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Bartels

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[54] RESPIRATION SYSTEM

[72] Inventor: **Harold Bartels,** Reseda, Calif.

[73] Assignee: **Puritan-Bennett Corporation,** Kansas City, Mo.

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[51] **Int. Cl.** **G05d 11/02**

[58] **Field of Search** ..... 137/98, 63 R, 111, 114; 128/29

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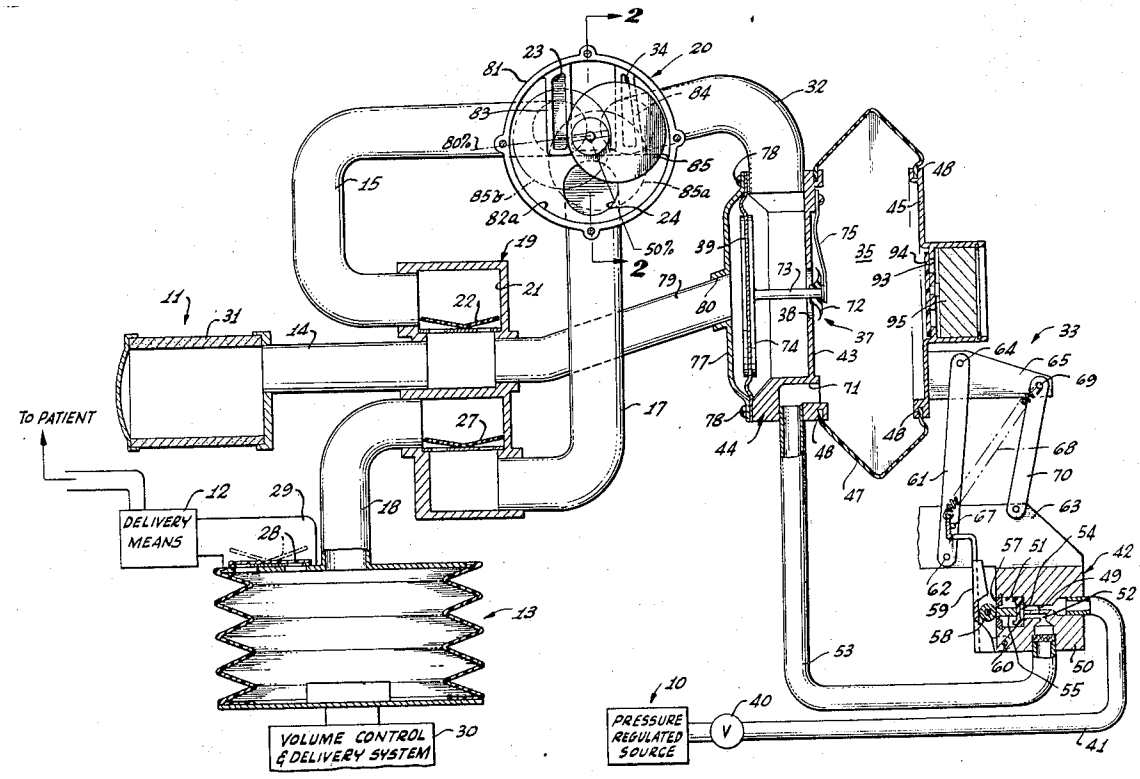
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Primary Examiner—Herbert F. Ross
Assistant Examiner—William H. Wright
Attorney—Fulwider, Patton, Rieber, Lee & Utecht

[57] **ABSTRACT**

A respiration system for mixing oxygen from a pressure-regulated source with room air at ambient pressure in a proportion which is infinitely variable. Air and oxygen are drawn through a proportioning valve having inlets with effective flow areas of the same relationship as the proportion of air and oxygen desired. The pressure at the oxygen inlet is varied in accordance with air pressure variations by a pressure-operated balancing valve for admitting oxygen from a reservoir in response to sensed variations in the air intake pressure. Selective adjustment of the air/oxygen proportion of the mixture is accomplished with a manually movable valve member for varying the inlet area relationship.

14 Claims, 2 Drawing Figures



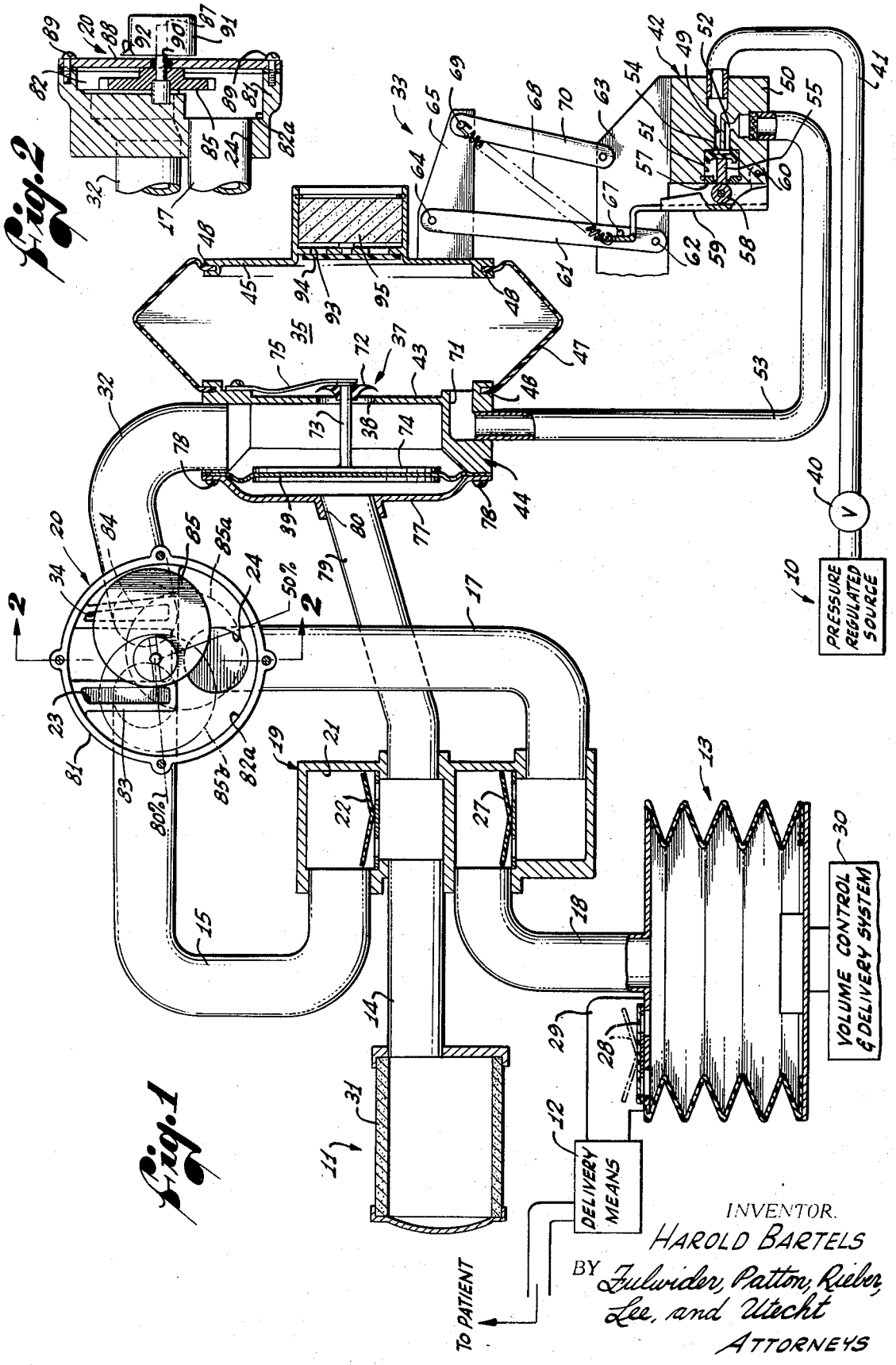


Fig. 1

Fig. 2

INVENTOR.
HAROLD BARTELS
BY Fulwider, Patton, Rieber, Lee, and Utecht
ATTORNEYS

RESPIRATION SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to the mixing of gases in selected proportions for delivery to a patient and has particular reference to respiration systems in which oxygen or another gas is admixed with air to provide an enriched mixture for assisting respiration or ventilating a person suffering from a respiratory deficiency.

Respiration systems for this purpose feed oxygen into the air at a selected rate and supply the mixture cyclically under suitable control pressure to a device such as a mask or tube through which the mixture is delivered to the patient to inflate his lungs in a manner similar to normal inhalation. Following delivery of a controlled volume of the mixture to the patient, the control pressure is relieved and the patient normally is permitted to exhale without assistance. Volume control and delivery apparatus for systems of this type are known in the art and are used to deliver the desired volume of mixed gases through the delivery device to the patient at the desired rate and pressure during the patient's inspirator phase.

Both proportion of oxygen to air and the volume of the mixture supplied during each breathing cycle will vary from patient to patient, and also will vary as the condition of a patient changes and is different as indicated. Accordingly, it is necessary that the rate of feed of oxygen to the respiration system be altered to meet different conditions. It is important from the standpoint of the welfare of the patient that the proportion remain substantially constant for any given setting of the system. In other words, for a given setting, the proportion of the gas supplied to the patient should be very close to the indicated proportion and should not vary appreciably from one respirator cycle to the next. MOreover, it is highly desirable that the system be infinitely adjustable between the limits of no enrichment, i.e., room air alone (21 percent oxygen), and 100 percent oxygen.

A number of factors make it difficult to achieve and maintain the desired proportion accurately and on a repetitive basis. The total volume of gas supplied changes, sometimes considerably, from one cycle to the next. In addition, the rate at which oxygen or air, or both, must be supplied may vary from one cycle to the next and even within a given cycle. Changes within the system itself, such as depletion of the pressure of the stored oxygen and variations in the characteristics of filters, also tend to affect performance.

While various types of proportioning systems have been proposed and used, the foregoing complicating factors have prevented the available systems from providing and maintaining satisfactory proportioning under changing conditions in a practical and economical manner.

SUMMARY OF THE INVENTION

The present invention resides in a respiration system that overcomes the foregoing difficulties by accurately mixing air and gas, such as oxygen, in an easily controllable manner and supplying the mixture to a delivery device while maintaining the proportion very close to constant despite variations in volume requirements, source pressures of air and oxygen, and the like. Moreover, the proportion of oxygen to air is selectively and infinitely variable over a wide range in a simple, rapid and accurate manner.

For these purposes, the preferred embodiment of the invention shown and described herein comprises an intake for air, preferably at ambient pressure, an oxygen conduit for supplying oxygen at a controlled pressure directly correlated with the intake air pressure, and preferably at the same pressure, and a proportioning device having two inlets communicating respectively with the air intake and with the oxygen conduit. This proportioning device mixes the air and the oxygen at the correlated pressures, and a balancing valve controls the feeding of oxygen to the oxygen conduit to vary the feed rate in response to sensed variations in pressure in the air intake.

The preferred balancing valve includes a pressure-responsive diaphragm operator subjected to oxygen pressure on one side and signal air pressure on the other side derived from the sensed air intake pressure, so that an increase in air intake pressure increases the signal pressure to open the balancing valve and increase the oxygen pressure, while a reduction in air intake pressure acts on the balancing valve to reduce the oxygen pressure. In this manner, the system is made self-regulating to adapt itself to changing conditions.

The selective adjustment of the proportion of oxygen added to the air flow is accomplished simply and reliably by varying the areas of the air and oxygen inlets with a valve for selecting a progression of different area relationships simply by moving a valve member through a range of available positions. When the pressure of air and oxygen at the proportioning inlets are maintained substantially the same, this variation in the area relationship of the inlets correspondingly varies the proportion in which the gases are mixed. Infinite variation of the proportion is possible from the minimum oxygen concentration to the maximum concentration.

Other objects and advantages of the invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view showing the basic components of a respiration system embodying the novel features of the present invention, many of the components being shown in cross-section; and

FIG. 2 is a fragmentary cross-sectional view taken along the line 2—2 of FIG. 1, through the proportioning device, the cover plate of which is removed in FIG. 1 and in place in FIG. 2.

DETAILED DESCRIPTION

As shown in the drawings for purposes of illustration, the invention is embodied in a respiration system for mixing oxygen from a suitable source **10** with air from an air intake **11** and delivering the resulting mixture cyclically through conventional delivery means **12** to a patient suffering from a respiratory deficiency. Air is drawn into the system by a pump **13**, preferably of the reciprocating bellows type, which communicates with the air intake **11** through conduits **14**, **15**, **17** and **18** connected together through a manifold **19**, and is enriched with oxygen in passing through a proportioning device **20** interposed in the air flow path between the conduits **15** and **17**.

The four conduits **14**, **15**, **17** and **18** are pipes of relatively large cross-section, the first and second conduits **14** and **15** being connected through a passage **21** in the upper portion of the manifold and a one-way check valve **22** permitting air to flow through the passage only from the intake pipe **14** toward the proportioning device **19** and an air inlet **23** therein. The third conduit **17** extends from an outlet **24** of the proportioning device back to a lower passage **25** in the manifold, in which a second one-way check valve **27** permits the mixture of air and oxygen to flow only toward the pump **13** through the conduit **18**. A third check valve **28** mounted in the end of the bellows controls the output flow from the pump to the delivery device **12**, being closed automatically during the intake or expansion stroke of the pump and opening automatically during the output or contraction stroke of the latter to permit the gas mixture to flow out of the pump through a conduit **29** while the check valve **27** is closed.

The reciprocation of the bellows pump **13** is accomplished by a volume control and delivery system **30** for controlling the cycles of operation, including the volume and rate of flow and the timing of the cycles. Both the delivery system and the delivery device, which may be a face mask, tube or the like, are well known in the art and thus are shown only generally herein.

For optimum simplicity and economy of operation, the preferred source of air for the system is room air at ambient

pressure which is drawn into the intake conduit **14** through a conventional air filter **31** mounted on the free end of the conduit. Oxygen typically is supplied under compression in storage cylinders or through a central supply system, either of which can be the source **10**, and is delivered to the proportioning device **20** through an oxygen conduit **32** and a control apparatus, indicated generally at **33**, to be mixed with the incoming air passing through the proportioning device. The oxygen conduit receives oxygen from the control apparatus and communicates with an oxygen inlet **34** in the proportioning device.

In accordance with the primary aspect of the present invention, the apparatus **33** controls the relative pressure of the air and oxygen available at the air and oxygen inlets **23** and **34** of the proportioning device **20** by automatically adjusting the pressure of the oxygen in the conduit **32** in response to sensed variations in the pressure in the air intake conduit **14**. This makes it possible to select any desired proportion of oxygen to air with a proportioning device for simply varying the areas of the air and oxygen inlets, avoids deviations from the selected proportion that otherwise would be produced by changes in air pressure and the resulting flow rates, and provides consistency and reliability in the selection of oxygen concentrations.

To these ends, the control apparatus **33** includes a variable volume reservoir **35** for holding a supply of oxygen at a controlled pressure slightly above ambient air pressure, and a pressure-responsive balancing valve **37** opens and closes a balancing port **38** between the reservoir and the oxygen conduit **32** automatically in response to air pressure changes in the intake conduit **14**. The operator of this balancing valve is a diaphragm **39** which is subjected on one side to the pressure of the oxygen in the conduit **32** and on the other side to a signal pressure derived from the pressure of the air in the intake conduit **14**, the diaphragm being connected to the balancing valve to open and close the valve in response to changes in the pressure differential across the diaphragm indicating a need to increase or decrease the oxygen pressure in order to maintain the inlet pressures equal at the proportioning device.

As shown in detail in the right-hand portion of FIG. **1**, oxygen from the source **10**, at a suitable source pressure, for example, 45 psi, enters the respiration system through a valve **40** and a supply conduit **41** leading to a demand valve **42** for feeding the oxygen, when needed, into the reservoir **35**, the demand valve constituting part of the control apparatus **33**. Herein, the reservoir is a variable-volume chamber defined by a fixed wall **43** on one side of a manifold **44** in which the balancing port **38** is formed, a movable wall **45** opposite the fixed wall and supported for free movement toward and away from the fixed wall, and a freely flexible annular wall **47** having edges that are sealed in grooves **48** in the two walls **43** and **45** to complete the reservoir chamber.

The supply conduit **41** opens into a passage **49** in the body **50** of the demand valve **42**, and this passage extends through the body to the closed inner end of a bore **51**. From this bore, a second passage **52** leads to a conduit **53** for carrying the oxygen to the reservoir **35**. To control the flow between the two passages **49** and **52**, a flexible diaphragm **54** is positioned in the bore **51**, normally in spaced relation with the open ends of the two passages, and is movable into and out of blocking relation with the passages by a plunger **55** in the bore. This plunger is slidable back and forth in an annular bushing **57** fast in the open end of the bore, and its outer end abuts against a roller **58** that is carried on the lower end portion of a bell crank **59** pivoted at **60** on the valve body **50**. From the pivot, the bell crank extends generally horizontally to the left and then upwardly beyond the roller alongside an upright link **61** for moving the bell crank, and thus the roller **58** and the plunger **55**, back and forth as the reservoir chamber **35** expands and contracts.

Below the upper end of the bell crank **59**, the link **61** is pivoted at **62** on a support **63** on which the valve body **50** is mounted, and above the crank, the link is pivoted at **64** on a bracket **65** projecting to the right from the movable wall **45** of the reservoir. An abutment **67** on the link between its two pivots engages one side of an offset upper end portion of the bell crank, and a coiled extension spring **68** is stretched between this offset portion and a pin **69** adjacent the free right end of the bracket, thus holding the crank against the abutment **67**.

It will be seen in FIG. **1** that the spring **68** is inclined downwardly and to the left from the bracket **65**, and thus exerts a force on the bracket tending to move it and the movable chamber wall **45** to the left. A second link **70** is pivoted adjacent its opposite ends on the bracket and on the support **63**, generally parallel to the first link **61**, and thus cooperates with the first link to form a movable mounting for the reservoir wall **45**.

The conduit **53** receiving oxygen from the demand valve **42** communicates with the reservoir chamber **35** through a passage **71** in the lower portion of the balancing valve manifold **44**, and thus delivers the oxygen to the reservoir chamber to fill the latter, tending to shift the movable wall **45** to the right to expand the chamber against the contracting action of the spring **68**. By proper selection and orientation of the spring, the demand valve **42** is set to open and feed oxygen into the reservoir chamber in response to the escape of oxygen to the conduit **32** through the balancing port **38**, and to maintain a substantially constant volume of oxygen in the reservoir at a selected pressure slightly above the pressure at which air and oxygen are to be fed to the proportioning device **20**. For example, the reservoir pressure can be on the order of one-fiftieth of a pound per square inch above atmospheric pressure.

An oxygen escapes from the reservoir chamber **35** into the oxygen conduit **32** when the port **38** is open, the reservoir begins to contract and the accompanying movement of the wall **45** to the left rocks the link counterclockwise about the lower pivot **62**, thereby pulling the upper end of the bell crank **59** to the left and permitting the demand valve **42** to crack open and deliver oxygen through the conduit **53** to the reservoir chamber. When the balancing port **38** is closed to stop the flow to the oxygen conduit **32**, the continuing feeding of oxygen to the reservoir chamber urges the movable wall **45** to the right and thus eventually acts through the link **61**, the bell crank **59**, the roller **58** and the plunger **55** to press the demand valve diaphragm **54** toward the open end of the conduit **52**, thereby blocking the conduit and shutting off the supply of oxygen to the reservoir chamber when it reaches a selected volume.

The balancing valve **37** has a poppet-type closure **72**, preferably a disc having a flexible peripheral flange for engaging the fixed wall **43** around the port **38**, mounted on a stem **73** which extends through the port and across the interior of the manifold **44**, the stem being fastened to the diaphragm and to lightweight perpendicular plates **74** secured to both sides of the diaphragm so as to move the valve closure between open and closed positions as the diaphragm moves back and forth. For purposes of centering and guiding the closure **72**, a flat spring **75** is attached at one end to the fixed wall **43** inside the reservoir chamber **35** and at the other end to the valve closure, and is stressed to bias the latter away from the wall with a light force.

Around the mounting plate **74**, the flexible edge portion of the diaphragm **39** is clamped and sealed between the side of the manifold remote from the reservoir chamber **35** and a dished cover **77** which is fastened to the manifold by screws **78**. With the mounting plate spaced from the clamped edges of the diaphragm, the latter remains free to flex and move back and forth in response to changing pressure differentials across the diaphragm, thereby moving the balancing valve **72** back and forth relative to the port **38**, the open position being shown in FIG. **1**.

To apply signal pressure from the air intake conduit **14** to the left side of the diaphragm, a conduit **79** communicates between an opening **80** in the diaphragm cover **77** and the central portion of the intake manifold **19**, just ahead of the check valve **22** so as to be subjected to the same pressure as

the intake conduit **14** and to transmit this pressure with negligible losses to the left side of the diaphragm. The pressure on the other side, of course, is the pressure of the oxygen in the balancing valve manifold **44** and in the oxygen conduit **32**.

While the proportioning device **20** may take various forms, the presently preferred form shown herein for purposes of illustration comprises a hollow, generally cylindrical body **81** defining a chamber **82** (see FIG. 2) into which the two inlets **23** and **34** open, the inlets being elongated, generally rectangular slots offset to one side of the center of the body and surrounded by raised webs **83** and **84** having flat end surfaces disposed in a common plane. A valve plate in the shape of a disc **85** is eccentrically pivoted on a shouldered pin **87** journaled in the cylindrical body, and is swingable back and forth across the ends of the inlet slots with one side in snug sliding relation with the flat end surfaces of the surrounding webs, so as to be movable across the slots into different selected positions in which the disc covers, and thus closes, different selected portions of the slots.

The conduit **17** extending from the proportioning device **20** toward the bellows pump **13** opens into the body in a recessed portion **82***a* of the chamber **82** through the outlet port **24** which is spaced below the plane of the valve disc **85** so as to remain fully open in all positions of the disc. Accordingly, the effective flow area of this conduit is unaffected by the disc, while the effective flow areas of the slots forming the inlets **23** and **34** can be changed by changing the position of the disc.

The interior of the valve body **81** is closed and sealed by a cover plate **88** (FIG. 2) that is secured to the body by fasteners **89**, the cover plate being formed with an opening **90** through which the pivot pin **87** of the valve disc **85** extends. An O-ring seals the pin rotatably in this opening, and a knob **91** is fastened to the outer end of the pin to serve as a grip for use in manually positioning the disc relative to the inlets **23** and **34**. A pointer **92** formed on one side of the knob indicates the angular position of the disc, and a scale may be applied to the outer side of the cover plate and calibrated in terms of the proportion of oxygen to air to be obtained in each such position, thus providing a direct indication of the proper angular position of the knob to obtain a particular concentration of oxygen in the mixture.

With the illustrative proportioning device **20**, the available concentrations of oxygen range from 21 percent through 100 percent, including any intermediate value that may be desired. In the position of the disc **85** shown in full in FIG. 1, in which the air inlet **23** is fully uncovered and only a small area at one end of the oxygen inlet **34** is uncovered, the proportioning device delivers sufficient oxygen to the air to raise the oxygen content to about 24 percent. In the position of the disc shown by the dash line **85***a*, the oxygen content will be 50 percent, and in the third position shown by the dot-dash line **85***b*, the oxygen percentage will be 80 percent. It will be seen that the flow area relationship changes progressively so that the percentage, in effect, is infinitely variable within the range of 21 to 100 percent, the air inlet **23** being fully closed for delivery of 100 percent oxygen.

While the manner of operation of the system should be apparent from the foregoing description of the various components, a brief summary of operation may be helpful in gaining a full appreciation of the system and its several features. Let it be assumed that the deliver means **12** is properly applied to a patient and that the volume control and delivery system **30** is in operation at the beginning of an intake stroke of the bellows pump **13**, with the proportioning device **20** set for slight enrichment such as 24 percent oxygen, as shown in full in FIG. 1, with the valve **40** open to deliver oxygen from the source **10** to the demand valve **42**, with the reservoir chamber **35** filled so that the demand valve diaphragm **54** is on the closed position, and with the pressure balanced at the air and oxygen inlets **23** and **34** so that the poppet closure **72** is in the closed position (not shown).

As the bellows pump **13** is expanded to draw in a charge of gas for delivery to the patient, the higher pressure outside the delivery check valve **28** closes this valve while the reduced pressure in the conduit **18** causes the check valve **27** to open and transmit the suction or negative pressure developed by the pump through the conduit **17** to the proportioning device **20**. Accordingly, mixed air and oxygen are drawn from the proportioning device and replenished by air and oxygen from the inlets **23** and **34** in direct proportion to the effective flow areas of the inlets.

The accompanying reduction in pressure in the air conduit **15** results in opening of the check valve **22** and the drawing of air into the conduit **14** through the filter **31**. At the same time, the changed pressure beneath or ahead of the check valve **22** is transmitted as signal pressure through the conduit **79** to the chamber on the left side of the diaphragm **39**, and tends to unbalance the net force acting on the diaphragm to hold the poppet closure **72** in the closed position.

It can be seen that this net force is the sum of all of the closing forces (i.e., the force exerted by the oxygen in the reservoir chamber **35** on the poppet closure, plus the force exerted by the oxygen in the manifold **44** on the diaphragm **39**), less the sum of all of the opening forces (i.e., the force of the spring **75**, plus the force exerted by the oxygen in the manifold on the poppet closure, plus the force exerted by the signal air pressure on the diaphragm). These forces are carefully balanced so that a reduction in the pressure of the oxygen in the conduit **32** and in the manifold **44** relative to the pressure of the air in the intake conduit **14** results in opening of the balancing valve **37** to supply additional oxygen to the conduit **32** and thus to the inlet **34**, while a reduction in the air pressure in the intake conduit **14** relative to the oxygen pressure at the inlet **34** results in closing of the balancing valve.

The air pressure transmitted by the signal conduit **79** to the left side of the diaphragm **39** is not the same as the pressure in the oxygen conduit **32**. The latter pressure normally is substantially the same as the pressure in the conduit **17** between the pump **13** and the outlet port **24**, while the negative or subatmospheric pressure in the air conduits **14** and **79** is reduced (made less negative) primarily by the restriction of the flow path through the proportioning device **20**. Accordingly, a pressure imbalance is obtained across the diaphragm for proper operation of the balancing valve.

After the pump **13** has completed its intake stroke and has been filled with the mixture of air and oxygen in the selected proportion, the volume control and delivery system **30** begins to contract the bellows, increasing the internal pressure and thus closing the check valve **27** while opening the valve **28** to admit the mixture through the conduit **29** to the delivery means **12** and the patient. During the output stroke of the pump, pressures in the intake conduits can return to ambient pressure and the balancing valve can close to maintain the balanced pressure conditions at the proportioning inlets **23** and **34**, thereby terminating the flow of oxygen into the proportioning device until the next intake stroke of the pump begins.

To change the proportion of oxygen, the valve disc **85** is simply turned to a new position providing any desired new area relationship between the inlets **23** and **34**, as indicated by the calibrated scale on the cover plate **88**. If changes are made in the flow rate or volume of air per cycle, the system automatically adapts itself to provide the selected proportion of oxygen, regardless of changes in rate and volume.

Suitable safety measures can be provided to avoid any possibility of harm to a patient in case of malfunctioning of any part of the system. For example, an alarm system (not shown) can be provided to initiate a warning signal, either audible or visible, or both, if for any reason the oxygen system fails to supply oxygen to the reservoir chamber **35**. The movable wall **45** of the chamber is provided with an inlet **93** that is normally closed by a check valve **94** which will open if the pressure within the reservoir drops below ambient pressure, thereby admitting air into the reservoir through a filter **95**. In addition, the flexible wall **47** of the reservoir may be secured to the movable wall **45** to pull free if excessive oxygen pressure

develops in the reservoir, thereby preventing such pressure from being transmitted to the remainder of the system. These and other safety measures may be included in the system, but do not form any part of the present invention.

From the foregoing, it will be seen that the present invention provides an improved respiration system in which air and oxygen are mixed in a selected proportion that remains substantially constant despite variations that occur in supply pressure, flow rates, pressure drop across the intake filter, and other variables inherent in such a system. Moreover, the proportion is infinitely variable in a simple, direct and accurate manner, and the system utilizes readily available components that do not result in objectionable deviations after prolonged use, and can be combined in a relatively simple and inexpensive manner with presently available companion equipment. It also will be evident that, while a presently preferred form has been illustrated and described, various modifications may be made without departing from the spirit and scope of the invention.

I claim:

1. In a respiration system for mixing oxygen with room air in a selected proportion and supplying the mixture to a delivery device, the combination of:

air intake means including an intake conduit having an open end for receiving room air substantially at ambient pressure;

oxygen supply means including a reservoir for holding a quantity of oxygen, a demand valve responsive to changes in the quantity of oxygen in said reservoir and operable to replenish the oxygen therein whenever the quantity falls below a selected amount, and an oxygen conduit for receiving oxygen from said reservoir;

a proportioning device having air and oxygen inlets of preselected effective flow areas having the same area relationship as the proportion of oxygen to be added to the air, said air inlet communicating with said air intake conduit and said oxygen inlet communicating with said oxygen conduit to admit air and oxygen, respectively, into said proportioning device, the latter also having an outlet for the mixture;

a pump communicating with said outlet and operable cyclically to draw the mixture therefrom while drawing additional air and oxygen into said proportioning device through said inlets;

a balancing valve controlling the flow of oxygen from said reservoir to said oxygen conduit and thus to said oxygen inlet;

and means for sensing changes in the relative pressures of air and oxygen at said inlets and operating said balancing valve to vary the flow of oxygen to said oxygen conduit and maintain said pressures substantially equal.

2. A respiration system as defined in claim **1** in which said sensing means includes a movable diaphragm connected to said balancing valve to open and close the latter as the diaphragm moves back and forth, one side of the diaphragm being exposed to oxygen at the pressure in said oxygen conduit, means defining a chamber at the other side of said diaphragm, and means transmitting the pressure at said air intake means to said chamber, thereby to open said balancing valve when the oxygen and air pressures produce a preselected pressure differential across said diaphragm and to close the balancing valve when the pressure differential drops below said preselected pressure differential.

3. A respiration system as defined in claim **2** in which said oxygen supply means maintains the quantity of oxygen in said reservoir slightly above ambient pressure.

4. A respiration system as defined in claim **1** in which said proportioning device includes means for selectively varying the effective flow areas of said inlets to vary said proportion.

5. In a respiration system for mixing a respirating gas in a selected proportion with air and supplying the mixture to a delivery device, the combination of:

air intake means;

supply means for receiving said respiration gas from a source;

a proportioning device having gas and air inlets of preselected effective flow areas communicating respectively with said supply means and said air intake means to receive respirating gas and air therefrom, and having an outlet for the resulting mixture;

a pump communicating with said outlet to draw said mixture therefrom and thereby draw air and respirating gas into said proportioning device through said inlets;

and means for sensing the pressure of air in said air intake means and varying the pressure of said respirating gas in said supply means in accordance with variations in said air pressure, thereby to maintain the proportion of respirating gas in said mixture constant despite variations in air flow.

6. A respiration system as defined in claim **5** in which said proportioning device includes selectively adjustable means for changing the effective flow areas of said inlets and thereby providing different selected proportions of respirating gas in said mixture.

7. A respiration system as defined in claim **5** in which said air intake means draws air into said system substantially at ambient pressure, and said supply means includes a reservoir for holding respirating gas at approximately ambient pressure, and a conduit from said reservoir to said respirating gas inlet of said proportioning device, said pressure sensing and varying means including a balancing valve controlling the flow of gas from said reservoir to said conduit and means for opening and closing said balancing valve in response to changes in the pressure in said air intake means to maintain the gas in said conduit at the same pressure as the air at said air inlet.

8. A respiration system as defined in claim **7** in which said reservoir has a variable volume chamber, means applying a preselected force tending to reduce the volume of said chamber and maintaining the pressure therein above ambient pressure, and a demand valve actuated by reduction of the volume of said chamber to a selected size to feed said gas thereto, thereby to maintain a preselected approximate volume of said gas in said chamber for delivery to said conduit by said balancing valve.

9. A respiration system as defined in claim **7** in which said opening and closing means for said balancing valve comprise a diaphragm operator exposed on one side to the pressure of said gas in said conduit, and means transmitting the pressure in said air intake to the other side of said operator, the latter being connected to said balancing valve to open the valve in response to a rise in the pressure in said air intake relative to the gas pressure in said conduit, and to close the valve in response to a drop in the air intake pressure relative to the gas pressure in said conduit.

10. A respiration system as defined in claim **9** in which the gas pressure in said conduit is maintained substantially the same as the pressure at said outlet, and said proportioning device creates a pressure drop between said outlet and said air intake.

11. A respiration system as defined in claim **7** in which said proportioning device includes a member selectively movable across said inlets and operable in different positions relative to the inlets to uncover different selected areas of the inlets, thereby to provide different selected proportions of respirating gas in said mixture.

12. A respiration system as defined in claim **11** in which said valve member progressively varies the proportion of gas in said mixture through an infinite number of proportions within a preselected range.

13. A respiration system as defined in claim **11** in which said proportioning device has a chamber into which said inlets open on a common plane, and said valve member is a plate pivoted in said chamber for back and forth movement relative to said inlets with one side of the plate on said plane to slide across said inlets into different positions in which different relative areas of said inlets are uncovered as effective flow areas.

14. In a respiration system for mixing a first gas with a second gas in a selected proportion and delivering the mixture to a using device, the combination of:

first and second supply means for receiving said first and second gases, respectively, at controlled pressures;

a proportioning device having first and second inlets of selected areas communicating with said first and second supply means, respectively, to receive gases therefrom in a proportion depending upon said areas;

means for drawing mixed gasses from said proportioning device and thereby drawing the respective gases through said inlets into said proportioning device;

a balancing valve controlling the flow of said first gas through said first supply means to said first inlet;

and means responsive to the pressure exerted by said drawing means on said second gas supply means and operating said balancing valve to vary the pressure of said first gas at said first inlet in accordance with variations in the pressure of said second gas at said second inlet, thereby to adjust the volume of said first gas flowing through said first inlet in accordance with variations in the volume of said second gas flowing through said second inlet.

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