Nov. 26, 1957 B. B. HOLMES 2,814,291

RESPIRATORY APPARATUS

Filed April 25, 1952 3 Sheets-Sheet 1

FIG. 1

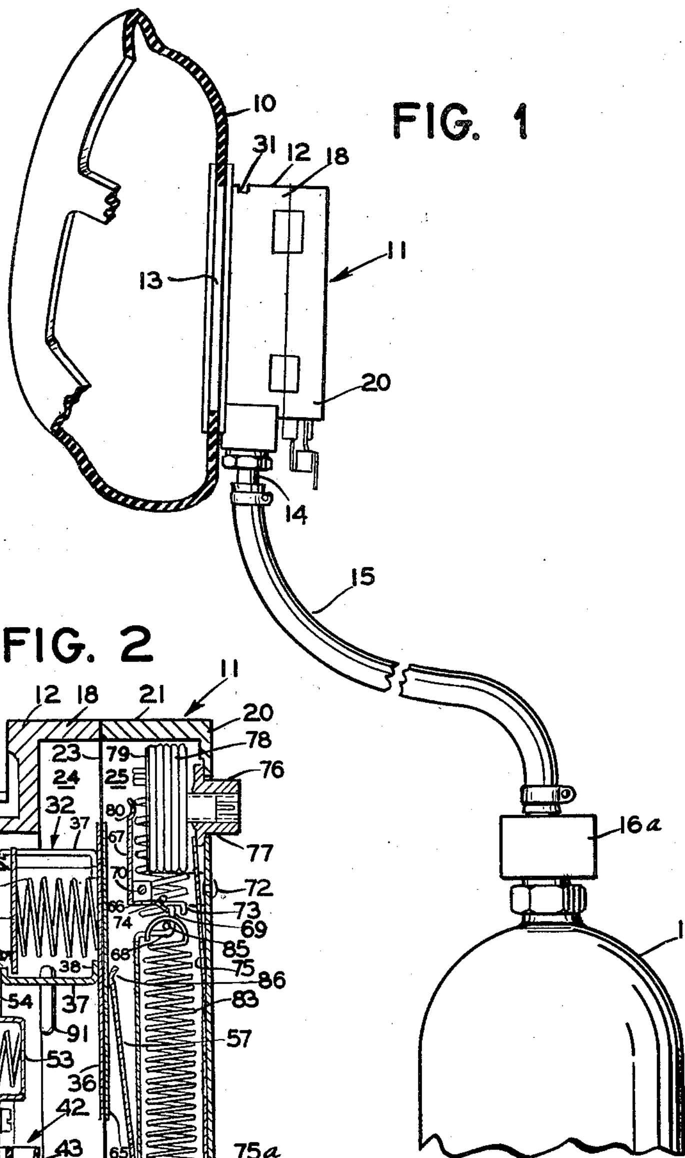
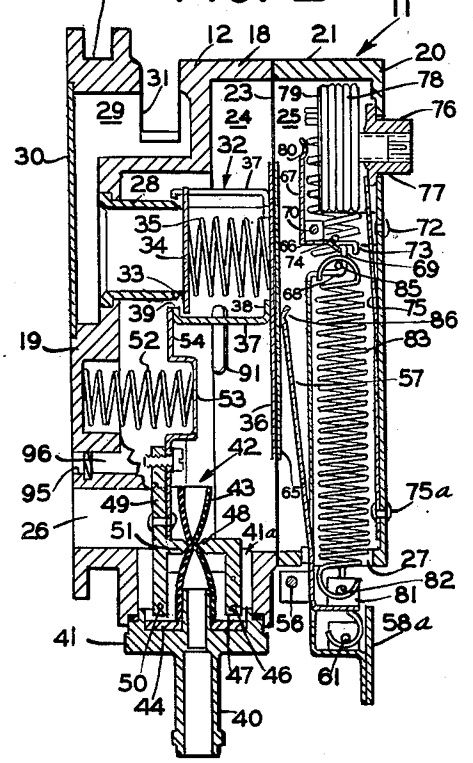


FIG. 2



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Nov. 26, 1957 B. B. HOLMES 2,814,291

RESPIRATORY APPARATUS

Filed April 25, 1952 3 Sheets-Sheet 2

FIG. 3

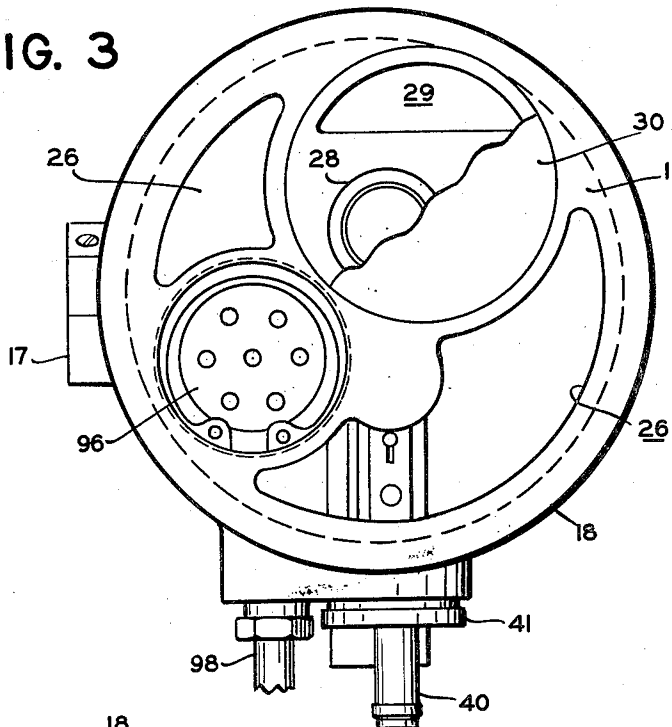
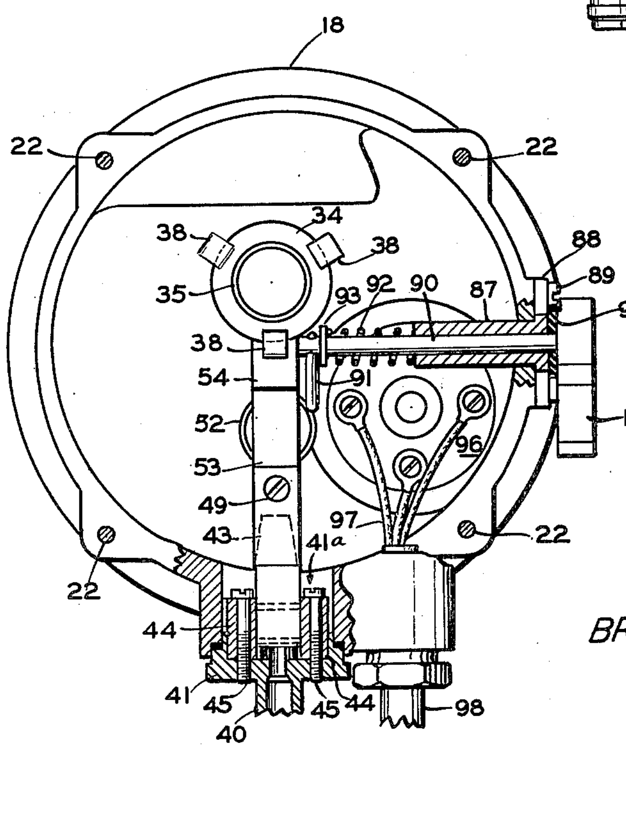


FIG. 4



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RESPIRATORY APPARATUS

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FIG. 5

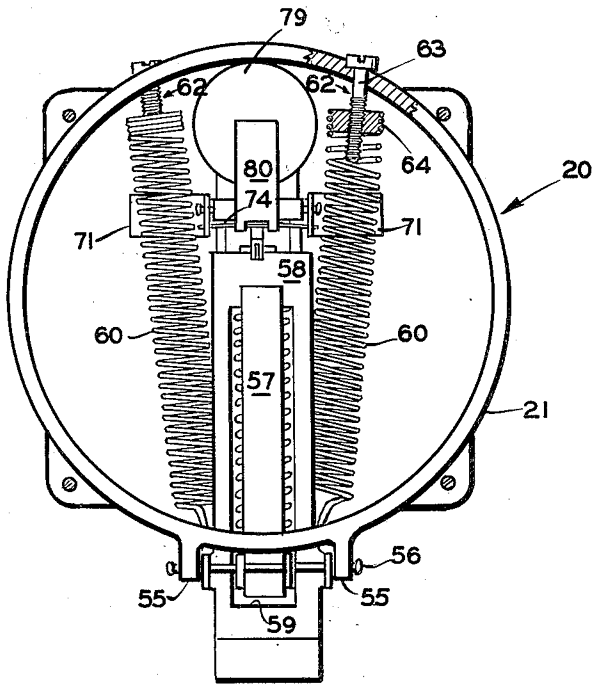
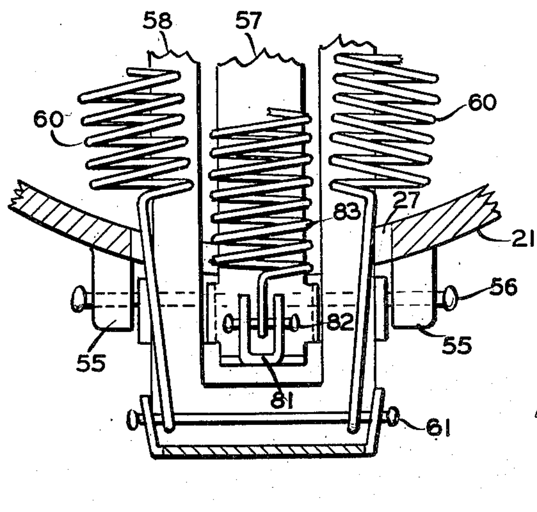


FIG. 6



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2,814,291

RESPIRATORY APPARATUS

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Application April 25, 1952, Serial No. 284,333

9 Claims. (Cl. 128—142)

This invention in general relates to respiratory apparatus and more particularly to a novel demand regulator for controlling the delivery of respirant gases to an aviator's breathing mask.

With the advent of prolonged high altitude flights it has become common practice to equip the aviator with a breathing mask to which is supplied the oxygen required to sustain life at high altitude. The oxygen supply system usually comprises one or more bottles, or flasks, of compressed oxygen that are carried by the aircraft, and a demand regulator that is operated by the breathing of the aviator to control the quantity and pressure of the oxygen delivered from the bottles to the mask.

The present invention contemplates and has for one of its objects, the provision of a novel demand regulator that is constructed and arranged to be carried by, and form a part of an aviator's breathing mask and which includes a novel demand valve, that is operated in response to the aviator's breathing to regulate the quantity and pressure of oxygen supplied to the breathing mask.

A further object of the instant invention is to conserve the supply of oxygen available for use by the aviator and to that end the novel demand regulator contemplated herein embodies means whereby ambient air may be supplied to the breathing mask. Thus, at altitudes where the ambient air contains sufficient oxygen to maintain normal human efficiency, for example, at altitudes below 10,000 feet, the regulator is adjustable to permit the aviator to breathe the ambient air.

The present invention also has for one of its objects the provision of means for preventing the dilution of the oxygen supplied to the breathing mask. To this end, the instant demand regulator embodies novel means whereby, when oxygen is supplied to the mask, the demand valve is actuated so as to maintain within the mask a slight positive pressure relative to ambient atmospheric pressure, to thereby prevent any inward leakage of ambient air into the mask and the consequent dilution of the oxygen supplied thereto.

A still further object of the instant invention is to provide means whereby at relatively high altitudes, for example, in excess of 40,000 feet, the oxygen supplied to the mask may be forced into the lungs of the aviator. Therefore, the novel demand regulator contemplated herein embodies means that is automatically responsive to the ambient atmospheric pressure at a predetermined altitude to actuate the demand valve so as to build up the pressure of the oxygen within the regulator and mask to a value where the oxygen will be forced into the lugs of the aviator.

To provide means for conserving the supply of oxygen and to permit comfortable descent from relatively high altitudes, the novel regulator hereof also embodies means for resetting, or readjusting the atmospheric pressure responsive means to thereby discontinue the high pressure of oxygen within the mask.

The foregoing and other objects and advantages of the instant invention will appear more fully hereinafter

from a consideration of the detailed description which follows, taken together with the accompanying drawings wherein one embodiment of the invention is illustrated by way of example. It is to be expressly understood, however, that the drawings are for the purpose of illustration only, and are not to be construed as defining the limits of the invention.

Referring to the drawings wherein like reference characters designate like parts throughout the various views:

Fig. 1 is a schematic illustration, partially in section, showing the novel regulator contemplated herein associated with an aviator's breathing mask and connected to a source of oxygen;

Fig. 2 is a longitudinal section through the regulator;

Fig. 3 is an end view of the regulator as seen from the interior of the mask;

Fig. 4 is an elevational view of the regulator, partially in section, with the cover and diaphragm removed;

Fig. 5 is an elevational view of the inside of the cover; and

Fig. 6 is a fragmentary view, partially in section showing the mounting of the primary and secondary levers to the cover.

Referring now to the drawing and particularly Fig. 1, the reference character **10** indicates a breathing mask of the type that is adapted to be secured to the face of an aviator. The novel demand regulator contemplated herein, and indicated generally by the reference character **11**, includes a casing **12** having a peripheral groove **13** whereby regulator **11** is mounted within a suitable opening formed in mask **10**. When so mounted, regulator **11** is disposed in front of the mouth and nose of the aviator's face. Regulator **11** is provided with an inlet fitting **14** which communicates through a suitable conduit **15** with a source of gaseous oxygen contained in a bottle **16** carried by the aircraft. A pressure reducer **16*a*** in the line **15** between bottle **16** and regulator **11** serves to supply constant pressure, low pressure oxygen gas to inlet **14**. As will hereinafter be more fully set forth, regulator **11** also includes a lever **17** (Fig. 4) which is effective in one position, to operate regulator **11** so as to communicate the interior of mask **10** with ambient atmosphere, while in a second position thereof, regulator **11** becomes effective to deliver oxygen from bottle **16** to mask **10** in response to the aviator's breathing.

Referring now to Fig. 2 wherein the details of construction and arrangement of regulator **11** are shown, casing **12** includes a substantially hollow cylindrical body **18** having a wall **19** disposed across one end while the opposite, or open end thereof is closed by a cap, or cover **20** having a cylindrical side wall **21** that is adapted to mate with the open end of body **18**. Cover **20** is removably secured to body **18** by suitable fastening means such as bolts **22** (Fig. 4). When cover **20** is secured to body **18** the mating edges of body **18** and side wall **21** of cover **20** cooperate to clampingly secure therebetween the peripheral portion of a flexible diaphragm **23**.

Diaphragm **23** serves to divide the interior of casing **12** into a first chamber **24** defined by body **18**, wall **19** and diaphragm **23** and a second chamber **25** defined by cover **20**, the side wall **21** thereof and diaphragm **23**. Chamber **24** communicates by way of suitable ports, or openings **26** formed in end wall **19** with the interior of mask **10**, while chamber **25** communicates with atmosphere through a suitable opening **27** formed in end wall **21** of cover **20**. Therefore, diaphragm **23** serves as a common wall between chambers **24** and **25** and since these chambers communicate with the interior of mask **10** and ambient atmosphere, respectively, it is manifest that diaphragm **23** is moved in response to a pressure differential produced between chambers **24** and **25** by the respiration of the aviator wearing mask **10**. Thus, upon an exhalation by the aviator, the pressure in chamber 24 rises to a value above that of the ambient atmospheric pressure in chamber 25 and diaphragm 23 moves outwardly or in the direction of cover 20. Conversely, upon an inhalation by the aviator the pressure in chamber 24 is reduced to a value below that in chamber 25 and diaphragm 23, therefore, moves inwardly of chamber 24 in the direction of end wall 19.

Chamber 24 also communicates through a tubular member 28 mounted through end wall 19 with a chamber 29 formed in end wall 19. Chamber 29 is closed to the interior of mask 10 by a plate 30 that is secured at its peripheral portion to end wall 19 by suitable fastening means, not shown. Chamber 29, in turn, communicates with the exterior of casing 12 through a slot 31 formed through regulator body 18. Thus, a passageway between chamber 24 and the exterior of casing 12 is provided comprising member 28, chamber 29 and slot 31.

Communication between chamber 24 and the exterior of casing 12 through the aforenoted passageway is controlled by a vent valve assembly generally indicated by the reference character 32. To form vent valve assembly 32, tube 28 is extended partially into chamber 24 and the end of tube 28 disposed therein is provided with an annular valve seat 33. A valve disc 34 is biased into a sealing engagement with valve seat 33 by a spring 35 that is operatively positioned between the upstream side of disc 34 and a bearing plate 36 that is suitably secured to the central portion of diaphragm 23. Valve disc 34 has a greater diameter than its coacting valve seat 33 to the end that the edge of disc 34 extends outwardly beyond the limits of seat 33. A plurality of fingers 37, having inwardly disposed lateral flanges 38 and 39 at the oposite ends thereof are secured by flanges 38 to bearing plate 36. Fingers 37 are disposed so that the flanges 39 thereof are engageable with the edge of disc 34 at the downstream side thereof. Moreover, the length of each finger 37 is such that when diaphragm 23 is in a null position as shown in Fig. 2, lateral flanges 39 are slightly spaced from and out of contact with disc 34 to the end that spring 35 is free to engage disc 34 with its coacting seat 33 to close communication through member 28.

Due to the foregoing construction and arrangement of parts, when diaphragm 23 is actuated to move outwardly, i. e., in the direction of cover 20, lateral flanges 39 of fingers 37, engage disc 34 and lift the same off its coacting seat 33 against the bias of spring 35 thus opening chamber 29 to chamber 24 and communicating the latter through chamber 29 and tube 28 with the exterior of casing 12. On the other hand, an inward movement of diaphragm 23 from a null position causes lateral flanges 39 to move further away from disc 34 and at the same time spring 35 is further compressed to increase the sealing engagement of disc 34 with its coacting seat 33.

As hereinbefore set forth, gaseous oxygen is supplied from bottle 16 through conduit 15 to inlet fitting 14 of regulator 11. Inlet 14 includes an inlet pipe 40 to which conduit 15 is connected and a mounting flange 41 formed thereon is secured to body 18 by suitable means, not shown. Flange 41 serves to close the outer end of an opening 41*a* formed in body 18 and which communicates at the inner end thereof with chamber 24.

Demand valve means 42 are provided to control the flow of oxygen through inlet fitting 14 into chamber 24. To that end, pipe 40 is extended partially into opening 41*a* and a section of resilient tubing 43, made of soft rubber or a like material, is sealingly secured thereto so as to form a continuation of pipe 40 that extends partially into chamber 24. A support block 44, mounted to the inner side of flange 41 by bolts 45 (Fig. 4) has fixedly secured to one side thereof by pins 46, a member 47 having a laterally disposed clamping jaw 48. A lever 49, pivotally mounted at one end by a pin 50 to the opposite side of block 44 is also provided with a clamping jaw 51. Fixed and movable jaws 48 and 51, respectively, are disposed relative to each other and to tube 43 so as to be engageable with tube 43 on diametrically opposite sides thereof and medially of its length. Lever 49 extends into chamber 24 and a spring 52 operatively positioned between end wall 19 and a U-shaped recess 53 formed on lever 49 biases the latter in a direction whereby jaw 51 is moved toward jaw 48 to the end that tube 43 is clamped therebetween to close the same and prevent oxygen from entering chamber 24. The inner, or free end 54 of lever 49 is engaged with a lateral flange 39 of one of the fingers 37. It is noted, that when jaws 51 and 48 are cooperating to close tube 43, end 54 of lever 49 contacts flange 39 but there is no load transmitted from spring 52 through lever 49 to finger 37.

As shown in Figs. 5 and 6, cover 20 has formed thereon a pair of spaced, outstanding lugs 55 that are disposed on either side of opening 27 which carry a pivot pin 56. Primary and secondary levers 57 and 58 are mounted, adjacent to the outer end thereof, for independent pivotal movement about pin 56 and extend through opening 27 into cover 20. To accommodate this mounting and pivotal movement of levers 57 and 58, the latter is provided with a rectangular opening 59.

A pair of tension springs 60 secured at one end to a transverse pin 61 carried by the outer end of secondary lever 58 extend through opening 27 and across the interior of cover 20 where the opposite ends thereof are secured to adjustment members 62. Each adjustment member 62 comprises a bolt 63 rotatably mounted through side wall 21 and a nut 64 to which springs 60 are secured. By rotating bolt 63 in the proper direction, nut 64 is moved on bolt 63 so as to adjust the tension of springs 60. Springs 60 tend to pivot lever 58 about pin 56 in a direction whereby the inner end of lever 58 engages a second bearing plate 65 secured to the central portion of diaphragm 23.

To prevent the aforenoted pivotal movement of lever 58 until such time as it is desired, the inner end of lever 58 is constructed and arranged to engage an arm 66 of a bellcrank 67. More particularly, the inner end of lever 58 is first bent at right angles to the length of lever 58 to form a transverse portion 68 and then bent at right angles to portion 68 to form a lateral extension 69 that engages the outer end of arm 66 of bellcrank 67. Bellcrank 67 is mounted for pivotal movement about a pin 70 that is carried in a pair of spaced brackets 71. Brackets 71 are secured by rivets 72 to the inner side of cover 20. Adjacent the outer end thereof, arm 66 is provided with a right angle extension 73, and a spring wire 74 carried by brackets 71 engages arm 66 at the point where extension 73 is joined thereto. Spring 74 biases bellcrank 67 in a clockwise direction, as shown in Fig. 2, to the end that the outer end of arm 66 is maintained in engagement with the end of extension 69.

Cover 20 has also mounted therein a leaf spring 75 that is secured at one end by a rivet 75*a* to the inner surface of cover 20. At the other end thereof, spring 75 engages and supports a cap or button 76 that extends partially through an opening 77 formed in cover 20, to the exterior of said cover. An aneroid 78 mounted on button 76 is positioned within cover 20 so as to have the end plate 79 thereof adjacent to and engageable with arm 80 of bellcrank 67.

Primary lever 57 is provided adjacent its outer end with a U-shaped bracket 81 which carries a transverse pin 82. A tension spring 83 secured at one of its ends to pin 82 extends through opening 27 into cover 20 where the opposite end thereof passes through a slot formed in transverse portion 68 and extension 69 of lever 58 and engages with a cross pin 85. Cross pin 85 is held in engagement with transverse portion 68 of lever 58 by the tension of spring 83. Spring 83 serves to bias primary lever 57 in a direction whereby the free end 86 thereof engages bearing plate 65 of diaphragm 23.

As hereinbefore set forth, regulator **11** is provided with a lever **17** which is operable in one position to permit the ambient air to be delivered to mask **10**, while a second position of lever **17** adjusts regulator **11** to the end that oxygen is delivered to mask **10**. More particularly, as shown in Figs. 2 and 4, a sleeve **87** having a flange **88** is secured by flange **88** to body **18** by bolts **89**. Sleeve **87** extends through a suitable opening in body **18** into chamber **24**. A shaft **90**, rotatably supported in sleeve **87**, has secured thereto at its outer end lever **17**, while at the inner end thereof it is provided with a laterally disposed arm **91** that is engageable with plate **36** when the former is moved to a position normal to the latter by lever **17**. A spring **92** encircling shaft **90** and operative between a washer **93** on shaft **90** which abuts arm **91** and the inner end of sleeve **87** biases shaft **90** in a direction to draw lever **17** into engagement with a resilient washer **94** that is interposed between the adjacent surfaces of flange **88** and lever **17**. Due to this construction and arrangement, washer **94** serves to seal any leakage along shaft **90** between chamber **24** to the exterior of casing **12**. Moreover, lever **17** is drawn in frictional engagement with washer **94** to the end that lever **17** will remain in a fixed position relative to washer **94** until manually moved therefrom.

Regulator body **18** has also formed therein a chamber **95** into which is mounted a microphone **96**. Suitable electrical leads **97** pass through a fitting **98** secured to body **18** and are connected to microphone **96**.

Having described the details of construction and arrangement of parts of the novel regulator contemplated herein, the operation of the device is as follows.

At low altitudes, e. g., below 10,000 feet, where the ambient air contains a sufficient supply of oxygen to permit normal human efficiency, lever **17** is turned to move shaft **90** and hence arm **91** to a position where the latter is normal to bearing plate **36**. This movement of arm **91** moves bearing plate **36** and hence diaphragm **23** outwardly, i. e., in the direction of cover **20** against the bias of primary lever **57**. Upon the outward movement of diaphragm **23**, fingers **37** also move outwardly and out of contact with the free end **54** of lever **49** thereby permitting spring **52** to maintain demand valve **42** closed, while flanges **39** engage and raise disc **34** off its coacting seat **33** to open vent valve **32**. Chamber **24** is thereby placed in communication with the exterior of regulator **11** through tube member **28**, chamber **29** and slot **31**. Therefore, in response to the respiration of the aviator wearing mask **10**, ambient air is drawn into mask **10**, and the exhalation of the aviator is exhausted therefrom through the passageway defined by slot **31**, chamber **29**, member **28**, chamber **24** and ports **26**. During respiration, arm **91** serves to maintain diaphragm **23** in the outwardly disposed or inactive position thereof to the end that demand valve **42** remains closed and vent valve **32** remains open.

When the aviator reaches an altitude where oxygen is required to maintain normal efficiency, i. e., above 10,000 feet, lever **17** is turned manually to the position shown in Fig. 4. This turning of lever **17** is transmitted through shaft **90** to arm **91** and the latter is moved to a position parallel to diaphragm **23**, as shown in Figs. 2 and 4. As arm **91** is disengaged from plate **36**, diaphragm **23** moves inwardly in the direction of wall **19** and fingers **37** also move inwardly thereby permitting spring **35** to seat disc **34** on valve seat **33** to the end that vent valve **32** is closed and chamber **24** is closed to the exterior of regulator **11**. Primary lever **57** and spring **83** cooperate to place a load upon diaphragm **23** that is transmitted through fingers **37** to the free end **54** of lever **49** of the demand valve. Due to this loading, lever **49** is moved and movable jaw **51** carried thereby moves away from fixed jaw **48** to permit a relatively slight flow of oxygen through inlet **40** and tube **43** into chamber **24**. As the oxygen enters chamber **24**, the pressure thereof becomes effective on diaphragm **23** to move the same outwardly against the bias of primary lever **57** and spring **52** moves lever **49** so as to move jaw **51** toward jaw **48** to close off flow through tube **43**. When the oxygen pressure within chamber **24** reaches a value of about .25 inch of water this pressure is effective on diaphragm **23** to produce a force that balances the force imposed thereon by primary lever **57**. At this time, tube **43** is clamped between jaws **51** and **48** to prevent flow through tube **43**. Thus, primary lever **57** serves to maintain a positive or "safety" pressure within chamber **24** and mask **10** of about .25 inch of water, to the end that any leakage between mask **10** and the face of the aviator wearing the same is outwardly into the ambient atmosphere. This outward leakage prevents the dilution of the oxygen within mask **10**.

The description hereinbefore set forth, relates to the operation of regulator **11** during the pause between an inhalation and exhalation of the aviator. Upon an inhalation, the suction produced thereby in mask **10** and chamber **24** moves diaphragm **23** inwardly of chamber **24**. This inward movement of diaphragm **23** and fingers **37** secured thereto pivots lever **49** against the bias of spring **52** and moves jaw **51** away from jaw **48**. Tube **43** opens and oxygen flows into chamber **24** and from thence through ports **26** into mask **10** and the aviator's lungs. It is also noted, the inward movement of diaphragm **23** increases the bias of spring **35** on disc **34** so that a positive sealing engagement between disc **34** and its coacting seat **32** is assured.

Upon exhalation, diaphragm **23** moves outwardly into cover **20** in response to the increase of pressure within chamber **24** due to the exhalation. During the initial portion of the outward movement of diaphragm **23** and fingers **37**, spring **52** moves lever **49** to clamp tube **43** between jaws **51** and **48** to cut off the flow of oxygen into chamber **24**. As fingers **37** continue to move outwardly with diaphragm **23**, flanges **39** first engage disc **34** and then lift the same off its coacting seat **33** to permit the exhalation to pass through member **28**, chamber **29** and slot **31** to atmosphere.

The operation of regulator **11** hereinbefore set forth, assures the delivery of a sufficient quantity of oxygen to the aviator up to an altitude of about 40,000 feet. Above this altitude it is necessary to supply the aviator with oxygen under a pressure sufficiently high to force the oxygen into his lungs. The present regulator operates to accomplish the end as follows. During ascent, to high altitude, aneroid **78** expands in response to the decrease in ambient atmospheric pressure. The expansion of aneroid **78** is adjusted to the end that at slightly below an altitude of 40,000 feet, end plate **79** of bellows **78** engages arm **80** of bellcrank **67** and begins to rotate the same in a counterclockwise direction as shown in Fig. 2 against the bias of spring **74**. At an altitude of about 40,000 feet, aneroid **78** will have rotated bellcrank **67** to a point where arm **66** thereof disengages from extension **69** of secondary lever **58**. Secondary lever **58** is then pivoted by springs **60** and engages bearing plate **65** of diaphragm **23**. Thus, at this time, both primary lever **57** and secondary lever **58** are engaged with plate **65** and impose a bias through their respective springs **83** and **60** on diaphragm **23** that moves the latter inwardly of chamber **24**. The inward movement of diaphragm **23** and fingers **37** pivots lever **49** against the bias of spring **52** to move jaw **51** away from jaw **48** thereby permitting oxygen to flow through tube **43** into chamber **24**. Due to the additional load imposed on diaphragm **23** by secondary lever **58**, the oxygen pressure in chamber **24** builds up until it reaches a value of about 15 inches of water before it becomes effective on diaphragm **23** to produce a force that balances the force imposed on diaphragm **23** by the primary and secondary levers **57** and **58**, respectively. Thus, when both levers are effective on diaphragm **23**, a pressure of 15 inches of water is maintained in chamber **24** and hence mask **10**.

It is manifest, therefore, that when the aviator inhales, the oxygen supplied to mask **10** is forced into the lungs of the aviator. Upon exhalation, regulator **11** operates as aforesaid to open valve **32** and permit the exhalation to vent through member **28**, chamber **29** and slot **31** to atmosphere.

In the event the aviator descends into a lower altitude where pressure breathing is no longer required, aneroid **78** contracts in response to the ambient atmospheric pressure at the lower altitude. As aneroid **78** contracts, spring **74** rotates bellcrank **67** to the position shown in Fig. 2. Secondary lever **58** is reengaged manually with arm **66** of bellcrank **67** by the aviator pressing, or pushing on the outer end **58***a* of lever **58** so as to rotate the same against the bias of springs **60**. As lever **58** rotates in this direction, the lateral extension **69** thereof engages arm **66** and rotates the same in a clockwise direction, as shown in Fig. 2, against the bias of spring **74**. When extension **69** clears the end of arm **66**, spring **74** moves the latter in a counterclockwise direction until such rotation is arrested by extension **73**, at which time arm **66** is in engagement with extension **69** of lever **58** to lock the latter in the position shown in Fig. 2.

As hereinbefore set forth, aneroid **78** is resiliently supported in cover **20** by a leaf spring **75** and button **76**, to which aneroid **78** is secured, extends to the exterior of cover **20**. Therefore, in the event the aviator desires to set the regulator for pressure breathing manually, he merely presses on button **76** to move it inwardly of cover **20** against the bias of leaf spring **75**. The resulting inward movement of aneroid **78** engages the bottom plate **79** thereof with arm **80** of bellcrank **67** and moves the same to disengage arm **66** from extension **69** of lever **58**. Lever **58** is then released to rotate in response to the bias of springs **61** to a position where it engages bearing plate **65** of diaphragm **23**. Regulator **11** will then operate, as hereinbefore set forth, to maintain the pressure of the oxygen in chamber **24** and hence mask **10** at a value of 15 inches of water.

Having thus described the details of construction and operation of the novel oxygen demand regulator contemplated herein, it will be apparent to one skilled in the art that the various objects of the instant invention hereinbefore set forth have been achieved.

Moreover, while only one embodiment of the novel demand regulator has been illustrated and described, various changes in the form and arrangement of the various elements which will now be apparent to those skilled in the art, may be made without departing from the scope of the invention.

What is claimed is:

1. An oxygen demand regulator adapted to be mounted to and form a part of a breathing mask, said regulator including a breathing chamber communicating with the mask, a respiratory responsive diaphragm in said chamber, an inlet to said chamber, a demand valve controlling flow through said inlet into said chamber, said demand valve including a resilient tube extending partially into said chamber, a fixed jaw engageable with one side of said tube, a movable jaw engageable with the opposite side of said tube, a lever for moving said movable jaw relative to said fixed jaw to engage said tube therebetween and thereby control flow through said tube, means biasing said lever in a direction whereby said tube is clamped between said jaws to close flow through said tube, a passageway communicating said chamber to the exterior of said regulator, a vent valve controlling flow through said passageway, said vent valve including a valve seat, a valve disc engageable with said valve seat, resilient means biasing said disc into engagement with said seat, and one or more fingers carried by said diaphragm and engageable with said valve disc, at least one of said fingers engageable with said lever whereby movement of said diaphragm in one direction engages said one finger with said lever and actuates said lever to move said movable jaw away from said fixed jaw to permit flow through said tube, and movement of said diaphragm in a second direction engages said fingers with said valve disc to disengage said valve disc from said valve seat to thereby communicate said chamber through said passageway with the exterior of said casing.

2. An oxygen demand regulator adapted to be mounted to and form a part of a breathing mask, said regulator including a breathing chamber communicating with the mask, a respiratory responsive diaphragm in said chamber, an inlet to said chamber, a demand valve controlling flow through said inlet into said chamber, said demand valve including a resilient tube extending partially into said chamber, a fixed jaw engageable with one side of said tube, a movable jaw engageable with the opposite side of said tube, a lever for moving said movable jaw relative to said fixed jaw to engage said tube therebetween and thereby control flow through said tube, means biasing said lever in a direction whereby said tube is clamped between said jaws to close flow through said tube, and means for operatively engaging said lever with said diaphragm whereby movement of said diaphragm in one direction actuates said lever to move said movable jaw away from said fixed jaw to thereby permit flow through said tube into said chamber.

3. An oxygen demand regulator adapted to be mounted to and form a part of a breathing mask, said regulator including a breathing chamber communicating with the mask, a respiratory responsive diaphragm in said chamber, an inlet to said chamber, a demand valve controlling flow through said inlet into said chamber, said demand valve including a resilient tube extending partially into said chamber, a fixed jaw engageable with one side of said tube, a movable jaw engageable with the opposite side of said tube, a lever for moving said movable jaw relative to said fixed jaw to engage said tube therebetween and thereby control flow through said tube, means biasing said lever in a direction whereby said tube is clamped between said jaws to close flow through said tube, means for operatively engaging said lever with said diaphragm whereby movement of said diaphragm in one direction actuates said lever to move said movable jaw away from said fixed jaw to thereby permit flow through said tube into said chamber, and normally closed vent means communicating said chamber to the exterior of said regulator and operable by said engaging means whereby movement of said diaphragm in a second direction opens said vent means.

4. An oxygen demand regulator adapted to be mounted to and form a part of a breathing mask, said regulator including a breathing chamber communicating with the mask, a respiratory responsive diaphragm in said chamber, an inlet to said chamber, a demand valve controlling flow through said inlet into said chamber, said demand valve including a resilient tube terminating in said chamber, a fixed jaw engageable with one side of said tube, a movable jaw engageable with the opposite side of said tube, a lever for moving said movable jaw relative to said fixed jaw to engage said tube therebetween and thereby control flow through said tube, means biasing said lever in a direction whereby said tube is clamped between said jaws to close flow through said tube, means for operatively engaging said lever with said diaphragm whereby movement of said diaphragm in one direction actuates said lever to move said movable jaw away from said fixed jaw to thereby permit flow through said tube into said chamber, normally closed vent means communicating said chamber to the exterior of said regulator and operable by said engaging means whereby movement of said diaphragm in a second direction opens said vent means, and means for moving said diaphragm in said second direction to a predetermined position where said vent means are opened and maintaining said diaphragm in said predetermined position.

5. In an oxygen demand regulator having a casing for connection to a breathing mask, the combination compris-

ing a breathing chamber in said casing, a demand valve controlling the flow of pressurized oxygen into said chamber, a respiratory responsive diaphragm controlling the operation of said demand valve, a pivot pin carried by said casing, a primary lever pivotally mounted at one end on said pivot pin and engageable at the opposite end thereof with said diaphragm, means biasing said primary lever to pivot on said pin whereby the opposite end of said primary lever normally engages said diaphragm and imposes a first predetermined force thereon to thereby actuate said demand valve to maintain a first predetermined pressure of oxygen in said chamber, a secondary lever pivotally mounted at one end on said pivot pin and engageable at the other end thereof with said diaphragm, means biasing said secondary lever for pivotal movement on said pin whereby the opposite end of said secondary lever engages said diaphragm, latching means engageable with said other end of said secondary lever to prevent the pivotal movement thereof, and altitude responsive means engageable with said latching means for releasing said secondary lever from said latching means at a predetermined altitude whereby said secondary lever is pivoted by its biasing means to engage said diaphragm, said primary and secondary levers being effective to impose a second predetermined force on said diaphragm to thereby actuate said demand valve to maintain a second predetermined pressure of oxygen in said chamber.

6. In an oxygen demand regulator having a casing for connection to a breathing mask, the combination comprising a breathing chamber in said casing, a demand valve controlling the flow of pressurized oxygen into said chamber, a respiratory responsive diaphragm controlling the operation of said demand valve, a pivot pin carried by said casing, a pair of levers, each of said levers mounted at one end to said pin and engageable at its opposite end with said diaphragm, resilient means individual to each lever and biasing its lever to pivot on said pin to engage the opposite end thereof with said diaphragm and impose a predetermined force thereon, one of said levers normally engaging said diaphragm and effective to impose a predetermined force thereon whereby said diaphragm operates said demand valve to maintain a first predetermined pressure of oxygen in said chamber, and altitude responsive means engageable with the other lever, said altitude responsive means normally operative to hold said other lever out of engagement with said diaphragm at altitudes below a predetermined altitude and to release said other lever for engagement with said diaphragm at said predetermined altitude, said other lever being effective upon engagement with said diaphragm to increase the predetermined force imposed thereon to a second predetermined force whereby said diaphragm operates said demand valve to maintain a second predetermined pressure of oxygen in said chamber.

7. In an oxygen demand regulator having a casing for connection to a breathing mask, the combination comprising a breathing chamber in said casing, a demand valve controlling the flow of pressurized oxygen into said chamber, a respiratory responsive diaphragm controlling the operation of said demand valve, a pivot pin carried by said casing, a pair of levers, each of said levers mounted at one end on said pin and engageable at its opposite end with said diaphragm, resilient means individual to each lever and biasing its lever to pivot on said pin to engage the opposite end thereof with said diaphragm and impose a predetermined force thereon, one of said levers normally engaging said diaphragm and effective to impose a predetermined force thereon whereby said diaphragm operates said demand valve to maintain a first predetermined pressure of oxygen in said chamber, and altitude responsive means engageable with the other lever, said altitude responsive means normally operative to hold said other lever out of engagement with said diaphragm at altitudes below a predetermined altitude and to release said other lever for engagement with said diaphragm at said predetermined altitude, said other lever being effective upon engagement with said diaphragm to increase the predetermined force imposed thereon to a second predetermined force whereby said diaphragm operates said demand valve to maintain a second predetermined pressure of oxygen in said chamber, and manually operable means for actuating said altitude responsive means to release said other lever.

8. In an oxygen demand regulator, the combination comprising a chamber, an oxygen inlet to said chamber, inlet valve means controlling flow through said inlet into said chamber, a respiratory responsive diaphragm in said chamber, vent means communicating said chamber to atmosphere, means carried by said diaphragm and engageable with said inlet valve and vent means to alternately open and close said inlet valve and vent means in response to respirations, resilient means biasing said diaphragm to actuate said inlet valve and vent means to maintain a predetermined pressure of oxygen in said chamber, second resilient means engageable with said diaphragm to bias the same in conjunction with said first resilient means to actuate said inlet valve and vent means to maintain a second predetermined pressure of oxygen in said chamber, and means engageable with said diaphragm and operable to move said diaphragm against the bias of said first and second resilient means to a position whereby said inlet valve means close and said vent means open to thereby vent said chamber to atmosphere.

9. An oxygen demand regulator comprising a breathing chamber having an oxygen inlet, a demand valve at the inlet controlling the flow of oxygen into said chamber, a vent valve, a respiration responsive diaphragm in the chamber, means carried by said diaphragm and operated thereby to alternately open and close said demand valve and vent valve, means for biasing the diaphragm in a direction to open the demand valve, and means including an aneroid for rendering the biasing means operative when the regulator is at not less than a predetermined altitude.

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