 and 51, controlling venting of the transfer section to atmosphere, are also energized by the closing of the switch 13 in response to sensing of a predetermined pressure condition in the vessel 10. Energization of solenoid 50 is via L_1 , switch 70, line 72, switch 13, line 73, a line 74 connected to line 73, the solenoid of valve 50, a line 76 connecting the solenoid of valve 50 and line 80, line 80, and switch 70 to L_2 . Similarly the energization of solenoid valve 51 is via line L_1 , switch 70, line 72, switch 13, line 73, a line 75, the solenoid of valve 51, a line 77 connecting the solenoid of valve 51 and line 80, line 80, and switch 70 to L_2 . The normally-closed solenoid-operated valves 36 and 37 in the supply section, and the normally-open solenoid-operated valves 50 and 51 in communication with the transfer section are thus operated together by closing of the switch 13 in response to detection of a predetermined pressure condition in vessel 10 indicating that the supply of oxygen and air should be replenished. The valves 50 and 51 thereupon close, preventing any loss of oxygen and air, while at the same time the valves 36 and 37 open, initiating a filling period during which oxygen and air flow from the supply section through the transfer section to the receiving and dispensing vessel 10. This flow of oxygen and air to vessel 10 is in the desired proportions due to the settings of the valves 24 and 25, and the sizes of the restricted openings provided by orifices 26 and 27, and continues until pressure switch 13 opens on detection of a pressure condition of about 46 p.s.i. gauge in the vessel 10, terminating the filling period.

The alarm signal for the system of the single figure, including an audible signal from buzzer 15 and a visual signal from red lamp 16, is actuated by closing of the pressure-responsive switch 14 on sensing of an undesirable low pressure condition in the vessel 10 as described above. (This is assuming that the audible portion of the alarm signal has not been cancelled as covered below.) The circuit for the energization of buzzer 15 is via line L_1 , switch 70, line 72, a line 92 connected to line 72, a line 90 connected to line 92 and switch 14, switch 14, a line 86 connected to switch 14, a line 87 connected to line 86, a line 93 connected to line 87, through buzzer 15, a line 94 connected to a buzzer 15, a movable contact 95 of a relay 96, and a line 98, to line 80 and through switch 70 to L_2 . The circuit for lamp 16 is similar except that one terminal of lamp 16 is connected to the junction of lines 87 and 93, and the other terminal of lamp 16 is directly connected to line 80, and via line 80 through switch 70, to L_2 . It will be noted that the relay contact 95 in the circuit of buzzer 15 does not form part of the circuit of lamp 16. The relay 96 controlling contact 95 can thus be utilized for cancelling the audible signal emitted by the buzzer 15. This feature is desirable in hospital service where a prolonged audible signal may be objectionable because of interference with patient comfort. Once an alarm signal indicating a condition requiring remedial action is noticed and acted upon to correct the condition, there is no longer a need for a continuing audible signal. The system of the single figure therefore provides means for cancelling the audible buzzer signal including a relay 96 and a single pole, single throw switch 97 which may advantageously be of the momentary contact type. If an audible signal is desired, switch 97 is disposed in open condition as shown,

and relay 96 will not be energized. The circuit to buzzer 15 can then be completed as described above. However, if it is desired to cancel the audible portion of the alarm signal, the switch 97 is closed against contact 109 completing a circuit through the coil of relay 96, energizing it, and causing the movable contact 95 of relay 96 to move out of engagement with the relay contact connected to the line 94 and into engagement with a contact 99. The circuit for the energization of relay 96 may be traced as follows: L_1 through switch 70, line 72, line 92, line 90, switch 14, line 87, line 93, the coil of relay 96, switch 97, line 80, and switch 70 to L_2 . After energization of relay 96 the holding circuit for the relay 96 is complete through contact 99, and movable contact 95 which is connected to L_2 via lines 98 and 80. As movable contact 95 is out of engagement with the contact connected to line 94, the buzzer 15 is in open circuit condition and therefore cannot emit an audible signal even though pressure-responsive switch 14 is in closed condition.

As mentioned above, the pressure-responsive switches 34 and 35 in the oxygen and air lines, close to actuate the audible and visual alarm signals on detection of a predetermined pressure condition in the lines 32 and 33. Energization of the alarm signal on closing of switch 34 is via L_1 , switch 70, line 72, a line 101, switch 34, a line 85, line 86, line 87 and through lamp 16 to line 80 and L_2 , and line 87, line 93 to buzzer 15, line 94, contact 95, line 98, line 80 to L_2 . Energization through switch 35 is similar except that the path to the switch 35 from L_1 and switch 70 includes lines 92 and 91, and the connection between switch 35 and line 86 is via a line 102.

The pressure-responsive switches 56 and 57, in communication with transfer or spillout section conduits 54 and 55, respectively, close in response to sensing of a pressure condition below about 30 p.s.i. gauge in the transfer section. However, the closing of either switch 56 or switch 57 can actuate the alarm signals only under certain conditions. To be more specific, the contacts of switches 56 and 57 are in parallel with each other, and in series with a pair of timer actuated contacts 112 and 113 described below. Therefore the closing of either switch 56 or switch 57 will actuate the alarm signal only if the timer actuated contacts are closed. The circuit will be traced only through switch 56, for the sake of brevity, as the switch 57 alarm circuit is substantially the same. Energization of an alarm signal via switch 56 is as follows: L_1 through switch 70, line 72, a line 103 connecting switch 56 to line 72, switch 56, a line 104, through a line 105, and through timer-controlled contacts 112 and 113 (assumed to be closed), to the junction point connected to lamp 16 and line 93, through lamp 16 to line 80, switch 70 and L_2 , and through line 93, buzzer 15, line 94, contact 95, line 98, to line 80, switch 70 and L_2 .

The system illustrated in the single figure includes means for preventing a premature alarm signal in the event the solenoid-operated valves associated with the transfer section are slow to operate, resulting in a momentary pressure condition which would permit actuation of the alarm signal. The means for preventing premature alarm signals includes an electrical timer mechanism 110 which when energized causes the rotation of an associated cam 111 which is provided with a projection for closing a movable timer contact 112 against a fixed timer contact 113. The timer and cam arrangement is conventional and is so arranged that the contacts 112 and 113 close approximately three seconds after energization of the timer mechanism 110 and remain closed until interruption of the timer mechanism circuit actuates reset of the timer. The cam 111 is provided with reset means including a spring member for quickly returning the cam to a position in which the projection is out of registration with the movable contact 112, opening the circuit through the timer contacts. The reset time for the timer employed in the illustrated embodiment is ap-

proximately one-third of a second. The timer mechanism 110 is in series with the contacts of pressure-responsive switch 13 which is in communication with vessel 10. The circuit for timer mechanism 110 can be traced as follows: L₁, switch 70, line 72, switch 13, line 73, a line 106, timer mechanism 110, line 107, line 80, switch 70 to L₂. Timer mechanism 110 will therefore be energized on closing of pressure-responsive switch 13 in response to sensing of an undesirable low pressure (below about 41 p.s.i. gauge) in vessel 10. The timer controlled contacts 112 and 113 are in series with the contacts of pressure-responsive switches 56 and 57 for actuating the alarm signal devices 15 and 16 as described above. Therefore, even though one of the pressure-responsive switches 56 and 57 is actuated to close by sensing of an undesirable pressure condition in the transfer section conduits 54 and 55, an alarm signal will not be actuated until sufficient time has elapsed for the timer mechanism 110 to cause rotation of cam 111 and completion of the alarm signal circuit by closing of contact 112 against contact 113. This delay period permits the solenoid valves 36 and 37, and 50 and 51 ample time to complete their operations before an alarm signal can be sounded. In conjunction with the timer 110 the transfer section orifices 52 and 53 provide restrictions in the outlets of the valves 50 and 51 so that the transfer section pressure decreases to atmosphere over a longer period of time than would be the case without the provision of orifices 52 and 53. This provision has been found advantageous because as pressure-responsive switches 56 and 57 close on sensing of a pressure below about 30 p.s.i. gauge in the transfer section, the transfer section pressure must be maintained above this level until the timer contacts have had time to reset to open condition, opening the alarm circuits including switches 56 and 57, in order to prevent a premature alarm signal. This transfer section delay provision therefore permits the valve operations to be completed and the system to stabilize before the alarm signals can be actuated, preventing premature operation of alarm signals in the first second or two after operation of the solenoids is actuated.

From the foregoing explanation, it will be apparent that when the nursery consumes a portion of the oxygen and air mixture in vessel 10, the pressure in vessel 10 falls by a certain amount. When the pressure in vessel 10 reaches a level at which the supply should be replenished, pressure-responsive switch 13 senses this condition and is actuated to close, which in turn, causes opening of the normally-closed solenoid-operated valves 36 and 37, and closing of the valves 50 and 51 in the transfer section, initiating the filling operation. During the filling operation oxygen and air are automatically proportioned and delivered to vessel 10 to replenish the supply of the mixture therein while maintaining the desired safe oxygen concentration in vessel 10. The filling operation continues until the desired pressure condition is restored in the vessel 10, completing the cycle. On completion of the filling operation the transfer section is effective to isolate the vessel 10 from the supply section preventing any possible change in the mixture proportions due to leakage from the supply section. Key portions of the system are continuously monitored and alarm signals automatically actuated on sensing of potentially critical pressure conditions. The system described above thus provides fully automatic operation for an oxygen-air proportioner system for hospital nurseries.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be understood that various modifications may be made therein and are intended to be included within the scope of the appended claims.

What is claimed is:

1. In a gas proportioner system, a vessel for dispensing a gaseous mixture, means for supplying a predetermined mixture of gases to said vessel, including two or more

sources of different gases, conduits connecting said sources to said vessel, automatic means in said conduits for controlling the flow of gases from the respective sources whereby the gases are delivered to said vessel in the desired proportion, means in said conduits for interrupting the flow of gases to said vessel, automatic means in said conduits for preventing a flow of gases in the reverse direction from said vessel and means for ensuring that the proportions of a predetermined mixture of gases in said vessel are not affected by leakage through said gas flow interrupting means including, means for venting portions of said conduits between the respective gas flow interrupting means and said vessel, alarm signal means, and pressure-responsive means in communication with the vented portions of said conduits for sensing operation of said venting means, and for actuating said alarm signal means in response to sensing of a failure of said venting means to operate.

2. In a gas mixture proportioner system the combination comprising: a receiver section including a pressure-tight vessel for receiving and holding a gaseous mixture; a supply section for supplying gas to said receiver section including a source of gas under pressure, and outlet valve means; a transfer section including a conduit for connecting said supply section to said receiver section to effect the transfer of gas to said receiver section, and means for ensuring that the proportions of a mixture of gases formed in said vessel cannot be affected by leakage through said outlet valve means including venting means for venting said conduit; alarm signal means; and control means including first pressure-responsive means, said first pressure-responsive means actuating the opening of said outlet valve means and the closing of said venting means in response to detection of a first predetermined pressure in said vessel, and means including second pressure-responsive means in communication with said transfer section conduit for actuating said alarm signal means in response to sensing of a second predetermined pressure in said conduit.

3. In a system as claimed in claim 2, in which there is timer means controlled by said first pressure-responsive means, and means controlled by said timer means for delaying actuation of said alarm signal for a desired time interval after the detection by said first pressure-responsive means of said first predetermined pressure in said vessel.

4. A gas proportioner system comprising: a pressure-tight vessel for dispensing gas; supply means for supplying gas to said vessel during a filling period, including a source of gas under pressure, a transfer section for effecting a connection between the supply means and said vessel to establish a filling period, and for isolating said vessel from said supply means at other times, first pressure-responsive means for actuating the connection of said supply means and said vessel, alarm signal means, second pressure-responsive means for actuating said alarm signal means in response to sensing of a predetermined pressure in said transfer section, and means for delaying actuation of said alarm signal means for a predetermined time interval after the actuation of said connection between said supply section and said vessel.

5. In an oxygen-air proportioner system adapted for use in hospitals the combination with a first gas supply line having an inlet end connected to a source of oxygen and a second supply line connected to a source of air, each of said supply lines having an adjustable pressure regulator, flow controlling means, and an electrically operated valve therein, a gas receiving vessel communicating with the outlet of said first and second gas lines for receiving said oxygen and air; and an outlet line communicating with said gas receiving vessel for passing the mixed oxygen and air to the point of use, of a control system including means for venting the portions of said supply lines downstream of said valves to atmosphere when gas is not being supplied to said vessel to prevent gas leakage into said

vessel, a system for continuously monitoring the pressure in said vessel comprising a first switch connected in said monitoring system responsive to an undesirable low pressure condition in said vessel to concurrently actuate opening of said electrically operated valves to replenish the oxygen and air mixture in said vessel and closing of said venting means, an alarm system comprising audible and visual alarm signal devices to indicate an undesirable pressure condition in said proportioner system, a second switch connected in said pressure monitoring system to actuate said audible and visual alarm signal devices responsive to an undesirable low pressure condition in said vessel, and relay means for cancelling the audible signal when desirable to prevent interference with patient comfort.

6. In a gas proportioning system: a pressure-tight vessel for holding a gaseous mixture, conduit means for conducting gases to said vessel including means for proportioning the gases relative to each other, first valve means in said conduit means operable between open and closed positions, second valve means in said conduit means downstream of said first valve means, third valve means in said conduit means downstream of said second valve means for automatically preventing reverse flow of gases from said vessel, said second valve means including means for venting the conduit means between said first and third valve means when said second valve means is open, and means responsive to the pressure in said vessel for automatically opening said first valve means and closing said second valve means when the pressure in said vessel falls below a preselected value and for closing said first valve means and opening said second valve means when the pressure in said vessel attains a preselected high value so that upon failure of said first valve means to interrupt flow upon closing, gaseous venting occurs through said second valve means.

7. The gas proportioning system defined in claim 6, wherein said third valve means includes a check valve.

8. In a gas proportioning system: a vessel for holding a pressurized gaseous mixture, conduit means for conducting gases to said vessel including means for proportioning the gases relative to each other, alarm means in one circuit for emitting a visual signal, alarm means in another circuit separate from said one circuit for emitting an audible signal, means for sensing an abnormal pressure condition in said vessel, and means responsive to a signal from said sensing means for actuating both said visual alarm means and said audible alarm means, and means for cancelling the audible signal while enabling the visual signal to remain until the abnormal pressure condition has been obviated.

9. In a gas proportioned system: a vessel for holding a pressurized gaseous mixture, conduit means for conducting gases to said vessel including means for proportioning the gases relative to each other, said conduit means including a valve, means for sensing an abnormal pressure condition in said conduit, alarm means for emitting an alarm signal in response to a signal from said sensing means, and electrical time delay means for preventing the actuating of said alarm in the event said valve is slow in closing.

References Cited by the Examiner

UNITED STATES PATENTS

1,869,791	8/32	Wright	-----	137-102
1,960,144	5/34	Entriken	-----	137-218
2,200,310	5/40	Thayer	-----	137-557
2,877,798	3/59	Hanser	-----	137-596.1 X
3,032,053	5/62	Ross	-----	137-111
3,068,879	12/62	Snowman	-----	137-64 X
3,092,104	6/63	Cassidy	-----	137-64

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