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AUTOMATIC SAFETY AND PRESSURE BREATHING MEANS

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FIG. 1

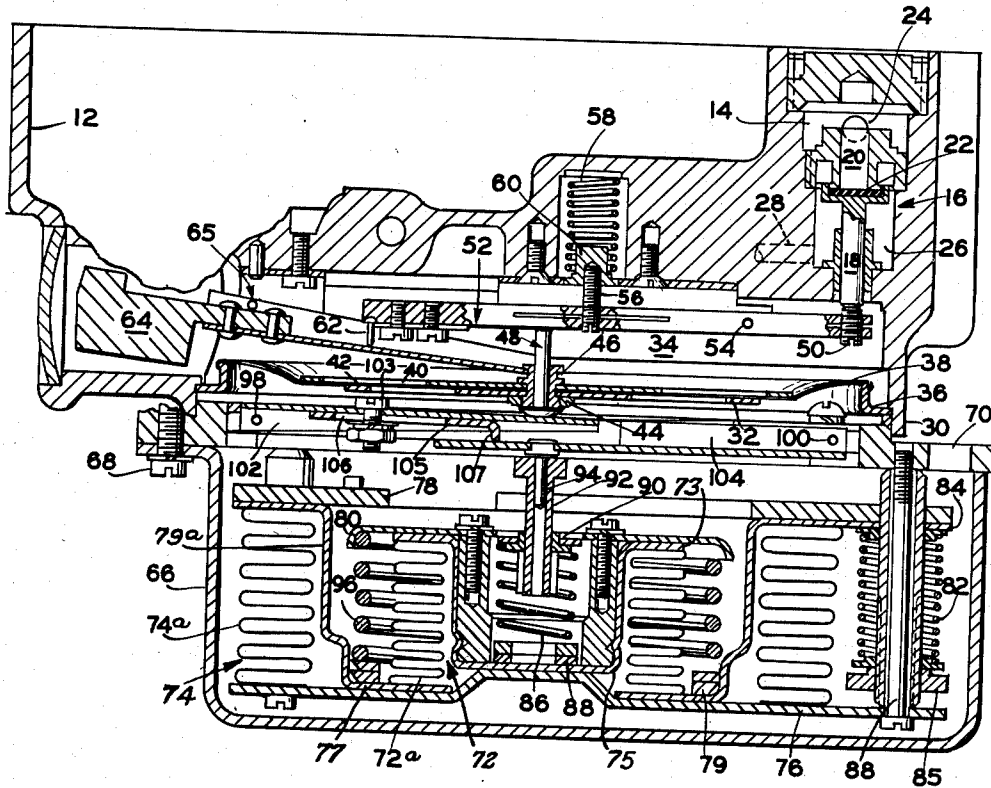
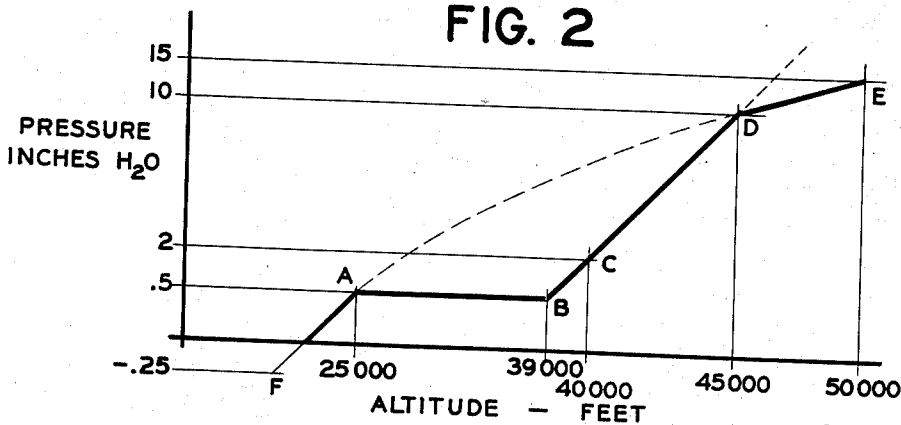


FIG. 2



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## UNITED STATES PATENT OFFICE

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AUTOMATIC SAFETY AND PRESSURE  
BREATHING MEANS

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11 Claims. (Cl. 128-142)

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The present invention relates generally to oxygen demand regulators and more particularly to means therein for insuring safety pressure and pressure breathing as required.

It is well known in the art that at altitudes above 40,000 feet, it is not possible to absorb oxygen at atmospheric pressure in sufficient quantity to maintain life. Therefore, means must be provided to supply oxygen under pressure to the lungs. Such means are called "pressure breathing."

Various types of oxygen supply systems have been devised in attempting to solve the problem of supplying the required oxygen at high altitudes. Of particular importance is the demand system which contemplates automatically providing the user with the proper amount of oxygen at various altitudes. The regulator for the demand system releases oxygen only in response to the diaphragm operated flow valve which is opened by the suction of the user's inhalations, and closes automatically when that suction ceases. The suction required of the user to operate the valve is approximately one quarter inch of water pressure. At about 25,000 to 40,000 feet it becomes necessary to prevent leakage of nitrogen into the mask from the ambient atmosphere so that the oxygen from the regulator will not be diluted.

The present invention contemplates providing a slight positive pressure of about one half inch of water at altitudes from 25,000 to 40,000 feet to protect the breather. This is called safety pressure.

It is, therefore, one of the objects of the present invention to provide novel oxygen regulator demand valve control means whereby a positive pressure of about one half inch of water will be maintained to protect the breather at altitudes from 25,000 to 40,000 feet against ambient air leaking into the mask and thereby diluting the oxygen.

Another object of the invention is to provide novel demand valve control means which will insure pressure breathing above 40,000 feet.

Still another object is to provide a novel demand valve control mechanism of the character indicated by which the demand valve is controlled by the respiratory responsive diaphragm during safety pressure breathing and in which the control of the demand valve by the respiratory responsive diaphragm is overridden to permit operation of the demand valve by pressure responsive members during pressure breathing.

Another object is to provide a novel control

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mechanism for a demand valve whereby the pressure of the oxygen delivered by the regulator is altered to meet particular oxygen requirements.

Another object is to provide a novel demand valve control for an oxygen regulator in which the pressure built up behind the valve is counterbalanced by spring pressures and diaphragm pressures applied through a compound lever system.

A further object of the invention is to provide novel oxygen regulator means of the above indicated nature which shall be simple and easy to manufacture, and yet positive and reliable in operation.

The foregoing and other objects and advantages 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.

In the drawings wherein like reference characters designate like parts:

Figure 1 is a view partly in section of a novel pressure demand oxygen regulator assembly embodying the novel subject matter of the present invention.

Figure 2 is a graph of the performance of the regulator at various altitudes.

Referring now to the drawings for a more detailed description of the invention, numeral 10 generally indicates an oxygen regulator such as, for example, is disclosed in copending applications Serial No. 60,585, filed November 17, 1948, for Demand Valve Control Mechanism, and Serial No. 161,601, filed May 12, 1950, for Pressure Compensated Pressure Reducer, and assigned to the assignee of the present invention.

The regulator 10 comprises a casting 12 having a recess 14 in which is housed a demand valve 16, the movable stem 18 of which carries a rubber gasket 20 which rests against a seat 22 in the closed position of the valve. The valve 16 seals the oxygen inlet port 24 and prevents the oxygen from entering a chamber 26 formed within the recess 14 by the valve seal 22, the chamber 26 being connected by a passageway 28 to the injector nozzle (not shown) of the demand regulator.

The bottom of the casting 12 is formed with dependent side walls 30 which together with a respiratory diaphragm assembly 32 form a sealed chamber 34 within the regulator. The chamber

34 is connected by suitable means (not shown) to the mask so that the suction of the mask user will operate the demand valve 16.

The diaphragm assembly 32 comprises an annular member 36 having fixed thereover a membrane or diaphragm 38. The diaphragm 38 has fixed to its center on either side thereof two pressure plates 40 and 42. The plates are made integral with a bushing 44 fixed to the diaphragm, said bushing being provided with a groove 46 for reasons hereinafter explained. A pin 48 is slideably received within the bushing.

It will be understood by those skilled in the art that the negative pressure or suction in the chamber 34 due to the inhalation of the mask user will cause the diaphragm 38 to rise, carrying therewith the plates 40 and 42, and the bushing 44. The exhalation of the mask wearer will create a positive pressure within the chamber 34 thereby causing the diaphragm 38 and its attendant elements to drop. The rise and fall of the diaphragm 38 is used for opening and closing the demand valve 16.

To this end, the stem 13 of the demand valve has attached thereto by any approved means such as screw 50, a lever 52 pivoted within the casting 12 as at 54. On the opposite side of the pivot 54, the lever 52 is connected as by screw 53 to a biasing means comprising a coil compression spring 58 and a spring retainer 60 threaded to the screw 56. It will be appreciated that the bias of spring 58 acts in a downward direction on the lever 52 tending to hold the stem 13 against the seat 22 thus sealing the oxygen inlet 24.

The lever 52 is movable through a pin 62 by a counterbalance lever 64 pivoted within the casting 12 as at 65. The pin 62 abuts the pivoted lever 52 so that any motion of the counterbalance lever 64 will be transmitted to lever 52 to operate demand valve 16. The lever 64 encompasses the bushing 44 within the groove 46 therein. The rise and fall of diaphragm 38 due to the breathing pressures communicated to chamber 34 will pivot the lever 64 about its pivot 65 by virtue of its connection to the bushing 44. The oscillations of the lever 64 are transmitted to the lever 52 by the abutment pin 62.

The lever 52 will thus be oscillated in a clockwise direction against the bias of the spring 58 to open the demand valve 16, the spring 58 tending to close the demand valve upon exhalation pressure being applied within the chamber 34.

The manner in which safety pressure and pressure breathing is insured at the proper altitudes is as follows: The regulator 10 is provided with an enclosure 66 fixed to the casting 12 in an approved manner as by screws 68, the enclosure being vented to ambient pressure as through a vent hole 70.

Fixed within the enclosure 66 are two nested aneroids, an inner one 72 and an outer one 74. Inner aneroid 72 is in the form of an evacuated bellows 72a that is sealingly secured at the upper end thereof to an outwardly extending circular flange 73 of a housing 75 centrally disposed within aneroid 72, while the lower end thereof is similarly attached to an inwardly disposed circular flange 77 formed on a substantially cylindrical housing 79a centrally positioned within aneroid 74. Outer aneroid 74 is also in the form of a bellows 74a that is sealingly joined at its upper end to an outwardly extending circular flange 84 formed on housing 79a and the lower end thereof is similarly attached to and sealed off by a bottom plate 76. As will be hereinafter

more fully set forth, at higher altitudes flange 77 is lifted off, or moved out of contact with, bottom plate 76, thus bottom plate 76 serves as a common means of sealing both inner and outer aneroids 72 and 74, respectively. A top shim 73 secured to the outer aneroid 74 protrudes over a top plate 80 of the inner aneroid 72 so that the distension of the inner aneroid will be stopped by the abutment of plate 80 against top shim 78, since the outer aneroid 74 begins to extend at a much higher altitude than the inner aneroid 72 as will hereinafter appear. A plurality of springs 82 only one of which is shown here bear against the flange 84 of housing 79a of the outer aneroid 74 and are anchored against a nut 85 on a threaded screw 88. By this novel arrangement of installing the springs 82 exteriorly of the aneroid 74 in an accessible location, it is a relatively simple matter to equalize the tension in all of the springs 82 by means of the nuts 85.

The inner aneroid 72 carries a light spring 86 in the center thereof installed between washers 88, and bushing retainer 90. The retainer 90 has secured thereto a hollow internally threaded stud 92 which protrudes through the top plate 80 and carries a threaded insert 94. A spring 96 exteriorly encompassing the aneroid 72 urges the same to distend toward the stop shims 78. The tension in spring 96 is exteriorly adjustable by means of shims 79 which may be added or removed as required.

Pivoted to the casting 12 as at 98 and 100 are two diametrically opposed arms 102 and 104, respectively. The arm 102 is so disposed within the regulator that its upper surface abuts the pin 48 received within the bushing 44 of the respiratory responsive diaphragm assembly 32. The arm 102 has fixed thereto as by screw 103 an adjustable arm 105 the screw 103 passing through an elongated slot 106 therein. The inner end of said arm is formed with a down-turned toe 107 which abuts the arm 104. It will be apparent that the arm 105 may be moved so as to adjust the point of abutment of the toe 107 with the arm 104. It is thus possible by adjusting the length of the arm 105 to vary the moment arms of the linkage system described so that the pressure of the oxygen delivered to the mask may be varied for predetermined altitudes in accordance with the preset requirements.

Having thus described the details of construction of the instant invention as shown in Figure 1, reference is now made to Figure 2 which graphically illustrates the relationship of pressure within regulator 10 to altitude, during the operation of the invention.

It will be apparent to one skilled in the art that as the altitude of the aircraft in which regulator 10 is installed increases, the decreasing ambient atmospheric pressure causes the aneroids 72 and 74 to distend. Inner aneroid 72 is set to begin distending at a lower altitude than outer aneroid 74. Therefore, at an altitude of about 22,000 feet, point F in Figure 2, inner aneroid 72, in response to the lowered ambient pressure, begins to distend.

During the early portion of the expansion of aneroid 72, the upward movement of plate 80 and housing 75 carried thereby moves insert 94 into engagement with lever 104 and takes up any clearance between levers 104 and 102, the head of pin 48 and grooved bushing 44, and the upper end of the pin 48 and lever 52. As aneroid 72 continues to expand plate 80 moves away from bushing retainer 90 and the force of spring 86

is thereby effective through insert 94, levers 104 and 102, and the head of pin 48 to raise diaphragm 38, while the end of pin 48 engaging lever 52 moves the lever 52 to open valve 16 and permit pressure to enter chamber 34. At about 25,000 feet, point A in Figure 2, plate 80 abuts shim 78 and further movement, or expansion, of aneroid 72 is arrested.

As shown in Fig. 2, a pressure of about one-half inch of water pressure is then present in chamber 34 and this pressure acting on diaphragm 38 effectively balances the force exerted by spring 86 through pin 48 on lever 52. Since aneroid 72 cannot expand due to the engagement of plate 80 with shim 78, the above-noted pressure within chamber 34 remains substantially constant. Thus, a safety pressure of about one-half inch of water is maintained in the regulator 10 and the mask to prevent any inward leakage of ambient air into the mask during flight between altitudes of about 25,000 feet to about 39,000 feet, line A—B of Figure 2.

Since it is desirable to provide pressure breathing at altitudes above 39,000 feet, outer aneroid 74 is designed to begin expanding slightly below this altitude. As aneroid 74 expands flange 77, which has heretofore remained in contact with plate 76, moves upwardly carrying along with it inner aneroid 72 and housing 75. Spring 86 is therefore compressed to its solid height between washers 88 and bushing 90. Since spring 86 is relatively light, the compression thereof by the expansion of aneroid 74 to its solid height has little or no effect on the lever 52 and, therefore, the pressure within chamber 34 remains substantially constant during this period. At point B of Figure 2, inner aneroid 72 is confined between flange 77 and shim 78 and spring 86 is fully compressed, it is manifest, therefore, that these elements now act as a solid member, or bar, to transmit the force, or pressure, exerted by aneroid 74 to the insert 94, levers 104 and 102 and pin 48 to lever 52.

As altitude increases above 39,000 feet, the force or pressure exerted by aneroid 74 increases in response to the decreasing ambient pressure and is transmitted, as above set forth, to lever 52 to operate valve 16. The resulting increase in pressure within chamber 34 is effective on diaphragm 38 to balance the increased force exerted by aneroid 74 to the end that at about 40,000 feet, point C in Figure 2, a pressure of two inches of water pressure is present within chamber 34, while at 45,000 feet, point D in Figure 2, chamber 34 contains a pressure of approximately ten inches of water pressure. It is to be noted that during this range of altitudes i. e., 39,000 feet to 45,000 feet, the force exerted by aneroid 74 increases but due to the balancing force exerted by the pressure within chamber 34 acting on diaphragm 38 there is no substantial expansion of aneroid 74.

At point D, i. e., about 45,000 feet, the force exerted by aneroid 74 begins to exceed the force exerted by aneroid 72 and aneroid 74 begins to expand. Since spring 86 is fully compressed, it is apparent that plate 80 does not follow shim 78. Flange 77, however, transmits the force of expanding aneroid 74 to spring 86 and, therefore, an increased force is exerted through spring 96, insert 94, levers 104 and 102, and pin 48 to lever 52 whereby valve 16 is operated to increase the pressure within chamber 34. Thus, at 50,000 feet, point E in Fig. 2, the desired pressure of fifteen

inches of water pressure is present within chamber 34.

Thus the desired pressure altitude relationship is obtained and may be insured by adjusting the forces on the aneroids by means of springs 82 and 96.

It will thus be seen that there is provided a novel control mechanism for the demand valve of an oxygen demand regulator in which the several objects of this invention are achieved and which is well adapted to meet the conditions of practical use.

Although only one embodiment and one application of the invention has been illustrated and described it will readily be apparent to those skilled in the art that changes in form and modifications may be made without departing from the spirit and the scope of the invention.

What is claimed is:

1. In a demand regulator having a casing adapted for connection to a breathing mask, a respiratory responsive diaphragm assembly and a valve within said casing, a control mechanism for said valve comprising a pivoted lever opening and closing said valve, an independently pivoted second lever actuated by deflections of the respiratory responsive diaphragm actuating said first lever, said first and second levers being positioned on one side of said diaphragm, a first and second aneroid on the other side of said diaphragm, a spring loaded stud attached to said second aneroid, a pair of pivoted levers constructed and arranged to transmit movements of said stud to said diaphragm, said second aneroid being set to expand at higher ambient pressures than said first aneroid to actuate said valve through said stud, second pair of levers and diaphragm, stop means on said first aneroid limiting the expansion of said second aneroid, and means connecting said first and second aneroids whereby said first aneroid coacts with said second aneroid at ambient pressures below said higher ambient pressure to actuate said valve through said stud, second pair of levers and diaphragms.

2. In a demand regulator including a casing having an outlet adapted for connection to a breathing mask, a respiratory responsive diaphragm, a valve, and actuating means operatively connected to said diaphragm and said valve for operating said valve, a control mechanism for the actuating means of said valve comprising a pair of nested aneroids on one side of said diaphragm, a pair of pivoted levers for transmitting movements of said aneroids to said diaphragm, the first of said aneroids being constructed and arranged to limit the expansion of the second of said aneroids, means carried by the second of said aneroids and engageable with said pair of pivoted levers for operating said actuating means at a predetermined ambient pressure, and means connecting the first of said aneroids to the second of said aneroids whereby the first of said aneroids cooperates with the second of said aneroids below said predetermined ambient pressure to operate actuating means.

3. In a demand regulator having a casing including an outlet adapted for connection to a breathing mask, a respiratory responsive diaphragm, and a valve operatively connected to said diaphragm, said valve normally controlled by respiratory pressure on said diaphragm, a control mechanism for said valve comprising a first and second aneroid on one side of said diaphragm, a pair of interconnected pivoted levers for transmitting movements of said aneroids to said dia-

phragm, one of said pivoted levers engageable with said diaphragm, and means carried by said second aneroid and engageable with the other of said pivoted levers whereby said diaphragm is biased to operate at reduced respiratory pressure at predetermined ambient pressures, said first aneroid being constructed and arranged to cooperate with said second aneroid below said predetermined ambient pressures to bias said diaphragm to override the respiratory control and open said valve.

4. An oxygen demand regulator adapted for use with a breathing mask comprising a casing, a pressure chamber in said casing having a respiratory controlled diaphragm defining one wall thereof, a demand valve operatively connected to said diaphragm for permitting the flow of oxygen into said chamber, an outlet from said chamber adapted for connection to said mask and providing for the flow of oxygen to said mask, a pair of nested interconnected aneroids, and a pair of interconnecting pivoted levers, one of said levers being operatively engageable with said diaphragm and the other with one of said aneroids whereby movements of said aneroids is transmitted to said diaphragm to actuate said diaphragm at predetermined ambient pressures, said interconnected aneroids being constructed and arranged whereby one of said aneroids biases said diaphragm to decrease the respiratory pressure required to operate said demand valve at predetermined ambient pressures, and the other of said aneroids below said predetermined ambient pressures to retain said demand valve in open position.

5. In a demand regulator having a casing including an outlet adapted for connection to a breathing mask, a respiratory responsive diaphragm, and a demand valve operatively connected to said diaphragm, said demand valve normally controlled by respiratory pressure on said diaphragm, a control mechanism for said valve comprising a first and second aneroid on one side of said diaphragm, said aneroids being adapted to expand sequentially in response to ambient pressure, means operatively connecting said aneroids, a pair of interconnected pivoted levers for transmitting movement of said aneroids to said diaphragm, means carried by the second of said aneroids and engageable with one of said pivoted levers whereby the sequential movements of said aneroids are transmitted to said diaphragm, a plurality of springs including adjustment means operable to adjust the tension of said springs exteriorly disposed about said first aneroid, a spring exteriorly disposed about said second aneroid, and a plurality of shims for adjusting the tension in said last-named spring.

6. In a demand regulator having a casing including an outlet adapted for connection to a breathing mask, a respiratory responsive diaphragm, and a demand valve operatively connected to said diaphragm, said demand valve normally controlled by respiratory pressure on said diaphragm, a control mechanism for said valve comprising a first and second aneroid on one side of said diaphragm, said aneroids being constructed and arranged for sequential expansion in response to changes in ambient pressure, means operatively connecting said aneroids, a pair of interconnected pivoted levers for transmitting movement of said aneroids to said diaphragm, means carried by the second of said aneroids and engageable with one of said pivoted levers whereby sequential movements of said

second and first aneroids are transmitted to said diaphragm, spring means exteriorly disposed about said aneroids for biasing said aneroids toward distended position, and adjustment means for said spring means to vary the force on said aneroids to thereby control the pressure exerted by said aneroids on said diaphragm.

7. In an oxygen demand regulator for use with a breathing mask and including a casing, a chamber within said casing having a respiratory responsive diaphragm defining a wall of said chamber and communicating with said mask, and a demand valve controlling the flow of oxygen into said chamber, a control mechanism for said demand valve comprising a plurality of levers operatively connecting said diaphragm to said valve, a plurality of interconnected aneroids set to distend sequentially at predetermined ambient pressures, a pair of interconnected pivoted levers, one of said pivoted levers operatively engageable with said diaphragm, and means carried by one of said aneroids and engageable with the other of said pivoted levers whereby movements of said aneroids is transmitted to said diaphragm to thereby actuate said demand valve and control the oxygen pressure in said chamber.

8. In an oxygen demand regulator for use with a breathing mask and including a casing, a chamber within said casing having a respiratory responsive diaphragm defining a wall of said chamber and communicating with said mask, and a demand valve controlling the flow of oxygen under pressure into said chamber, a control mechanism for said demand valve comprising a plurality of levers operatively connecting said diaphragm to said valve to open and close said valve, a plurality of interconnected aneroids responsive to ambient pressure and set to distend in sequence at desired altitudes, a pair of interconnected levers, means for varying the moment arm of one of said interconnected levers, one of said levers operatively engageable with said diaphragm, and means carried by one of said aneroids and engageable with the other of said interconnected levers for transmitting movements of said aneroids to said diaphragm to thereby operate said demand valve and regulate the flow of oxygen under pressure into said chamber.

9. In an oxygen demand regulator adapted for use with a breathing mask and including a casing having a pressure chamber, a respiratory responsive diaphragm forming one wall of said chamber, an outlet from said chamber adapted for connection to said mask, and a demand valve operatively connected to said diaphragm for controlling the flow of oxygen into said chamber, the improvement comprising a plurality of interconnected levers for raising and lowering said diaphragm to operate said demand valve, a pair of interconnected nested aneroids, means carried by the inner aneroid and adjustable to actuate said interconnected levers, said inner aneroid set to distend over a predetermined altitude span to maintain safety pressure in said chamber, and the outer aneroids set to distend at higher altitude to actuate said levers and maintain pressure breathing pressure in said chamber.

10. In an oxygen demand regulator adapted for use with a breathing mask and including a casing having a pressure chamber, a respiratory responsive diaphragm forming one wall of said chamber, an outlet from said chamber adapted for connection to said mask, a demand valve controlling the flow of oxygen into said chamber, and a lever mechanism connected to said demand

valve and to said diaphragm for opening and closing said demand valve in response to respiratory pressure applied to said chamber, in combination therewith, a pair of cooperating aneroids, and a pair of interconnected pivoted levers operatively engageable between one of said aneroids and said diaphragm for transmitting the movements of said aneroids to said diaphragm, one of said aneroids set to distend at predetermined altitudes to actuate said interconnected levers and diaphragm to increase the pressure to a desired value in said chamber, and the remaining aneroid set to begin distending a higher altitude to actuate said interconnected levers in concert with said first aneroid to further increase pressure in said chamber.

11. An oxygen demand regulator comprising a casing, a pressure chamber in said casing having an inlet adapted to receive oxygen under pressure, an outlet adapted for connection to a breathing mask, a pressure responsive diaphragm forming one wall of said chamber and having a centrally disposed bushing, a valve in said chamber regulating said inlet, a first lever pivotally mounted in said chamber and connected to said valve, spring means operatively engaging said first lever normally closing said valve, a second lever pivotally mounted in said chamber and connected to said first lever and the bushing of said diaphragm whereby movements of said diaphragm in response to pressure within said chamber operates said valve, a pin slidably mounted in said bushing and engageable at one end thereof with said first lever, abutment means at other end of said pin engageable with said bushing, a pair of interconnected levers pivotally mounted to said casing, one of said pair of levers engageable with said abutment means, an outer aneroid responsive to ambient pressure mounted to said casing, a plurality of springs exteriorly disposed about said outer aneroid, means for adjusting the tension of said springs to thereby vary the response of said outer aneroid to ambient pressure, an inner aneroid responsive to ambient

pressure nested within said outer aneroid, a spring exteriorly disposed about said inner aneroid, means for adjusting the tension of said spring to thereby vary the response of said inner aneroid to ambient pressure, means connecting said outer and inner aneroids, a housing carried by said inner aneroid and centrally disposed therein, an insert having a shoulder slidable within said housing and an end portion extending beyond the limits of said housing and engageable with the other of said pair of pivoted levers, a spring installed within said housing between the end wall thereof and the shoulder on said insert, and means carried by said outer aneroid for arresting the expansion of said inner aneroid, said inner aneroid being operative to expand at a predetermined ambient pressure to move said housing whereby said last-named spring is effective through said insert, pair of pivoted levers and pin to operate said valve to increase pressure within said chamber, said arresting means on said outer aneroid effective to limit the expansion of said inner aneroid to thereby limit the operation of said valve by said inner aneroid, said outer aneroid being operative to expand at ambient pressures below said predetermined ambient pressure and effective through said means for interconnecting said aneroids and the spring exteriorly disposed about said inner aneroid to actuate said valve to increase pressure within said chamber.

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