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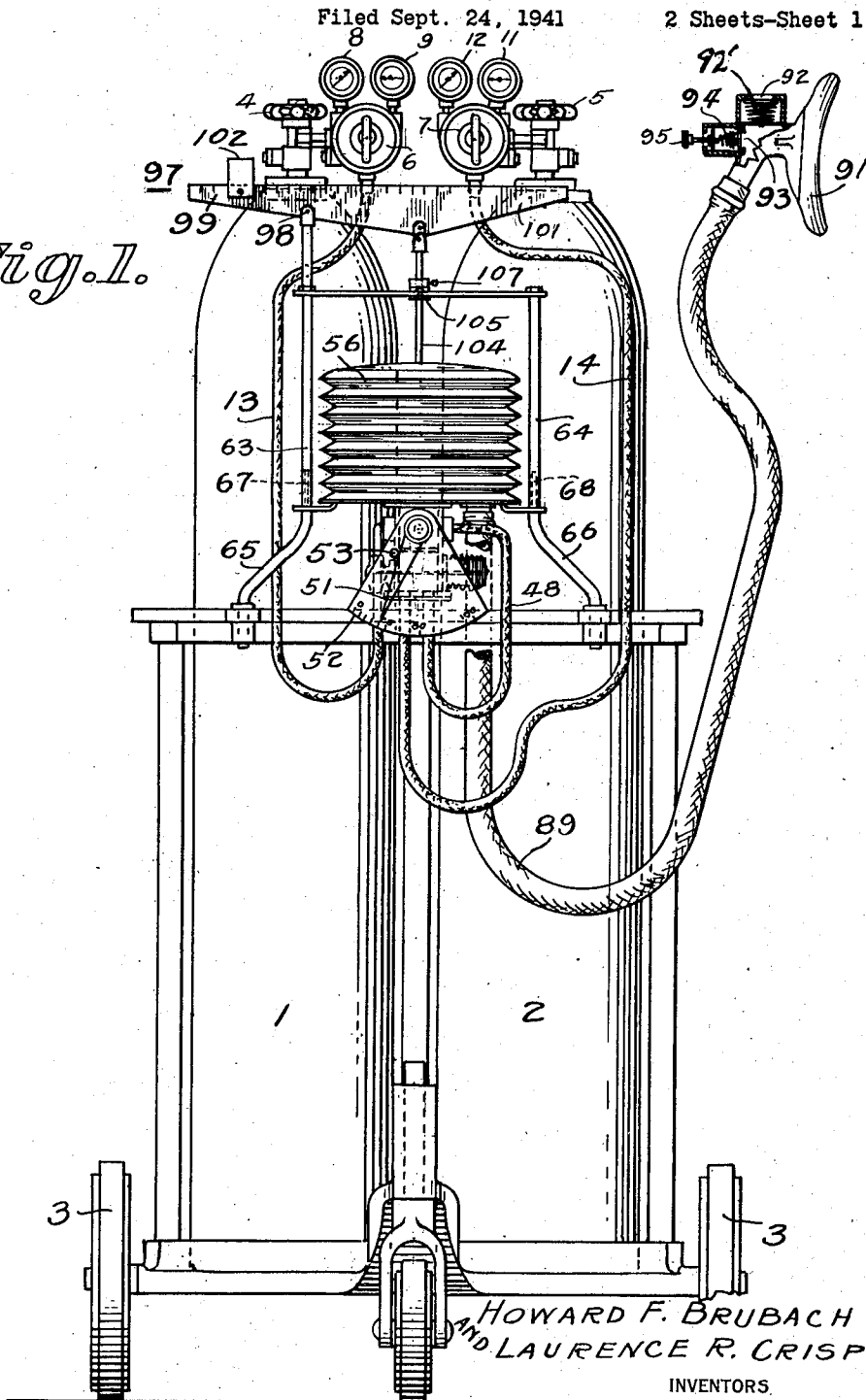
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APPARATUS FOR THE ADMINISTRATION OF GASEOUS MIXTURES

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Fig. 1.



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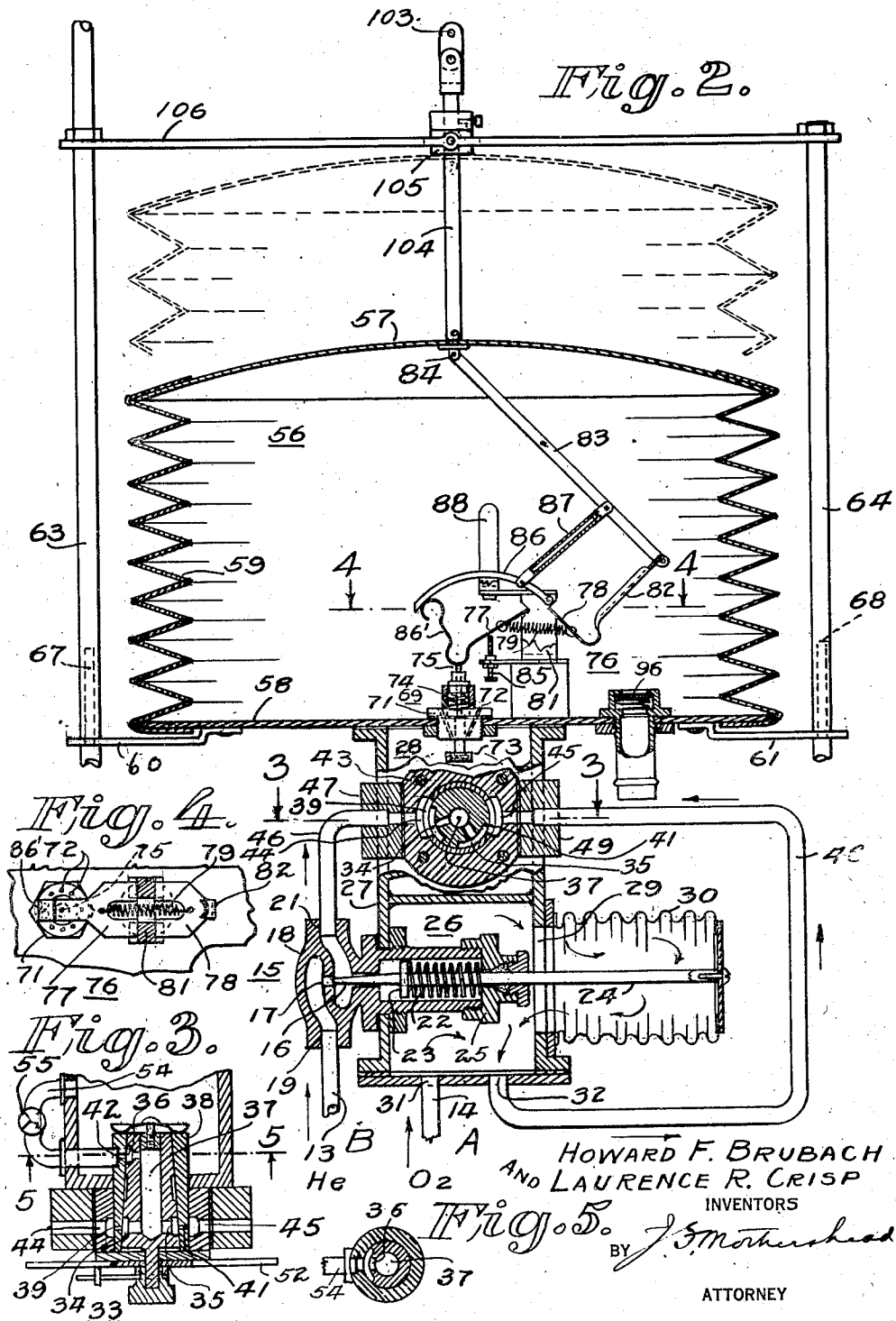
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UNITED STATES PATENT OFFICE

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APPARATUS FOR THE ADMINISTRATION OF
GASEOUS MIXTURESHoward F. Brubach, Wood Acres, and Laurence
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amended April 30, 1928; 370 O. G. 757)

The present invention relates to apparatus for the administration of gaseous mixtures.

It is an object of the invention to provide a simple, inexpensive, portable gas-administering apparatus which is safe as well as economical in operation.

Other objects of the invention will appear more fully from the following description taken in connection with the accompanying drawings wherein,

Fig. 1 is a front elevation view of the apparatus embodying the invention;

Fig. 2 is a detail view of the breathing chamber and adjacent parts, partially in section and partially with the walls broken away;

Fig. 3 is a horizontal sectional view on the line 3—3 of Fig. 2;

Fig. 4 is a horizontal sectional view on the line 4—4 of Fig. 2; and

Fig. 5 is a vertical sectional view on the line 5—5 of Fig. 3.

The apparatus embodying the present invention is particularly adapted to the safe and economical administration of oxygen-helium mixtures in predetermined proportions and at desired pressures. The importance of oxygen-helium mixtures arises from its therapeutic characteristics, giving it a wide application, as in the treatment of caisson disease, asthma, status asthmaticus, cardiac disease and the like.

In accordance with the present invention, a portable apparatus is provided whereby oxygen and helium may be drawn from separate tanks, mixed to any desired proportions and continuously delivered to a face mask at desired pressure. Since pure helium in the absence of oxygen causes extremely rapid asphyxiation, the invention also contemplates safety means which permits the flow of helium only when the required flow of oxygen is present.

Referring to the drawings, a helium cylinder 1 and an oxygen cylinder 2 are mounted on a portable carriage 3. Conventional hand valves 4 and 5 for controlling the flow of the gases, together with pressure-reducing valves 6 and 7, are also respectively associated with the cylinders 1 and 2. Pressure flow gauges 8 and 9 are connected to the high and low pressure sides of the pressure-reducing valve 6, while pressure flow gauges 11 and 12 are similarly connected with respect to the pressure-reducing valve 7.

The low pressure side of each reducing valve 6 and 7 is respectively connected by one of tubes 13 and 14 to safety means 15 which permits a supply of helium only when an adequate supply

of oxygen is assured. The safety means 15 comprises a valve 16 which is movable into open and closed positions with respect to a port 17 in a valve casing 18 having an inlet opening 19 connected to the tube 13 leading from the helium cylinder 1 and also having an outlet opening 21. The valve 16 is normally held in its closed position by a spring 22, one end of which engages a shoulder 23 on a stem 24 of the valve 16. The other end of the spring 22 abuts against, and is enclosed by, an extension 25 of the valve casing 18.

The valve stem 24 and the valve casing extension 25 are conveniently mounted in a lower chamber 26 of a housing 27 which is also provided with a top chamber 28 presently to be described. The lower chamber 26 has an opening 29 which is enclosed by a pressure-responsive device 30, such as a syphon bellows. The valve stem 24 may be secured to the outer end of the bellows so as to be actuated thereby. The lower chamber 26 is also provided with an inlet opening 31 connected to the oxygen-supply tube 14, and an outlet opening 32.

The parts of the safety means 15 are adjusted so that the syphon bellows 30 operates to actuate the valve 16 into its open position to uncover the port 17 only when oxygen under pressure is supplied through the tube 14 to the chamber 26. Should the oxygen pressure in the chamber 26 fall below the predetermined value for safe operation of the apparatus, then the syphon bellows 30 collapses sufficiently to permit the positive closure of the valve 16 by the spring 22, thereby stopping the flow of helium from the supply tube 13. In this manner, the danger of asphyxiation resulting from an interruption in the oxygen flow to the patient is prevented, without the necessity for any action on the part of the operator of the apparatus.

The present invention also contemplates proportioning and mixing means, whereby the oxygen and helium may be brought together and mixed in any one of a number of desired proportions. To this end, a valve 33 is provided with a pair of inlet ports 34 and 35, an outlet port 36 and a connecting mixing chamber 37. A valve casing 38 is provided with a pair of inlet ports 39 and 41 which respectively coact with the valve ports 34 and 35. An outlet port 42 in the casing 38 coacts with the valve outlet port 36.

The valve casing 38 is mounted in a valve block 43 provided with ports 44 and 45 which respectively align with the ports 39 and 41. The port 44 is connected by a tube 46 to the outlet opening

21 of the valve casing 18, thus completing the helium passageway to the mixing valve 33. A small block 47 serves to secure the end of the tube 45 in desired position on the valve block 43. The other inlet port 45 in the valve block 43 is connected by a tube 48 to the oxygen outlet opening 32 in the chamber 26, thereby completing the oxygen passageway to the mixing valve 33. A small block 49 serves to secure the tube 48 in desired position on the valve block 43.

The helium ports 34 and 39, and the oxygen ports 35 and 41, are so designed that the flow of gases therethrough may be progressively varied from zero to a maximum. The pairs of coacting ports 34, 39 and 35, 41 are also so related that the operation of the valve 33 automatically varies the relative proportions of the mixed gases through a range which preferably extends from zero to one hundred percent. As the proportion of one gas in the mixture is increased, that of the other gas is correspondingly decreased. This change in proportion may be indicated by a pointer 51 mounted on the end of the mixing valve 33 and movable over a scale 52.

If desired, a stop 53 may be located in the path of the pointer 51 to prevent the valve 33 from providing a mixture wherein the oxygen content is less than twenty percent. Should the percentage of oxygen be permitted to drop below this value, the danger of asphyxiation by the helium rapidly becomes acute.

The mixed gases pass from the mixing chamber 37 of the valve 33 through the coacting ports 36 and 42 to a tube 54. This tube opens into the top chamber 28, and it has a control valve 55 of conventional design for stopping the flow of the mixed gases when the apparatus is not in use.

In accordance with the present invention, the breathing chamber 56 is formed of a top plate 57, a bottom plate 58 and a connecting flexible member 59 forming the side wall of the chamber. The collapsed position of the breathing chamber 56 is shown in solid lines in Fig. 2, and the extended position is shown in dotted lines.

The bottom plate 58 of the breathing chamber 56 is conveniently provided with shoulders 60 and 61 which are respectively secured to upstanding tubular members 63 and 64. These members are removably supported on bracket arms 65 and 66 carried by the portable carriage 3. The arms 65 and 66 have short extensions 67 and 68, respectively, of reduced diameters which project upwardly into the tubular members 63 and 64. Such construction permits the removal of the breathing chamber 56 merely by lifting the chamber with its tubular members 63 and 64 sufficient to clear the ends of the extensions 67 and 68.

The bottom plate 58 of the breathing chamber 56 may conveniently form the upper wall of the top chamber 28 which contains the mixed gases. Passage of the gases from the chamber 28 into the breathing chamber 56 is controlled by an admission valve 69. This valve comprises a valve casing 71 located in the top wall of the chamber 28, and it is provided with a plurality of apertures 72 which connect the top chamber 28 and the breathing chamber 56. A valve disc 73 for closing the openings of the apertures 72 in the chamber 28, is normally held in its closure position by a spring 74 which abuts against a valve stem 75 of the valve disc 73. Movement of the valve disc 73 into its opening position is therefore against the force of the spring 74. Initial movement of the valve disc 73 is also retarded by the static

force thereon of the mixed gases in the chamber 28.

The dimensions of the apertures 72 and the open position of the valve disc 73 are such as to permit free and unrestricted flow of the mixed gases from the chamber 28 into the breathing chamber 56, so that the predetermined proportioning of the gases by the mixing valve 33 remains unchanged. Thus, the mixing valve 33 is left with full control of the proportioning of the mixed gases and is unaffected by the admission valve 69.

The present invention further contemplates means controlled by the breathing chamber 56, whereby the valve disc 73 may be actuated into its open position and preferably there held until the breathing chamber 56 has reached its desired expanded position. Accordingly, there is provided a spring-actuated toggle 76 which comprises a pair of fulcrumed members 77 and 78 with a spring 79 therebetween positioned to snap these members into their raised or lowered positions as desired. The members 77 and 78 are conveniently of bifurcated form with the ends thereof fulcrumed in notched edges of a U-shaped supporting member 81. The spring 79 is located therebetween as shown in Fig. 4.

The fulcrumed member 78 is provided with an arm 82 which is connected to an actuating link 83 pivotally secured at 84 to the center of the top wall 57 of the breathing chamber 56. The other fulcrumed member 77 of the toggle 76 operatively engages the valve stem 75 of the valve disc 73. An adjusting screw 85 serves to prevent further downward movement of the fulcrumed member 77 when the valve disc 73 has been actuated into its fully open position shown in Fig. 2.

Should the force of the toggle spring 79 not be sufficient to actuate the valve disc 73 into its open position against the force of the valve spring 74 and the force of the static gas pressure in chamber 28 acting on the valve disc 73, it is desirable to provide an initial opening force independent of that of the toggle 76. This additional force need be just sufficient to move the valve disc 73 so as to break the static force of the mixed gases thereon, whereupon the toggle 76 may operate to snap the valve disc 73 into its fully open position against the force of the valve spring 74.

To this end, a curved lever 86 is pivoted on the bifurcated supporting member 81 just above the toggle 76. The free end of the lever 86 abuts against an upward extension 86' of the toggle member 77, so that actuation of the lever 86 results in the desired downward force on the valve stem 75 to cause the required small initial movement of the valve disc 73. Movement of the lever 86 may be conveniently effected by a member 87 extending between the actuating link 83 and the lever 86. The member 87 may comprise telescoping sections affording a limited lost motion connection, permitting lengthening of the member 87 when the breathing chamber 56 approaches its elevated extended position. The vertical movement of the lever 86 may be guided by the opposed arms of a U-shaped member 88 secured to the top of the toggle support 81.

Thus, when the apparatus is in the position shown in Fig. 2, the toggle 76 holds the valve disc 73 in its open position until the breathing chamber 56 occupies its fully extended dotted-line position, at which time the link 83 has moved the toggle member 78 to such elevated position that the toggle spring 79 snaps the members 77 and 78

into their raised ineffective position. The valve spring 74 then snaps the valve disc 73 into its closed position, preventing the further flow of mixed gases from the chamber 28 into the breathing chamber 56.

Thereafter, with the gradual withdrawal of the gases from the breathing chamber 56 due to the use of the apparatus, the valve disc 73 remains in its closed position. When the breathing chamber 56 finally reaches its approximate collapsed position, the link 83 has moved the toggle 76 from its raised ineffective position to its lowered effective position. Should the valve disc 73 not then snap into its open position, a further slight collapsing of the breathing chamber 56 causes the link 83 to actuate the curved lever 86 downwardly. The arm 86' and valve stem 75 in contact therewith are then also actuated downwardly, resulting in a slight movement of the valve disc 73 just sufficient to break the static force of the mixed gases in chamber 28 on the disc 73. The toggle 76 now operates to snap the valve disc 73 into its fully open position shown in Fig. 2.

The mixed gases in the breathing chamber 56 are conveniently conveyed by a breathing tube 89 to a face mask 91. The mask 91 has an emergency intake valve 92 whereby air may be drawn into the mask in the event of stoppage of the flow of mixed gases from the breathing chamber 56. A spring 92' is adjusted so that the valve 92 is normally held in its closed position, except for the emergency condition just mentioned.

The face plate 91 is also provided with a discharge or exhaust valve 93. The pressure necessary to open the valve 93 may be varied by adjusting the force of a closure spring 94, as by moving an adjusting screw 95. Rebreathing into the breathing chamber 56 through the tube 89 is prevented by a spring-pressed check valve 96 which may be conveniently located at the point of connection of the tube 89 with the breathing chamber 56.

The present invention further contemplates means whereby, if desired, positive pressure of predetermined value may be maintained in the breathing chamber 56 and the face mask 91. Accordingly, there is provided a beam 97 which is fulcrumed at 98 on a vertical extension of the tubular member 63. The beam comprises arms 99 and 101, and a weight 102 is adjustably mounted thereon. The arm 101, at a point spaced from the fulcrum 98, is supported by linkage 103 and 104 on the top center of the upper plate 57 of the breathing chamber 56.

The link 104 is pivotally secured to the upper plate 57 of the breathing chamber 56. The link 104 is also guided in its substantially vertical movement by a bearing member 105 pivotally mounted in a cross member 106 connecting the upper ends of the tubular members 63 and 64. An adjustable stop 107 on the link 104 engages the bearing member 105 when the breathing chamber 56 has collapsed to the desired extent and thereby prevents the further collapse thereof.

The beam 97 may be calibrated in terms of pressure in the breathing chamber 56 and face mask 91. Adjustment of the weight 102 to the right of the fulcrum 98 retards the expansion of the breathing chamber 56, while adjustment of the weight 102 to the left of the fulcrum 98 assists in the expansion, thus permitting the pressure to be varied from atmosphere to a desired elevated value. When a particular positive pressure is desired in the breathing chamber 56 and face mask 91, the weight 102 is moved to a predeter-

mined position on the beam 97 as indicated by the scale. With the face mask 91 in position on the patient, the exhaust valve spring 94 is then adjusted so that free flow of gas through the exhaust valve 93 is just stopped.

In the operation of the apparatus, the pointer 51 is moved to the position on the scale 52 which gives the desired percentage of helium and oxygen. The valves 4 and 5 on the cylinders 1 and 2 are then opened until the proper flow pressure appears on the gauges 9 and 12, say five pounds.

Oxygen under pressure then enters the lower chamber 26 of the safety means, causing the movement of the safety valve 16 into its open position so as to permit the supply of helium to the mixing valve 33. Oxygen and helium now enter the proportioning and mixing valve 33, from which it passes through the shut-off valve 55 to the top chamber 28.

With the breathing chamber 56 in its collapsed position shown in Fig. 2, the valve disc 73 is also in its open position, so that the mixed gases pass into the breathing chamber 56. From here the gases pass through the check valve 96 to the face plate 91 and are inhaled by the patient.

The mixed gases continue to enter the breathing chamber 56 until it has been extended to its maximum position. At this time, the link 83 has moved the toggle 76 into such position that the spring 79 thereof snaps the fulcrumed members 77, 78 into their raised position, relieving the opening force on the valve stem 75. The valve spring 74 then snaps the valve disc 73 into its closed position.

As the patient inhales the gases from the breathing chamber 56, it gradually reaches the collapsed position shown in Fig. 2. The lever arm 86 then causes the valve disc 73 to move slightly to break the static force of the mixed gases thereon, whereupon the toggle 76 operates to snap the valve disc 73 into its open position. Mixed gases again enter the breathing chamber 56 from the top chamber 28, and the foregoing cycle of operations is repeated.

The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment to us of any royalty thereon.

We claim:

1. In apparatus for the administration of gaseous mixtures, the combination with a breathing chamber, of means for conducting one gas, means for conducting another gas, safety means for permitting the flow of the gases in both of said conducting means only when the gas pressure in one of said conducting means is a predetermined value, and means whereby the gases from said separate conducting means may be mixed and supplied to said breathing chamber, said last-mentioned means including a proportioning valve.

2. In apparatus of the class described, a breathing chamber, a valve for controlling the flow of gases to said breathing chamber, spring-pressed means successively operable to apply and remove an opening force to and from said valve, and means actuated by said breathing chamber for exerting an opening force on said valve separate from that exerted by said first-mentioned means.

3. In apparatus of the class described, the combination with a breathing chamber and an admission valve for said chamber, of means operable successively to apply and remove an opening force to and from said valve, said means being controlled by said breathing chamber, and means for exerting an independent opening force

on said valve, said last-mentioned means having a lost-motion connection with said breathing chamber.

4. In apparatus of the character described having a breathing chamber, a gas-control valve for said chamber having open and closed positions, a link actuated by said breathing chamber, a spring-actuated toggle, the arms of which are in operative relation to said valve and said link respectively, and means operatively connecting said link and said valve whereby an opening force may be exerted on said valve independently of said toggle.

5. In apparatus of the class described, an expansible breathing chamber, means whereby gases may be supplied thereto, and pressure-adjusting means for said breathing chamber, said last-mentioned means being adjustable to selectively retard or assist the expansion of said breathing chamber.

6. In apparatus of the class described, the combination with a breathing chamber expansible upon the supply of gases thereto, and an admission valve for said chamber controlled thereby, of means for assisting the expansion of said chamber as the gas is supplied thereto, said means comprising a beam having a fulcrum, one arm of said beam being operatively associated with said breathing chamber, and a weight movable on said beam.

7. In apparatus of the class described, a breathing chamber expansible upon the supply of gas thereto, an admission valve therefor movable into open and closed positions, a proportioning valve connected to said admission valve, means controlled by said breathing chamber whereby said admission valve may be held in its fully open position during at least a part of the time of expansion of said chamber, and adjustable means independent of said first-mentioned means tending to resist the expansion of said chamber whereby the pressure therein may be adjusted to a predetermined value.

8. Apparatus for the administration of gaseous mixtures comprising a breathing chamber, means for conducting one gas, means for conducting another gas, safety means for permitting the flow of gases in both of said conducting means only when the gas pressure in one of said conducting means is a predetermined value, means whereby the gases from said separate conducting means may be mixed and supplied to said breathing chamber, an admission valve for controlling the supply of the mixed gases to said chamber, and means operable successively to apply and remove an opening force to and from said admission valve.

9. In apparatus for the administration of gaseous mixtures, the combination with means for conducting one gas, means for conducting another gas, and a proportioning valve connected to both of said conducting means, of safety means whereby gas may flow in one of said conducting means only so long as gas is supplied to the other of said conducting means, a breathing chamber connected to said proportioning valve, and an admission valve for controlling the flow of the mixed gases into said breathing chamber.

10. In apparatus for the administration of gaseous mixtures having means for conducting one gas and means for conducting another gas, the combination with a proportioning valve connected to both of said conducting means, and safety means whereby gas may flow in one of said conducting means only so long as gas is

supplied to the other of said conducting means, of a breathing chamber connected to said proportioning valve, an admission valve for controlling the flow of the mixed gases into said breathing chamber, and means actuated by said breathing chamber for controlling said admission valve.

11. In apparatus for the administration of gaseous mixtures having means for conducting one gas and means for conducting another gas, the combination with a proportioning valve connected to both of said conducting means, safety means whereby gas may flow in one of said conducting means only so long as gas is supplied to the other of said conducting means, a breathing chamber connected to said proportioning valve, and an admission valve for controlling the flow of the mixed gases into said breathing chamber, of means actuated by said breathing chamber for controlling said admission valve, and means co-acting with said breathing chamber whereby the pressure of the mixed gases therein may be controlled.

12. In apparatus of the class described, a proportioning valve provided with a pair of inlet ports, an outlet port and a connecting mixing chamber, a valve casing having an outlet port for coacting with said valve outlet port, said casing also having an inlet port for each valve inlet port, each pair of valve and casing inlet ports being so related that the flow of gas therethrough may be progressively varied from approximately zero to a maximum, with the flow through one pair of ports increasing while that through the other pair of ports decreases, gas-conducting means respectively connected to said casing inlet ports, a breathing chamber having an admission valve therefor movable into open and closed positions, and gas-conducting means extending between said casing outlet port and said admission valve, said admission valve in its open position permitting free and unrestricted flow of the mixed gases therethrough, so that the predetermined proportioning of the gases by said first-mentioned valve remains unchanged by said admission valve.

13. In apparatus of the class described, means for conducting one gas, means for conducting another gas, a proportioning valve connected to each of said means whereby the gases may be mixed in predetermined proportions, means for permitting the flow of gas in one of said conducting means only when gas is supplied to the other of said conducting means, a breathing chamber connected to receive the mixed gases, an admission valve for controlling the flow of the mixed gases into said breathing chamber, said admission valve when open permitting free and unrestricted flow of the mixed gases, so that control of the proportioning of the mixed gases remains with said proportioning valve, and means controlled by the breathing chamber for operating the admission valve.

14. In apparatus of the class described having means for conducting one gas and means for conducting another gas, the combination with a proportioning valve connected to each of said means whereby the gases may be mixed in predetermined proportions, and means for permitting the flow of gas in one of said conducting means only when gas is supplied to the other of said conducting means, of a breathing chamber connected to receive the mixed gases, an admission valve for controlling the flow of the mixed gases into said breathing chamber, said admission valve when open permitting free and unrestricted flow of the

mixed gases, so that control of the proportioning of the mixed gases remains with said proportioning valve, means controlled by the breathing chamber for actuating the admission valve into one of its positions, a face mask connected to said breathing chamber, and means whereby the pressure of the mixed gases in said breathing chamber and said face mask may be controlled.

15. In apparatus of the class described, a housing provided with at least two chambers, one chamber having gas inlet and outlet openings, whereby gas under pressure may be supplied thereto and conveyed therefrom, a passageway

5 controlled by a valve, means whereby gas under pressure in said last-mentioned chamber may actuate said valve, a proportioning valve having one inlet port connected to said passageway and another inlet port connected to said chamber outlet opening, a breathing chamber, said proportioning valve having an outlet port connecting with the other of said two chambers, and an admission valve controlling the passage of mixed gases from said last-mentioned chamber into said breathing chamber.

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