

Oct. 15, 1946.

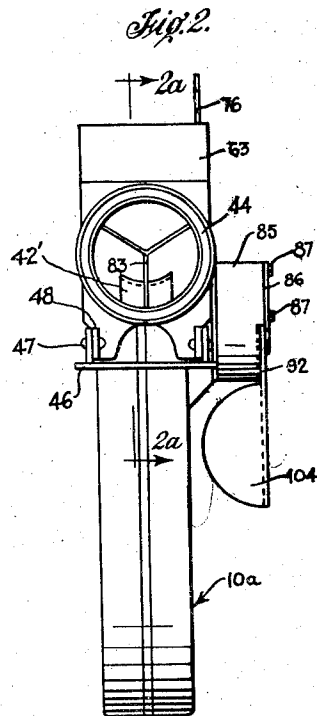
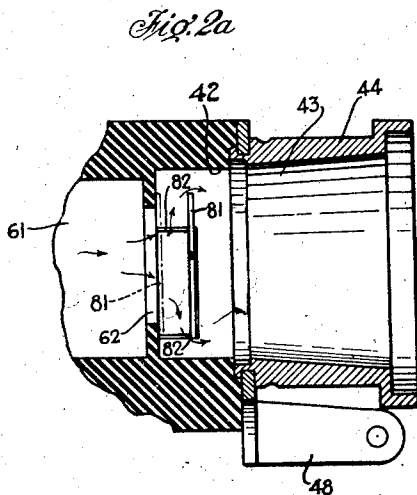
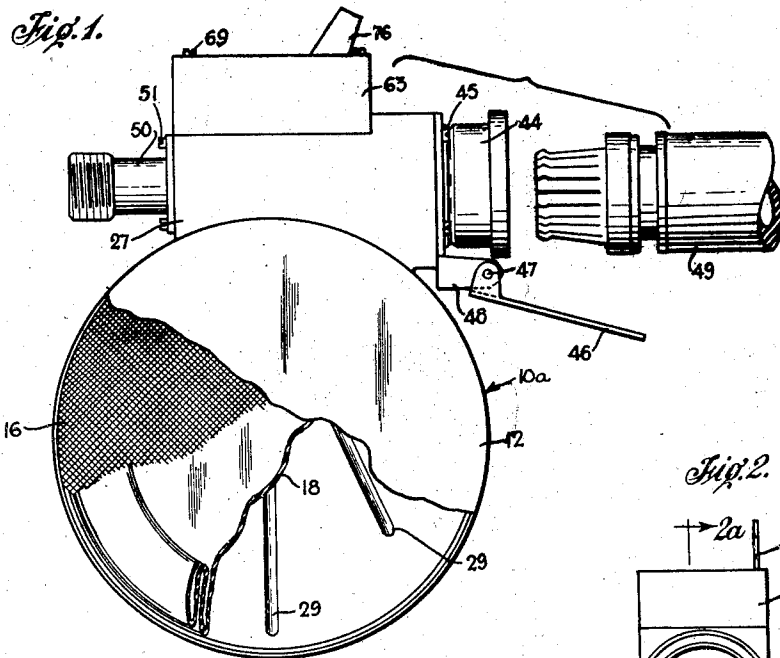
L. A. WIGGINS

2,409,327

OXYGEN DEMAND REGULATOR

Filed March 2, 1943

4 Sheets-Sheet 1



Inventor
LEONARD A. WIGGINS

Ely & Faye

Attorneys

384

Oct. 15, 1946.

L. A. WIGGINS

2,409,327

OXYGEN DEMAND REGULATOR

Filed March 2, 1943

4 Sheets-Sheet 2

Fig. 3.

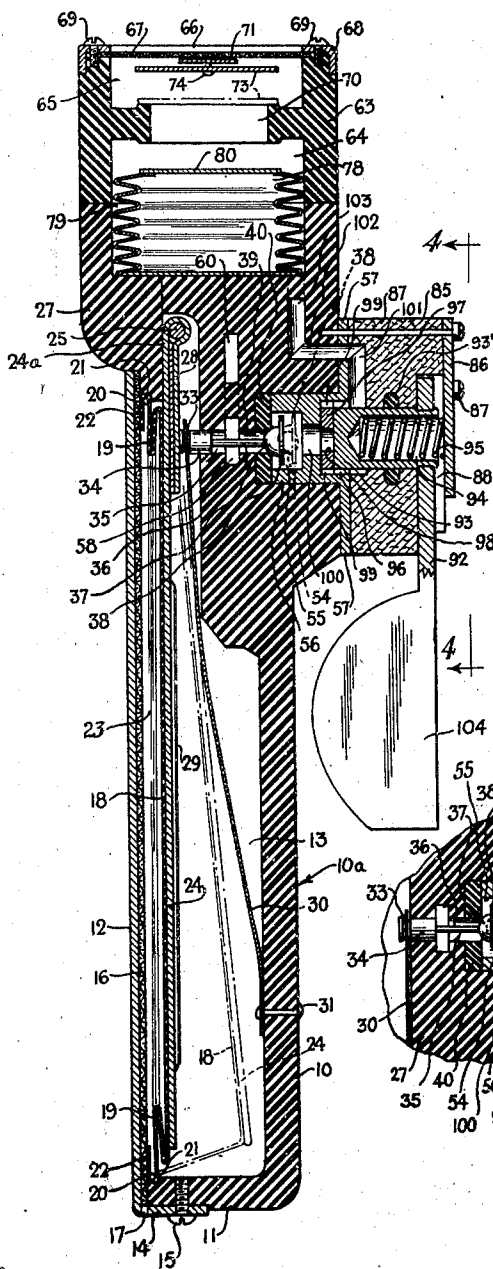


Fig. 4.

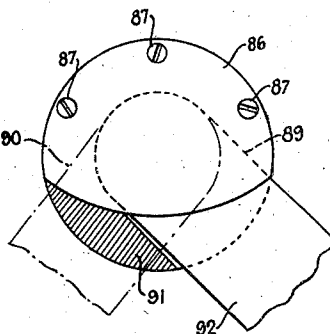


Fig. 5.

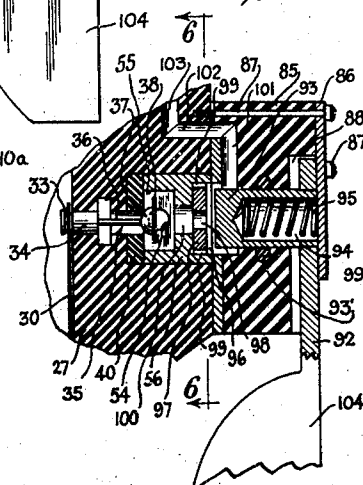
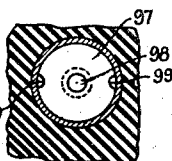


Fig. 6.



Inventor
LEONARD A. WIGGINS

By *Ely & Frye*

Attorneys

Oct. 15, 1946.

L. A. WIGGINS

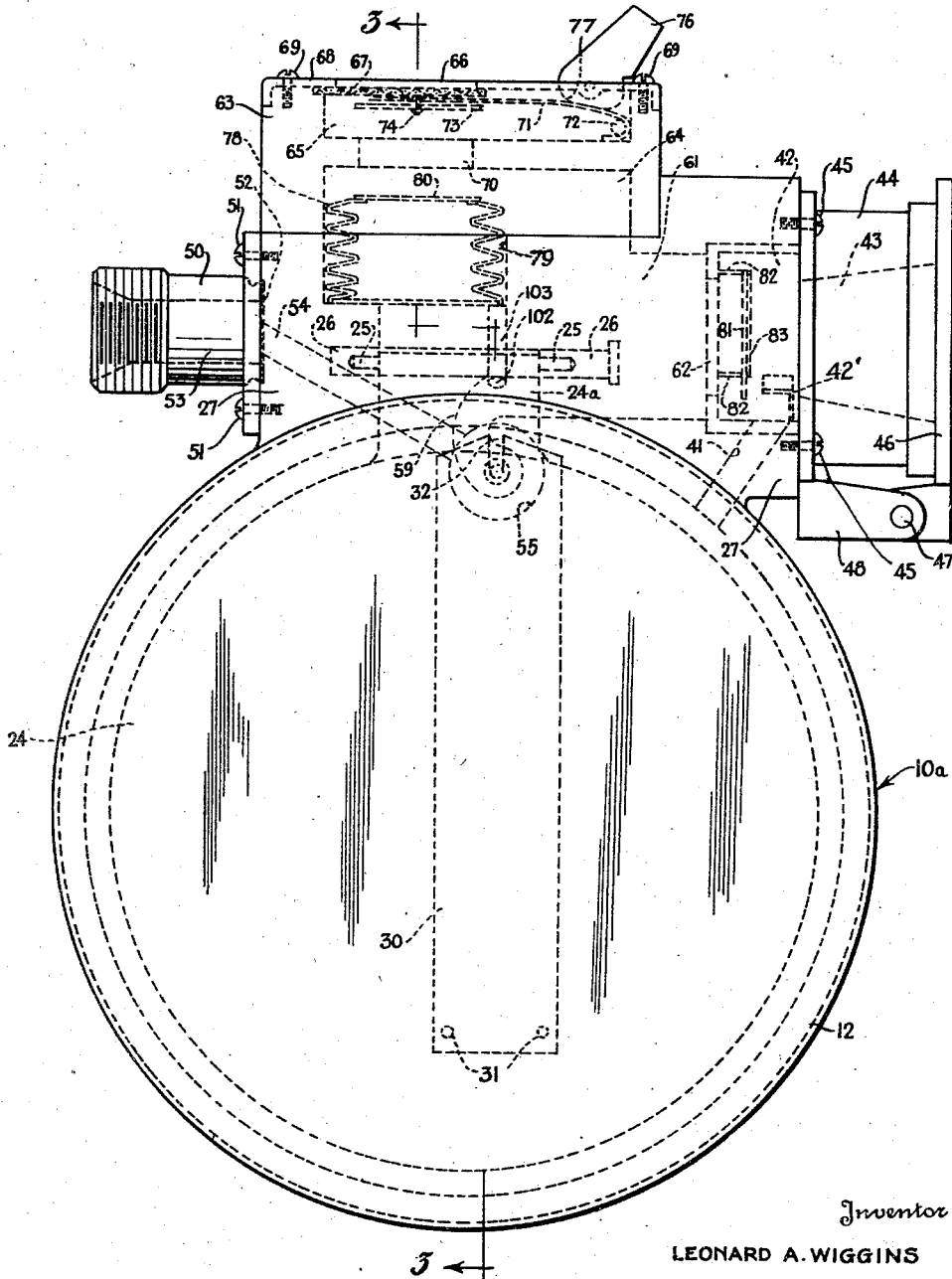
2,409,327

OXYGEN DEMAND REGULATOR

Filed March 2, 1943

4 Sheets-Sheet 3

Fig. 7.



Oct. 15, 1946.

L. A. WIGGINS
OXYGEN DEMAND REGULATOR

2,409,327

Filed March 2, 1943

4 Sheets-Sheet 4

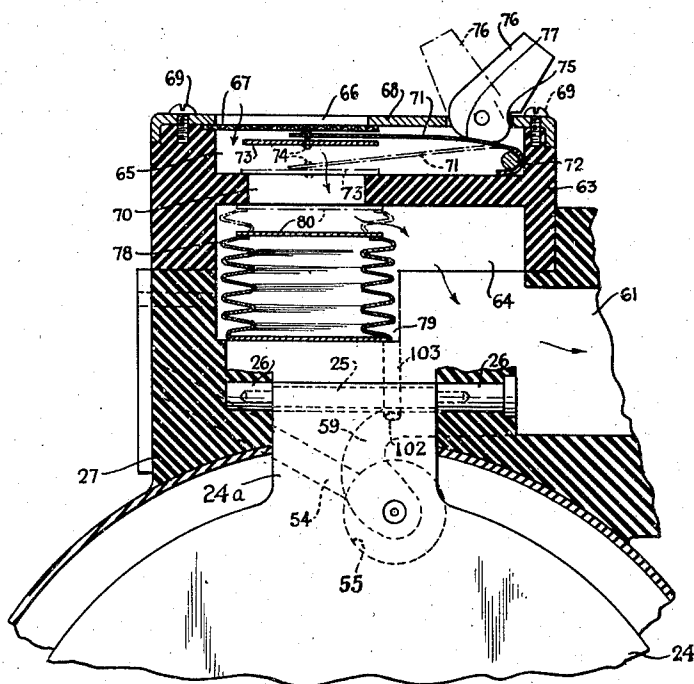


Fig. 8.

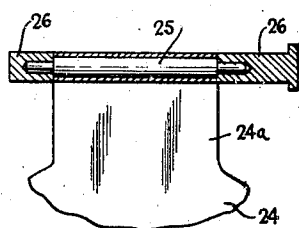


Fig. 9.

Inventor
LEONARD A. WIGGINS

Ely & Faye

Attorneys

UNITED STATES PATENT OFFICE

2,409,327

OXYGEN DEMAND REGULATOR

Leonard A. Wiggins, Cuyahoga Falls, Ohio

Application March 2, 1943, Serial No. 477,775

4 Claims. (Cl. 137-153)

1

This invention relates to improvements in oxygen regulators of the demand type wherein oxygen or a mixture of oxygen and air is passed through a mask into the mouth or nose of a person using the regulator as such person inhales.

More particularly the device is intended for use by persons at high altitudes, such as pilots, crewmembers and passengers of airplanes, but the principles involved are also applicable to supplying oxygen to patients in hospitals, and the mechanism is available to administer certain types of anaesthetics.

There have been several prior devices suggested for use in supplying oxygen to aviators at high altitudes, but for one reason or another these devices have been unsatisfactory. It is very important that the oxygen regulator function properly under all conditions of service, and at high altitudes a failure of the device may result in loss of life in as little as thirty seconds.

It is an object of this invention to provide an oxygen regulator of the demand type which is absolutely reliable under all conditions of service, the oxygen flow being under control so as to furnish the proper amount of mixed air and oxygen at certain altitudes, and to insure an adequate supply of oxygen alone at higher altitudes.

Another object is to provide a regulator of the type referred to having a chamber in which a diaphragm is mounted in a novel manner to cause an oxygen control valve to operate upon inhalation by the user of the device. After the initial operation of the control valve, it is another object to provide for further operation thereof either by continued inhalation, or in the alternative to supplement the action of inhalation by utilizing the oxygen or mixture during its passage to the user as a means for assisting inhalation in operating the valve.

A further object is to provide novel means to insure the presence of sufficient pressure on one side of the diaphragm to operate the control valve, when the pressure on the other side of the diaphragm is reduced either by inhalation alone, or by the latter supplemented by the action of the oxygen or mixture.

A further object is to provide a novel oxygen control valve with positive spring means for seating the valve at all times when it is not unseated by the action of the diaphragm, and to so arrange the valve that pressure of the oxygen tends to seat the valve and to keep it seated.

A further object is to pass the oxygen into a mixing chamber for oxygen and air with a whirling action whereby the motion of the oxygen

2

towards its outlet provides an injector action which tends to draw with it towards the outlet, air admitted into the mixing chamber.

A further object is to provide a novel manually operated means for preventing the admission of air into the device whenever desired, in addition to a Sylphon bellows which automatically controls the admission of air in accordance with the altitude at which the device is operating.

A further object is to provide a novel manually operated emergency valve for by-passing oxygen into the mixing chamber to insure a supply of oxygen for the user of the device in the event anything goes wrong with the regular supply, and this by-pass arrangement can also be used to supplement the regular supply when desired.

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

In the drawings:

Fig. 1 is a rear view of the device with parts broken away.

Fig. 2 is a side view,

Fig. 2a is an enlarged fragmentary section taken substantially on line 2a-2a of Fig. 2,

Fig. 3 is an enlarged vertical section taken substantially on line 3-3 of Fig. 7,

Fig. 4 is an enlarged fragmentary view of a portion of the front of the device looking in the direction of line 4-4 of Fig. 3,

Fig. 5 is an enlarged fragmentary section showing the emergency valve,

Fig. 6 is an enlarged fragmentary section taken substantially on line 6-6 of Fig. 5,

Fig. 7 is an enlarged rear view showing some of the interior parts in broken lines,

Fig. 8 is an enlarged fragmentary section showing the air control mechanism, and

Fig. 9 is an enlarged fragmentary section showing the mounting for the pivoted plate in the diaphragm chamber.

Referring to the drawings the numeral 10 designates the front wall of an annular housing, indicated as a whole by the numeral 10a, and having a side wall 11, which housing is preferably formed of Bakelite or other suitable material. The walls 10 and 11 in conjunction with a rear cover plate 12 define a chamber 13 which will be called the diaphragm chamber. Cover plate 12 is preferably formed of metal and its flange 14 is secured to wall 11 by a plurality of spaced screws 15.

The cover plate 12 holds in place against the end of wall 11, a perforated member such as a screen 16 which is slightly greater in area than

the opening covered by plate 12. As shown in Fig. 3, the flange 14 of plate 12 is provided with a plurality of openings 17 at spaced intervals, which openings are in line with screen 16 and consequently permit communication with the atmosphere through the rear of the housing 10a. These openings 17 are purposely placed in the side of the device to prevent accidental closing thereof which might occur if the openings were in the cover plate proper instead of the flange and the device was being carried in contact with the body of the user or some flat surface.

Inwardly of the screen 16, a rubber diaphragm 18 is arranged in the housing, being folded at its edges 19 and having an annular bead 20, preferably formed of wire or other inextensible material, which fits snugly in a cut-out portion 21 formed in wall 11 adjacent screen 16, leaving the end 22 of the diaphragm extended beyond the bead and in engagement with screen 16. This arrangement provides a snug fit for the diaphragm against the screen and permits the atmosphere, through openings 17, to communicate only with the space 23 between the cover plate 12 and the wall of the diaphragm.

The front surface of diaphragm 18 is in engagement with one face of an annular metal plate 24 having an upper extension 24a which is pivoted on pin 25 mounted in oilite bearings 26 carried in an extension 27 of the annular housing 10a. Extension 24a is folded over pin 25 and downwardly upon itself as indicated at 28 (Fig. 3) and plate 24 may be corrugated as at 29 to strengthen same. The area of the pivoted plate 24 is preferably slightly less than the area of the face of the diaphragm in engagement therewith so that all movement of the diaphragm toward plate 24 will instantly move the latter with the diaphragm without any lost motion.

On the inner face of wall 10, the lower end of a flat spring 30 is secured by means of bolts 31 or the like, while the upper end of this spring is bifurcated as at 32 (Fig. 7) to fit into a groove 33 formed in the valve head 34 of an oxygen control valve, indicated as a whole by the numeral 35. The outer end of valve head 34 is in engagement with the upper portion of the pivoted plate 24 just below the pivot pin 25 and spring 30 has a normal bias tending to maintain this engagement by constantly urging valve 35 toward the left as viewed in Fig. 3.

Valve 35 is preferably formed of a suitable metal and in addition to its head 34, comprises a stem 36 to which is connected the valve body 37 which is formed semi-spherical adjacent the stem and has an enlarged flattened end 38. The valve head 34 is slidable in a passage 39 and closes one end of this passage at all times to prevent oxygen from entering chamber 13. The opposite end of passage 39 is surrounded by an apertured valve seat 40, preferably formed of rubber, the arrangement being such that when the semi-spherical portion of valve 35 is in engagement with the valve seat 40, as shown in full lines in Fig. 3, oxygen cannot pass into passage 39. It will be noted that spring 30, in addition to holding the valve head 34 against the plate 24, also serves to keep valve 35 tightly seated when the diaphragm is in the full-line position of Fig. 3. The flattened end 38 prevents fluttering of the valve and provides an enlarged surface against which the pressure of the flow of oxygen seeking to pass valve 35 will be exerted, thus enabling the oxygen pressure to supplement the action of spring 30 in seating the valve and keeping it

seated. In the event the spring 30 should break, the flow of oxygen will be sufficient to cause the valve to seat.

Leading from chamber 13 through extension 27 of housing 10a is a passage 41 (Fig. 7) that communicates at its upper end with an outlet chamber 42, which in turn communicates with a passage 43 in an outlet fitting 44 secured to the housing extension 27 as by means of bolts 45. The outlet fitting 44 is adapted to be closed, when not in use, by means of a cover plate 46, pivoted at 47 to the outer end of a pair of spaced ears 48 carried below the fitting 44. Cover plate 46 can be swung downwardly, as in Figs. 1 and 2, and a nozzle member 49 forced into tight engagement with the fitting 44. This nozzle member is connected to one end of a hose (not shown) the other end of which leads into a face mask (not shown) in the usual manner.

To initially operate valve 35, the wearer of the mask inhales through the hose, which action, through the medium of passages 41 and 43 and outlet chamber 42, causes at least a partial evacuation of chamber 13 on one side of the diaphragm 18. This results in a lowering of the pressure on one side of the diaphragm while the pressure in space 23 on the other side thereof is not changed. Hence, there will be greater pressure on the latter side of the diaphragm which will cause the diaphragm to enlarge and move to approximately the broken-line position shown in Fig. 3. Movement of the diaphragm will move the pivoted plate 24 to approximately its broken-line position, which movement will slide valve 35 to its broken-line position and permit oxygen to flow past the valve into passage 39. It will be apparent that at any time the spring 30 exerts a greater force on plate 24 than the diaphragm exerts thereon, valve 35 and plate 24 will be returned to their starting position. For this reason the spring 30 should not be so strong as to prevent the operation of the diaphragm when there is pressure per square inch acting on the diaphragm equivalent to about $1/10$ of an inch water pressure or greater.

Oxygen is supplied to the device from a suitable source (not shown) and any conventional means may be utilized for reducing the pressure of the oxygen, which is usually at about 500 lbs. per square inch, to about 25 lbs. per square inch, as my device will readily operate with oxygen at such reduced pressure. A supply hose (not shown) is connected to an inlet fitting 50 secured as by screws 51 to extension 27 of housing 10a, preferably on the opposite side from the outlet fitting 44. A screen 52 may be placed at the end of the passage 53 in the fitting 50 to prevent the entrance of any foreign matter into the passage.

From the inner end of passage 53, oxygen is conducted through a passage 54 in extension 27, which latter passage leads downwardly into an oxygen chamber 55 formed in an annular casting 56 having flanges 57 for securing the casting to the housing extension 27. The inner end of casting 56 engages the rubber valve seat member 40 whereby when valve 35 is unseated, oxygen will flow from chamber 55 into passage 39.

Passage 39 communicates with the lower end 58 of an arcuate passage 59 (Figs. 7 and 8), the upper end 60 of which is in communication with a mixing chamber 61 formed in housing extension 27. Mixing chamber 61 communicates with

5

outlet chamber 42 through a reduced opening 62 formed between these two chambers.

Means are provided for permitting the entrance of air into the mixing chamber 61 and for this purpose a rectangular block 63 is suitably secured on the upper end of housing extension 27. Block 63 has a rectangular shaped opening 64 in its lower portion which communicates with chamber 61, and a similar opening 65 in its upper portion which communicates with the atmosphere through a smaller opening 66, which may be covered by a screen 67 to prevent the entrance of any foreign matter with the air. Screen 67 is held in place by a flanged cover plate 68 secured to the block 63 by screws 69. Openings 64 and 65 communicate with each other through a small annular opening 70.

The upper opening 65 in block 63 has one end of a flat spring 71 secured therein by means of a pin 72 suitably mounted in the block, and the other end of this spring is connected to a disc 73 formed of mica or Bakelite or other suitable material, the connection being through a somewhat elongated pin 74 that will allow the disc 73 to remain in a position to close opening 70 when moved from the full-line position to the dotted-line position shown in Fig. 8. Cover plate 68 is provided with an opening 75 (Fig. 8) in which is pivoted a cam lever 76 having a flat cam surface 77 on its lower end, which surface engages spring 71. When lever 76 is in the full-line position of Fig. 8, the spring 71 and disc 73 are in their full-line or raised positions, so that admission of air to chamber 61 is permitted. But when lever 76 is turned to its broken-line position in Fig. 8, spring 71 and disc 73 will be depressed to the broken-line position to shut off the passage of air to the mixing chamber 61. Thus, the user of this device can manually close or open the air passage to the atmosphere.

When the manual control is arranged to permit air to enter the device, I also provide an automatic control for the air in the form of a Syphon bellows 78, the operation of which is well understood in this art. To accommodate this bellows a socket 79 is arranged in housing extension 27 to receive the lower end of the bellows. Socket 79 communicates with opening 64 in block 63 whereby the bellows in its unexpanded position will extend into opening 64 below opening 70. The bellows will gradually expand, due to decrease in atmospheric pressure as a user of the device ascends to higher altitudes, and the present bellows is intended to vary from an unexpanded position which is maintained from sea level to about 5000 feet to a fully expanded position at about 30,000 feet. When fully expanded the disc 80 on the upper surface of the bellows will close opening 70 and prevent the entrance of air into the device, as indicated in broken lines in Fig. 8. Thus, the user of my device is furnished with a controlled supply of air that is diminished during ascent and increased during descent.

As previously mentioned, the oxygen enters the mixing chamber through the arcuate passage 59, which passage concentrates and whirls the oxygen toward the outlet chamber 42, the movement of the oxygen being in such manner that an injector action is produced whereby the oxygen tends to draw the air with it toward the outlet chamber 42. This injector action continues as long as air is admitted to the mixing chamber but will not be effective when only oxygen is admitted.

6

It will be apparent from the foregoing that either oxygen or a mixture of air and oxygen is directed through the outlet chamber 42 and into the mask of the user of the device whenever the control valve 35 is unseated, and the action of the latter valve under normal use will follow the breathing of the user, opening during inhalation and closing during exhalation.

In Figs. 2 and 7 I have shown an arcuate baffle 42' arranged in outlet chamber 42 adjacent the end of passage 41. This baffle is used when it is desired to have the diaphragm 18 operate solely by inhalation of the user, and when it is omitted, as in Fig. 2a, the action of the oxygen or mixture of air and oxygen as it passes through outlet chamber 42 toward the user's mask, will draw gas from diaphragm chamber 13 through passage 41 and thus supplement the action of inhalation in evacuating chamber 13.

When baffle 42' is omitted the action of the oxygen or mixture in drawing gas from chamber 13 reduces the suction required to operate valve 35 by inhalation (after the initial opening of valve 35 by inhalation), which reduces the pressure on the lungs of the user, and this becomes quite a factor when the device is used for long periods of time, more particularly at high altitudes. Also omission of the baffle allows flow of the oxygen mixture to build up a positive pressure in the hose and mask. This positive pressure is desirable under certain conditions at high altitudes. When the baffle is used it intercepts the flow of the oxygen or mixture out of chamber 42 and produces small eddy currents in the region of passage 41 which eliminate any tendency of the oxygen or mixture to draw gas through passage 41. Whether or not the baffle is used, valve 35 will close during exhalation. The use of baffles of varying sizes will produce conditions between the two extremes mentioned.

In the outlet chamber 42 means are provided to close the opening 62 in the event gases of exhalation seek to enter the mixing chamber 61. This means comprises a vertical disc 81, movably mounted on a plurality of pins 82, in this instance three, which are secured in housing extension 27 and extend into chamber 42 at spaced points around opening 62, the outer ends of these pins being connected by a spider member 83 which prevents movement of disc 81 beyond the spider. Disc 81 is normally in the full-line position shown in Fig. 2a and under normal operation, exhaled gases will have been passed out of the system through an exhaling valve (not shown) located adjacent the bottom of the face mask, or at some other point in the system. If, however, the exhaling valve should fail to function and the exhaled gases pass down the hose line leading to the outlet chamber 42, such gases will strike the disc 81 and move it to the broken-line position of Fig. 2a, shutting off the opening 62 and thereby preventing the entrance of such gases into the mixing chamber. In this manner, very little, if any, contamination of the oxygen or the mixture of air and oxygen in the mixing chamber by gases of exhalation is permitted.

We come now to the emergency valve which is located in the front of the device. As more clearly shown in Figs. 3, 4 and 5, an annular extension 85, preferably formed of Bakelite is placed outwardly of flange 57 on casting 56, and the latter, extension 85 and a cover plate 86 are secured to housing extension 27 by means of a plurality of spaced bolts 87. The outer face of extension member 85 is cut away to form a space

88. which is partially covered by the cover plate 86, said space 88 extending from line 89 to line 90 as shown on Fig. 4. A raised area 91, shown shaded on Fig. 4, and preferably raised about $\frac{3}{4}$ of an inch, is formed on the lower left-hand surface of the front face of extension 85 for a purpose to be described.

Mounted in the cut-away portion 88 is the flat upper end of a small handle 92 secured to a stub shaft 93 which is rotatable in a central opening formed in extension 85, said shaft being preferably surrounded with a rubber sealing ring 93'. Shaft 93 has a longitudinal opening 94 extending from its outer end to a point adjacent its inner end and a small coil spring 95 is arranged in this opening, said spring bearing at its outer end against cover plate 86 and at its inner end against the rear wall of the opening 95.

Shaft 93 acts as a valve and its inner end extends into an opening 96 formed in casting 56, and in the position shown in Fig. 3 engages one face of a preferably rubber washer or valve seat 97 having a central aperture 98 and additional apertures, which in this instance are oppositely disposed side apertures 99 cut in the outer peripheral portion of the washer. The central aperture 98 is in communication with the oxygen chamber 55 by means of a small opening 100 formed in casting 56, but oxygen cannot pass into opening 96 as long as the parts are in the position shown in Fig. 3, with shaft 93 closing aperture 98 and with casting 56 serving to close apertures 99.

Leading from opening 96 is a passage 101 formed in extension 85 which communicates with a passage 102 extending through flange 57 and into housing extension 27, the latter passage in turn communicating with a passage 103 which leads to the mixing chamber 61.

The emergency valve is operated by turning handle 92 from the full-line to the broken-line position shown in Fig. 4. Since the need for this emergency valve usually arises, if at all, at high altitudes, and since the user is ordinarily equipped with heavy gloves, I provide means to facilitate turning handle 92 with such gloves. Such means comprises wide wing portions 104 formed on the lower end of handle 92, and these wing portions can be quickly contacted by a gloved hand to operate the emergency valve.

When the handle 92 is turned to the broken-line position of Fig. 4, it moves outwardly about $\frac{3}{4}$ of an inch upon engaging the raised surface 91 and moves the shaft 93 forwardly against the action of spring 95 for about the same distance so that the parts are approximately in the position shown in Fig. 5. When the parts are in the latter position oxygen will pass from chamber 55 through opening 100, through one or more of the openings in valve seat 97 into opening 96, from which it is free to enter mixing chamber 61 through the passages 101, 102 and 103. Thus, an emergency supply of oxygen is provided which will pass from the chamber 61 through the hose leading to the mask of the user of the device.

To shut off the emergency valve, it is only necessary to return handle 92 to its full-line position in Fig. 4, at which time spring 95 acting against plate 86 will move shaft 93 tightly against valve seat 97 and shut off the flow of oxygen.

There are several features in connection with this emergency valve which are believed worthy of note. The handle 92 can be quickly manipulated by a user of the device and it is frictionally held in its broken-line position by its engage-

ment with the area 91, this frictional engagement being sufficient to prevent accidental movement of the handle unless the latter is subjected to a relatively substantial force. In other words, it is easier to move the handle to open the valve than to close it, and this is desirable because the emergency valve is needed quickly, if at all, but there is seldom any need to rush the closing operation.

Another feature of this emergency valve resides in the provision of the washer or valve seat 97 having peripheral openings in addition to the central opening. If only the central opening is provided, as is customary, movement of the device to different positions by the user or by action of the aircraft carrying the user, might jam the member 97 against the end of shaft 93 and thus shut off the flow of oxygen through the central aperture 98. Since, however, the outside diameter of member 97 is greater than the diameter of shaft 93, and the apertures 99 are located in the periphery of member 97 so as to allow passage of oxygen past the end of shaft 93, it is impossible for the flow of oxygen to be shut off regardless of the position occupied by member 97 while the valve is open. Thus, the emergency valve can be said to be fool-proof.

It is believed to be apparent that the invention is well calculated to secure the objects and advantages intended, and while I have shown and described the preferred form of the invention it will be obvious that modifications may be made therein without departing from the spirit of the invention or from the scope of the subjoined claims.

What is claimed is:

1. In a regulator of the character described having at least an inlet chamber and an outlet chamber and a valve between said chambers, a diaphragm chamber, a diaphragm mounted in said chamber and operable by atmospheric pressure to open said valve, and means to insure the provision of such pressure comprising a perforated member arranged between said diaphragm and a wall of said diaphragm chamber, a different wall of said diaphragm chamber being provided with a plurality of openings leading to the atmosphere adjacent said perforated member.

2. In a regulator of the character described having at least an inlet chamber and an outlet chamber and a valve between said chambers, a diaphragm chamber, a diaphragm mounted in said chamber and operable by atmospheric pressure to open said valve, and means to insure the provision of such pressure comprising a screen arranged between said diaphragm and the rear wall of said diaphragm chamber, the side wall of said diaphragm chamber being provided with a plurality of openings leading to the atmosphere adjacent said screen, whereby said openings will not be accidentally closed when the regulator is worn against the body of the user.

3. In a regulator of the character described having a chamber adapted to receive gas under pressure, a control valve in said chamber preventing the flow of said gas out of said chamber when seated, a diaphragm chamber, a diaphragm mounted in said chamber and being expandable by differential pressure between the sides thereof, a pivoted plate in constant engagement with said valve, said plate being movable upon expansion of said diaphragm to unseat said valve and allow said gas to leave said first-named chamber, spring means acting on said valve to

9

seat same whenever the force exerted by said spring is greater than the force expanding said diaphragm, the gas flow and pressure in said first-named chamber supplementing the action of said spring, said force acting to expand said diaphragm being atmospheric pressure, and means to insure the provision of such atmospheric pressure comprising a perforated member arranged between said diaphragm and a wall of said diaphragm chamber, a different wall of said diaphragm chamber being provided with a plurality of openings leading to the atmosphere adjacent said perforated member.

4. In a regulator of the character described having a chamber adapted to receive gas under pressure, a control valve in said chamber preventing the flow of said gas out of said chamber when seated, a diaphragm chamber, a diaphragm mounted in said chamber and being expandable by differential pressure between the sides thereof, a pivoted plate in constant engagement with

10

said valve, said plate being movable upon expansion of said diaphragm to unseat said valve and allow said gas to leave said first-named chamber, spring means acting on said valve to seat same whenever the force exerted by said spring is greater than the force expanding said diaphragm, the gas flow and pressure in said first-named chamber supplementing the action of said spring, said force acting to expand said diaphragm being atmospheric pressure, and means to insure the provision of such atmospheric pressure comprising a screen arranged between said diaphragm and the rear wall of said diaphragm chamber, the side wall of said diaphragm chamber being provided with a plurality of openings leading to the atmosphere adjacent said perforated member, whereby said openings will not be accidentally closed when the device is worn against the body of the user.

LEONARD A. WIGGINS.