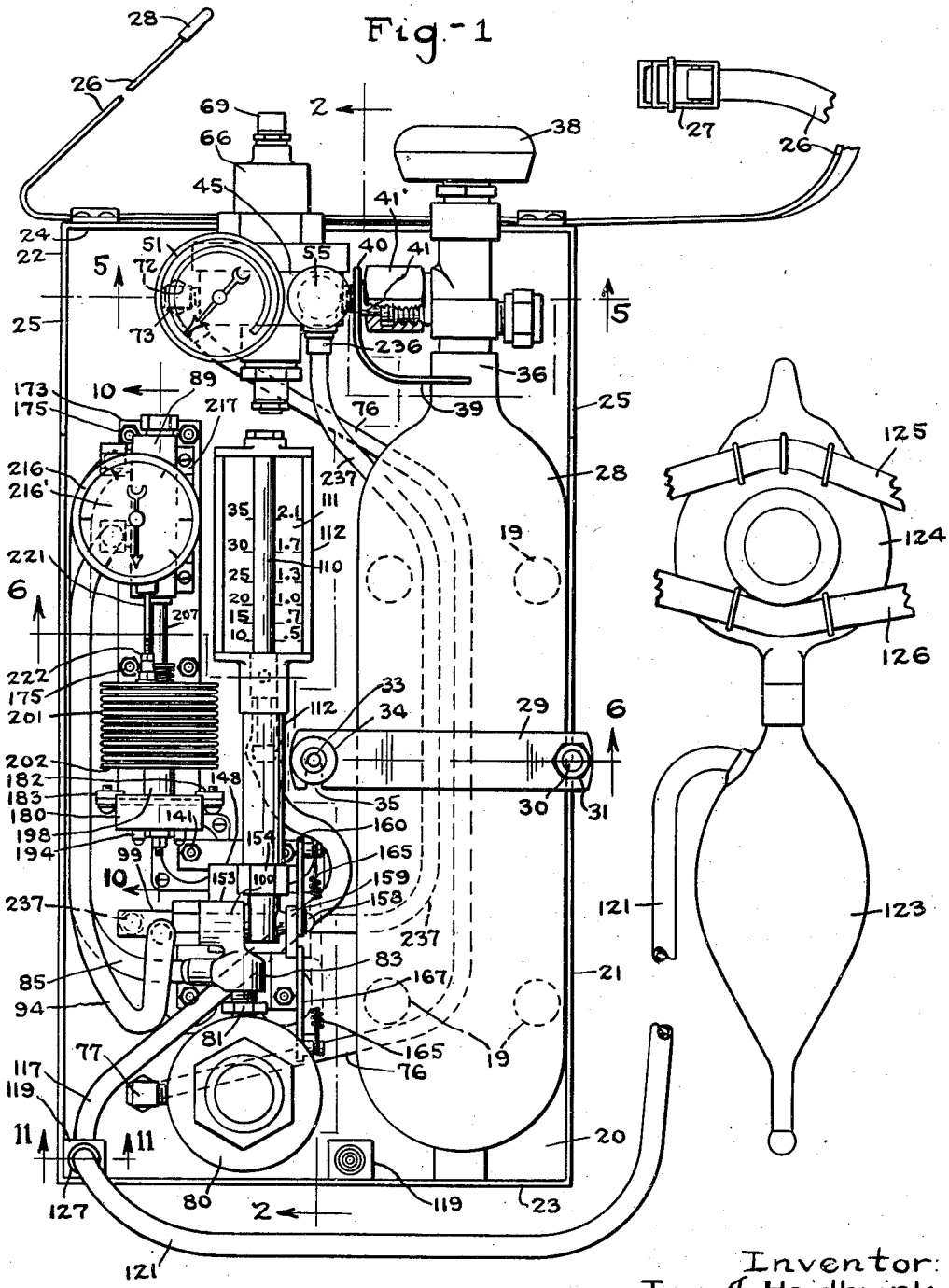
July 13, 1943. J. A. HEIDBRINK 2,324,389

PORTABLE OXYGEN AVIATION UNIT

Filed March 17, 1941 5 Sheets-Sheet 1

Fig. 1



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PORTABLE OXYGEN AVIATION UNIT

Filed March 17, 1941 5 Sheets-Sheet 2

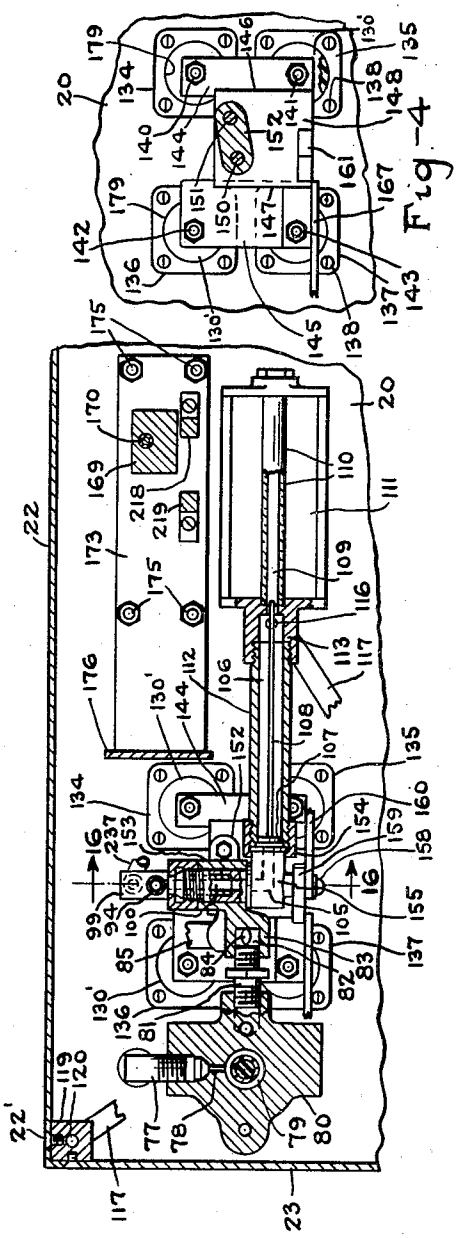


Fig-3

Fig-4

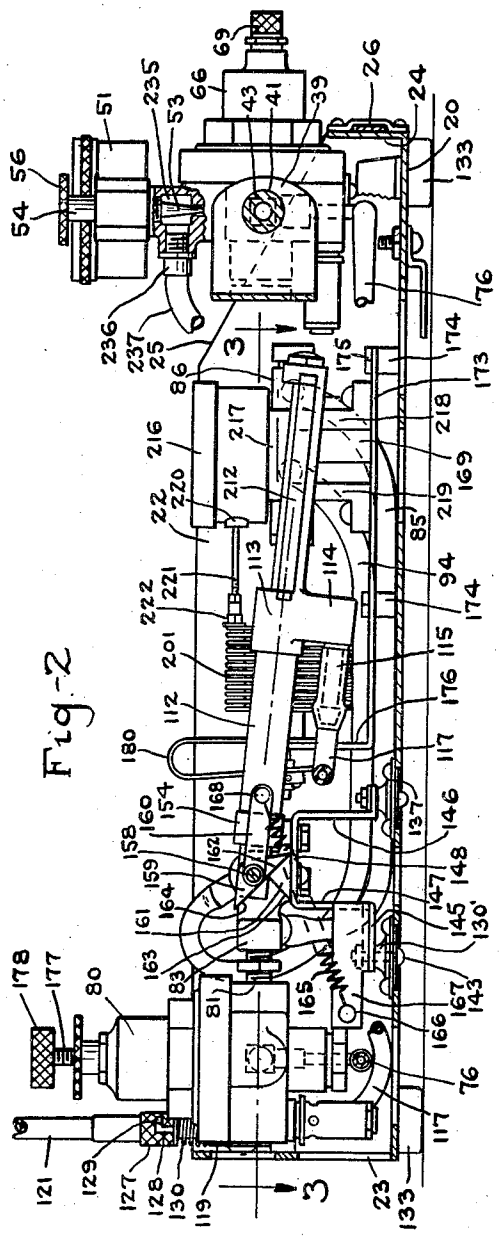


Fig-2

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PORTABLE OXYGEN AVIATION UNIT

Filed March 17, 1941 5 Sheets-Sheet 3

Fig-5

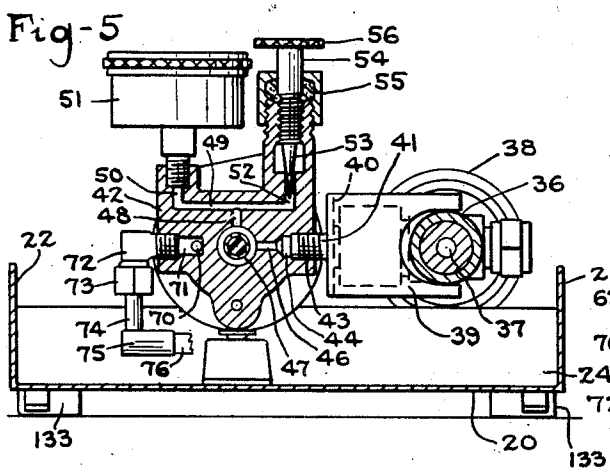


Fig-9

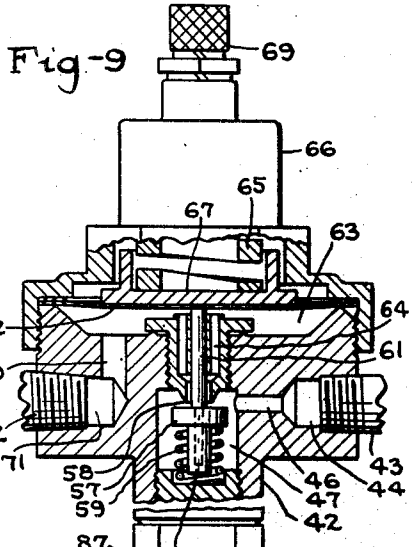


Fig-6

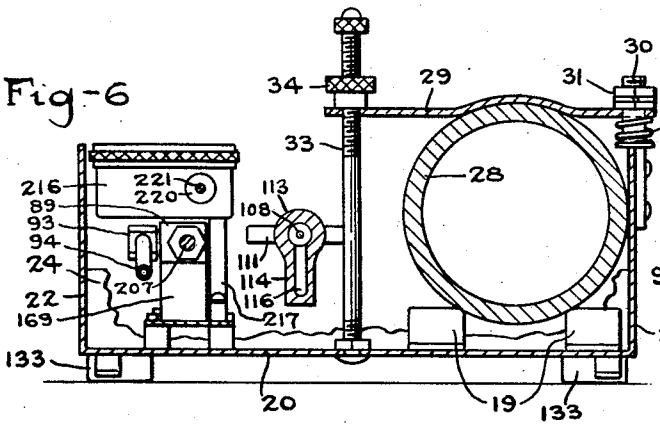


Fig-7

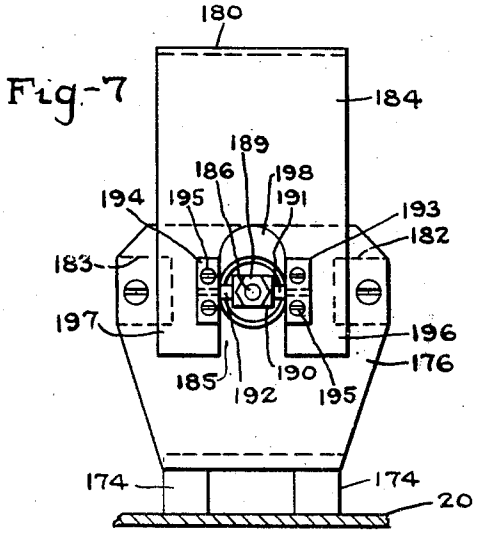
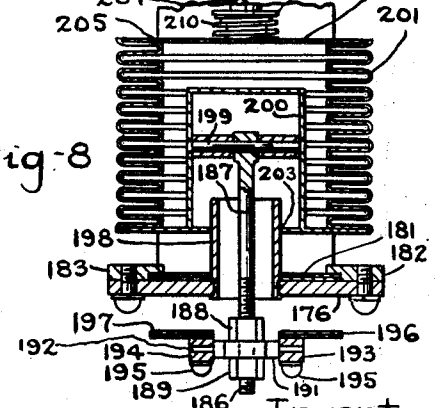


Fig-8



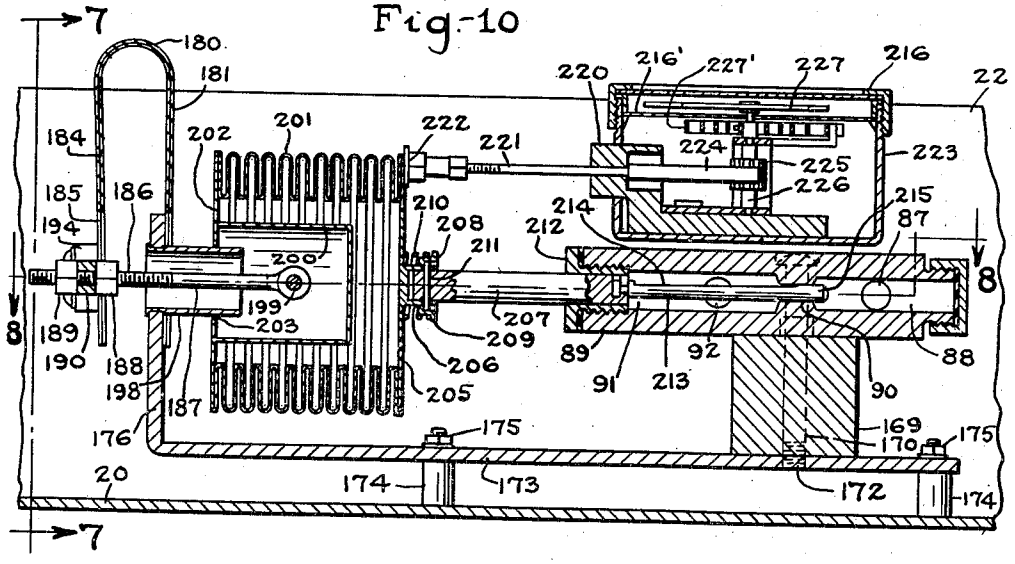
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PORTABLE OXYGEN AVIATION UNIT

Filed March 17, 1941 5 Sheets-Sheet 4

Fig.-10



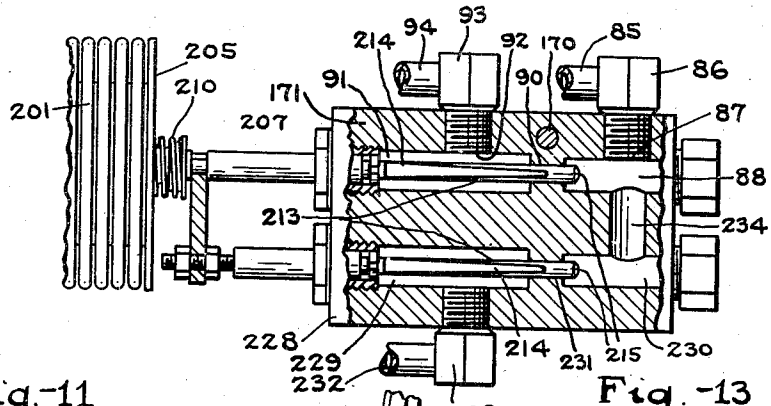


Fig.-13

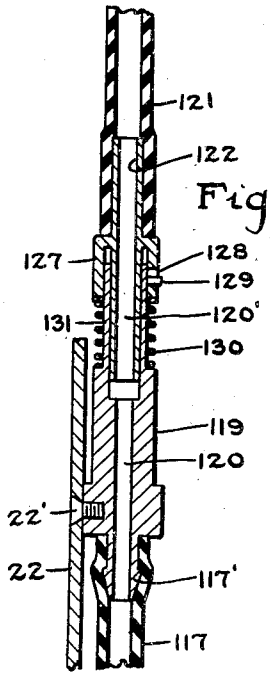


Fig.-11

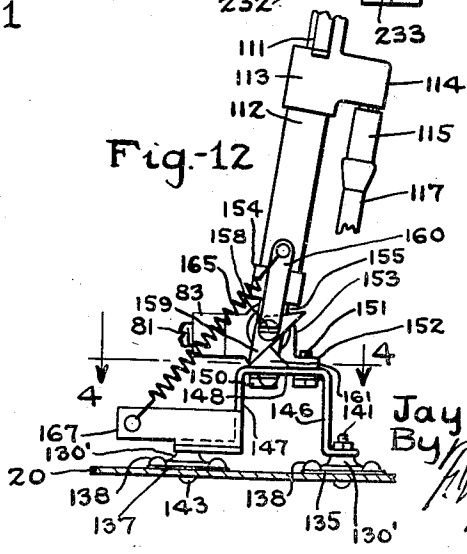


Fig.-12

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July 13, 1943. J. A. HEIDBRINK 2,324,389

PORTABLE OXYGEN AVIATION UNIT

Filed March 17, 1941 5 Sheets-Sheet 5

Fig.-14

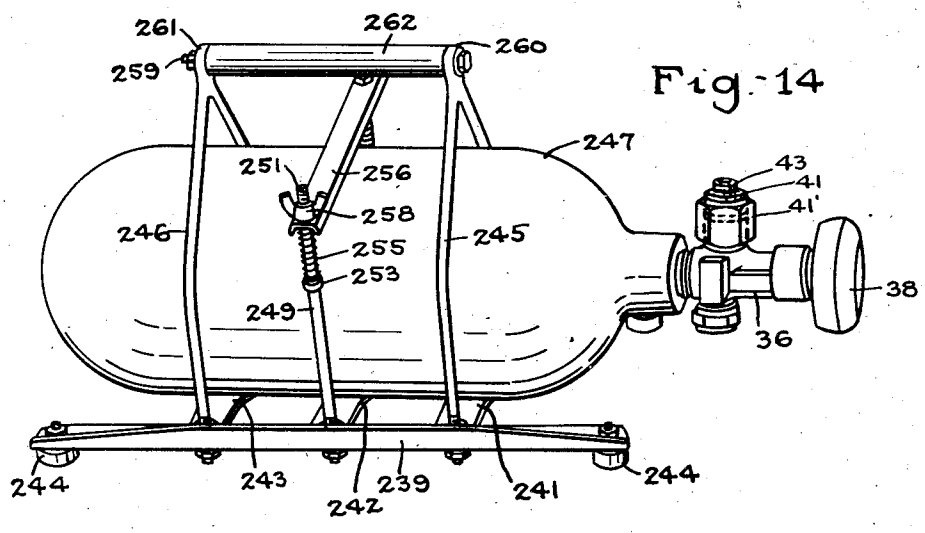
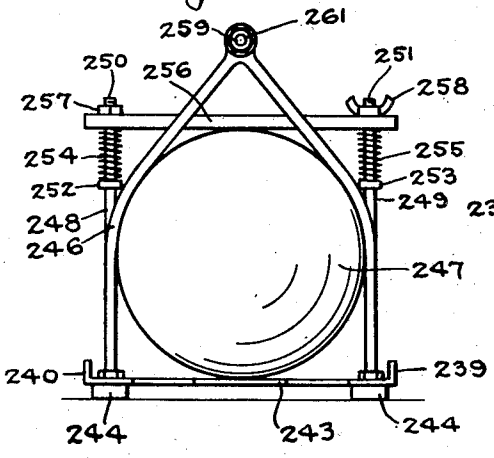


Fig.-15



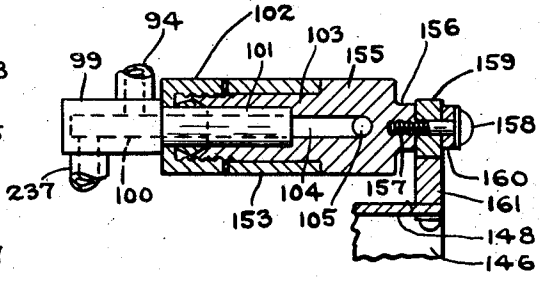


Fig.-16

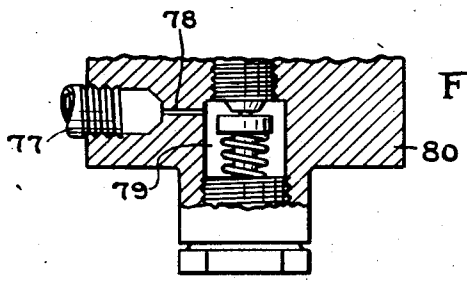


Fig.-17

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Patented July 13, 1943 2,324,389

UNITED STATES PATENT OFFICE

2,324,389

PORTABLE OXYGEN AVIATION UNIT

Jay A. Heidbrink, Minneapolis, Minn., assignor to Air Reduction Company, Incorporated, New York, N. Y., a corporation of New York

Application March 17, 1941, Serial No. 383,713

6 Claims. (Cl. 128—142)

My invention relates to a portable oxygen aviation unit and has for its object to provide in a readily transportable framework or casing a supply of oxygen connected through control means with a suitable mask to be worn by an aviator, passenger or any person in an air transport device which moves to such elevations that added oxygen for respiration is required.

Means for furnishing oxygen to aviators at great altitudes in practice has been provided mounted in and connected with the airplane structure and employing tanks holding relatively large quantities of compressed oxygen, which tanks are necessarily of considerable weight. Such means for supplying oxygen to the pilot or occupants of an airplane at high altitudes necessarily go with the plane, and airplanes which are not so equipped may be for that reason prohibited from going up into high altitudes where it might be desirable to fly the plane. On the other hand such planes may in general not be intended to go to high altitudes. Hence, with my portable unit available at hangars and flying fields, it will be practicable, for flights into high altitudes, to equip airplanes otherwise unequipped with quickly available means to supply a suitable amount of oxygen for such high altitude flights.

It is a principal object of my invention, therefore, to provide a small and relatively light assemblage having therein a tank or container of oxygen with passages connected therewith and control means in said passages, said passages finally connected to a suitable oxygen mask, the entire assemblage being readily transportable, so that one or more of said units may be readily taken into and from any airplane as desired and thereby furnish the pilot and other occupants with sufficient added oxygen at altitudes too high for safe normal breathing of such high altitude atmosphere.

It is a further object of my invention to provide such control means as will regulate the delivery of oxygen in a predetermined volume to the breather with automatic adjustment of said regulation for decreased atmospheric pressure due to elevation and for temperature changes.

The full objects and advantages of my invention will appear in connection with the detailed description thereof, and the particular features of invention by which the desired advantages are obtained are particularly pointed out in the claims.

In the drawings:

Fig. 1 is a top plan view of my oxygen delivering portable unit with some parts broken away.

Fig. 2 is a sectional elevation view taken on line 2—2 of Fig. 1.

Fig. 3 is a sectional partial plan view taken on line 3—3 of Fig. 2.

Fig. 4 is a sectional plan view of a part of what is shown in Fig. 3 taken on line 4—4 of Fig. 12.

Fig. 5 is a sectional transverse elevation view taken on line 5—5 of Fig. 1.

Fig. 6 is a sectional elevation transverse view taken on line 6—6 of Fig. 1.

Fig. 7 is an end elevation view of a part of the unit taken on line 7—7 of Fig. 10.

Fig. 8 is a sectional plan view of a part of the unit taken on line 8—8 of Fig. 10.

Fig. 9 is a part sectional plan view taken through the regulator valve at the top of Figs. 1 and 2.

Fig. 10 is a longitudinal sectional elevation view taken on line 10—10 of Fig. 1.

Fig. 11 is a sectional view taken on line 11—11 of Fig. 1.

Fig. 12 is a side elevation view showing the mounting of the flow gauge to permit it to swing into an erected position.

Fig. 13 is a sectional plan view similar to part of what is shown in Fig. 8 embodying a second gas outlet.

Fig. 14 is a side elevation view of a modified frame for carrying the oxygen tank and parts connected therewith.

Fig. 15 is an end elevation view of the arrangement shown in Fig. 14.

Fig. 16 is a fragmentary sectional view taken on line 16—16 of Fig. 3.

Fig. 17 is an enlarged sectional view through a part of the regulator appearing at the bottom left of Fig. 1 showing the limit port for conducting gases from said regulator into the control system.

As illustrated, an open topped box, Figs. 1, 2, 5 and 6, is provided with a bottom 20, side walls 21 and 22, and end walls 23 and 24, it being noted that side walls 21 and 22 are the same height above bottom 20 as rear end wall 23, but slope downwardly as indicated at 25 to the front end wall 24 which is of considerably less height than rear end wall 23. The box above described comprises the support for the assemblage of various instrumentalities and it may be provided with any carrying or supporting means, such as the strap 26 with buckle 27 and tab 28, as indicated in Fig. 1.

An oxygen tank 28 is normally held upon supporting projections 19 extending upwardly from bottom 20 and against side wall 21 by means of

a bar 29, Figs. 1 and 6, which is secured upon a threaded post 30 by means of a nut 31 bearing against a compression spring 32 and at its other end upon a post 33 having thereon a knurled hand nut 34. As shown in Fig. 1, the inner end of bar 29 is formed with a slot 35. Hence, in order to change tanks it is only necessary to screw up the knurled nut 34 sufficiently to take all pressure off of bar 29 when it can be swung to one side to permit the removal of one tank and insertion of a new tank. The manner in which nut 31 is held upon spring 32 permits this swinging movement.

The oxygen tank 28 is provided with a neck 36 having a passageway 37 leading from the interior of tank 28 and controlled by a valve in said passageway through operation of a valve handle 38 in a customary way. A fork 39, Figs. 1 and 5, has its prongs straddling the neck 36 and is provided with a portion 40 at right angles thereto which is secured by soldering, welding or the like to a shoulder 41, Fig. 5, on a casting 42 surrounding a threaded bolt 43 screwed into an aperture 44 in the casting 42, which forms part of a regulating valve, Figs. 1 and 5, designated generally as 45. The aperture or chamber 44 has connected therewith a port or passageway 46 which leads into a valve chamber 47, Fig. 9. As shown in Fig. 5, a port or passageway 48 leads from the chamber 47 to a transverse passageway 49. One part, 50, of passageway 49 leads to the primary pressure gauge 51. A second branch 52 from passageway 49 leads to a needle valve 53 which has its shank 54 passing through the stuffing box 55 and is controlled by thumb screw 56 on the shank 54 for a purpose later to be given.

Referring to Fig. 9, within the valve chamber 47 is a valve head 57 urged toward a valve seat 58 by a compression spring 59 surrounding the valve stem 60. A guide pin extension 61 projects from the valve disc 57 and engages with its free end a diaphragm 62 forming and sealing the top of a chamber 63. Passages 64 lead from valve chamber 47 into diaphragm chamber 62. A powerful compression spring 65 in a housing 66 engages a plunger 67 which in turn engages the diaphragm 62 and tends to force it against the end of pin 61 so as to push valve disc 57 away from the valve seat 58. By means of a knurled nut 69 the degree of pressure which the spring 65 exerts upon the diaphragm 62 may be varied as desired whereby the pressure at which the gas is delivered, as indicated by the gauge 51, may be regulated.

For normal operation the gas passes from diaphragm chamber 63 through a port opening 70 to a passageway 71. From passageway 71 the gas passes to a chamber in a head 72 to which is secured by a union 73, Fig. 5, pipe connections 74 and 75 with a flexible tubing connection 76 which runs, as indicated partly in dotted lines in Fig. 1, to a similar union connection 77 through a port 78 to a valve chamber 79 in a regulator valve block 80, from whence it passes through a union paessageway indicated at 81, Figs. 1 and 3. From passageway 81 the gas goes to a chamber 82 in a block 83, Fig. 3, and thence through a port 84 and a pipe 85, Figs. 1 and 8, to a block 86 from which leads a port passageway 87, Figs. 8 and 10, entering a valve chamber 88 having a valve control hereinafter to be described.

As shown in Figs. 3 and 17 the port 78 leading from passageway 77 is a limit port which conveys the gas into the valve chamber 79 in block 80. Regulation of volume of flow of gas from valve chamber 79 is easily effected in a well known way by valve plunger 177 operated by valve handle 178 so that more or less gas will pass in a customary manner to the union passageway 81. This arrangement is employed in practice where it is found desirable to pass more or less gas through the flow valve by increasing or decreasing its delivery pressure.

The valve chamber 88 is located in an elongated block 89. From valve chamber 88, Fig. 8, the gas is adapted to pass through a valve passageway 90 which is controlled by thermostat and aneroid means later to be described. From the passageway 90 the gas passes into a chamber 91 and thence through a port 92 into a connector block 93, Fig. 8, thence by means of a flexible tube 94, Figs. 1 and 8, to a passageway within a second connector block 99, continuous with a passageway indicated in dotted lines at 100, Figs. 1 and 16.

Passageway 100 is continuous with a passageway through a tube 101 which extends through a stuffing box 102 into a casting 103, Fig. 16. The gas then passes through a bore 104 in casting 103 to a passageway 105 which extends into a passageway 106, Fig. 3, having diverging walls. In passageway 106 is a piston 107 and stem 108 of a flow gauge, the stem 108 extending into a central passageway 109 of a glass tube 110 which is adjacent a gauge plate 111, Fig. 1. As clearly shown, this plate has on one side altitude designations, the figures indicating thousands of feet, and flow designations which indicate liters of oxygen delivered per minute. Passageway 106 is formed in a tubular member 112 which is united with a casting block 113 that carries the tube 110 and the gauge plate 111. Block 113 has an extension 114 carrying a nipple, shown in dotted lines at 115 in Fig. 2. An opening 116, Fig. 3, leads through said block and nipple so as to discharge into a flexible tube connection 117 which is secured, as indicated in Figs. 2 and 12, to the nipple 115.

The tube 117 is connected by means of a nipple 117' to a passageway 120 in a block 119, Figs. 1, 3 and 11, the block 119 being secured to a wall 22 by means of a screw 22'. As shown in Fig. 11, the passageway 120 is continued through a passageway 120' in an extension member 122 which forms a nipple for receiving the main oxygen delivery tube 121.

The tube 121 leads to a rebreathing bag 123 of an oronasal mask structure 124 adapted to be secured by straps 125 and 126 upon a wearer, the tube 121 being of suitable length to permit such securing. It will be noted that the escape opening 116 from passageway 106 is at the end of said passageway remote from the gas inlet end, which, traveling against the piston 107, forces it and the indicator rod 108 along the passageway 106 until the opening about piston 107 is sufficient to deliver the indicated amount of oxygen; and the end of the rod 108 in glass tube 110, adjacent the columns of figures at either side thereof on the gauge plate 111, indicates the volume of oxygen being delivered at different altitudes so that the pilot or operator will at all times be informed as to whether a sufficient delivery of oxygen is in fact taking place.

It may be desirable to separate the tube 121 from the assemblage on the support and to facilitate this I provide a narrowed finger piece 127, Figs. 2 and 11, which is held for ready removal by a bayonet slot 128 in which is received a pin 129 fast on the member 122, and a spring 130

surrounding an extension 131 from the block member 119 holds the parts in assembled position.

The support formed by the bottom 20 and side walls 21, 22, 23 and 24 is provided with feet 133, preferably of rubber, upon which the entire unit assembly may rest on a table, shelf, or the floor of an airplane, in any position convenient for observation. As the unit is carried the flow gauge structure, consisting of the parts 111, 112 and 113 is depressed into a semi-horizontal position, as shown clearly in Fig. 2. This also is the position of this flow gauge device as it appears in Figs. 1 and 3. It is frequently desirable, however, to have this flow gauge in an erected position and the mounting for permitting that is shown in detail in Figs. 1, 3, 4 and 12.

Four plates 134, 135, 136 and 137, each formed with a central circular opening 179 secured in position by means of screws 138 a set of rubber discs 130' overlying similar openings on the bottom member 20 to which the plates are screwed. Stands comprising bolts 140, 141, 142 and 143 are secured upon the rubber discs and in turn support bottom plates 144 and 145 of a bracket member, U-shaped in cross section, having vertical limbs 146 and 147 and a horizontal table portion 148 supported thereby. Parts carried by the table 148 are thus cushioned against vibration or shock.

Bolted to the top plate 148, as indicated in Fig. 4, by means of bolts 150 and 151 is the base 152, Figs. 4 and 12, of a supporting standard 153 through which extends the passageway 100 and to which is integrally united the block 83, Figs. 1 and 3. Secured to the lower end of tube 112 by means of a nut 154 is an extension member 155 through which passes the wire 105, Figs. 3 and 16, and which has in it the bore 104 leading to the gas passageway 100. The extension 155 has the laterally extended tubular portion 103 journaled inside of the supporting member 153, as clearly shown in Fig. 16.

The extension member 155 has formed thereon a centrally positioned boss 156 with a central threaded opening 157. A screw bolt 158 threaded into said opening secures to the boss in rigid position a triangular stop-piece 159 and a projecting arm 160, these parts being held rigidly in adjusted position by means of a screw bolt 158. A triangular stop 161 is adapted to have its faces 162 and 163 engaged by opposite end portions of the face 164 of the triangular stop-piece 159. A spring 165 is connected at 166 to a point near the end of a plate 167 fast on the bottom plate 145 of the bracket member. This spring is secured at its other end at 168 to the outer end of arm 160 and is so positioned that it swings past center to go from one position to another, as shown in Figs. 2 and 12 respectively, thereby holding with a toggle action the flow gauge in either its depressed or erected position as may be desired.

The block 89, as shown in Fig. 10, is secured to a supporting standard 169 by means of a bolt 170 which extends through the side wall 171 of the block 89 and through the supporting standard 169 as indicated in dotted lines in Fig. 10. The bolt 170 is threaded at 172 into a bracket plate 173 which is supported on posts 174, Fig. 10, secured by bolts 175 extending through the bracket plate 173 and posts 174, and the bottom plate 20, as clearly shown in Figs. 1 and 10. The posts 174 rest upon the bottom plate 20 and thus support the bracket plate 173. Bracket plate 173 has an upstanding bracket portion 176 of the form shown in Fig. 7. A bimetallic U-shaped thermostatic member 180 has one of its arms 181 secured by means of screw clamp plates 182 and 183 to the wing portions of bracket plate 176, as shown in Figs. 1 and 7.

The U-shaped thermostatic member 180 has its second arm 184 bifurcated at 185. The threaded end 186 of a rod 187 is provided with two nuts 188 and 189 which clamp between them a block 190 having thereon diametrically opposed outwardly extending trunnion members 191 and 192 which have portions extending between clamping blocks 193 and 194 fastened by screws 195 to the respective portions 196 and 197 of the thermostat leg 184 which is thereby pivotally or swingably connected with the rod 186.

Rod 187 extends through a tubular member 198 and is pivotally connected by means of a pin 199 with a cylindrical member 200 which is sealed within the body of an aneroid 201, as clearly shown in Figs. 8 and 10. The aneroid 201 is supported for sliding movements on the cylindrical extension 198 by a free fit of an opening in end wall 202 of the aneroid surrounding and engaging the cylindrical member 198, as indicated at 203 in Fig. 10. It follows that the position of the aneroid 201 is at all times dependent upon the relative positions of arms 181 and 184 of thermostat 180, that is, when, due to change in temperature, the arm 184 moves to the left, as shown in Fig. 10, it will cause the entire body of the aneroid to partake of that movement. When it moves to the right the body of the aneroid will correspondingly move in the opposite direction.

The end plate 205 of aneroid 201 is provided with a cup extension 206, Fig. 10, which is adapted to receive the end of a plunger shaft 207. A washer cap 208 with a flange portion 209, together with a spring 210, is adapted to hold a pin 211 extending through an opening in the end of rod 207 coupled to the cup portion 206.

The plunger rod 207 has a gas tight fit in an opening through a cap nut 212 threaded into the block 89 and is adapted to be moved along the block by movement of the wall 205 of aneroid 201. This movement takes place because of the bodily movement of the aneroid 201 by thermostat 180 and by the expansion of the thermostat itself due to changes of external pressure, such expansion thrusting against thermostat arm 184 and being translated to the front wall 205 of the aneroid.

Connected to the end of plunger shaft 207 and within chamber 91 of block 89 is a valve rod 213 which, as clearly shown in Figs. 9, 10 and 13, is cut away along one face, as indicated at 214. The diameter and circumference of the valve rod 213 are such that its end has a gas-tight fit in the opening 90 connecting chambers 88 and 91 in block 89. The cut-away portion 214 of valve rod 213 does not extend to the outer end of that rod but there is left a cylindrical portion 215 which will completely close the passageway between chambers 88 and 91 at normal elevations and temperatures, as clearly shown in Figs. 8, 10 and 13.

The operation of these instrumentalities will be apparent from the foregoing description. At normal elevations, such as those in which usually airplanes leave the ground, no oxygen will be passing to the mask because the flow of oxygen at its predetermined pressure is blocked by valve rod 215 in valve opening 90, and of course the mask will not then be worn. As higher elevations are reached and pressure falls the aneroid

201 expands and its front wall 205 operates to push the plunger 207 outwardly and with it the valve rod 213 and its cylindrical end 215. When this movement has progressed far enough to bring the end of the cut-away portion 214 beyond the opening 90 oxygen will begin to flow through opening 92 and tube 94 past flow gauge 112 and through pipes 117 and 121 to the rebreathing bag 123 and mask 124 where the wearer obtains the oxygen. As higher and higher elevations are reached the aneroid continues to expand with the result that the opening provided by cut-away portion 214 continually grows greater, so that, without changing the pressure at which the oxygen is delivered to the system, the flow is automatically increased for different elevations, as shown by the flow gauge 112, by regular increase of the delivery port opening.

But as higher altitudes are reached, there will inevitably be increased cold which will cause the air or gas within the aneroid to tend to decrease in density volume thus offsetting to some degree the movement of the end 205 of aneroid 201, so that uniform increase of port opening for uniform increase of elevation and pressure will not take place. However, as the cold decreases the density volume of air within the aneroid the bimetallic thermostatic member will move the aneroid and its end plate 205 bodily in the same direction that the expansion of gas within the aneroid moves the end plate 205 with the result that the component of these two movements will always be the same as would be the case if the temperature of the gas within the aneroid remained constant at its starting temperature. In this way temperature changes are compensated so that uniform and accurate increase or decrease of delivery of oxygen is effected as changes in elevation and consequent changes in atmospheric pressure are encountered.

An important feature of my invention is related to the above defined and explained means for temperature compensated adjustment of flow valve opening in the provision of an altimeter operated thereby, which is particularly accurate because of the aforesaid adjustment for temperature, and which may be observed both for determining the elevation to which the plane has been flown and as a check on the delivery of gas for given elevations shown by the flow gauge.

For the purpose of providing this accurate altimeter a gauge 216 is formed with a face plate 216 of Figs. 1, 2 and 3, which gauge is supported upon a bracket 217, Figs. 1 and 2, having depending arms 218, 219, Figs. 2 and 8, screwed to the bracket plate 173. The gauge has thereon a gauge extension 220, and through an opening therein runs a rod 221 held at 222 by means of a spring 227' in continuous contact with the front wall 205 of the aneroid 201. The rod 221 has attached thereto within guage casing 223 a rack 224, Fig. 10, engageable with a pinion 225 on a shaft 226 upon which is mounted the gauge needle 227 and the coil spring 227.

Calibrations on the face 216' of gauge 216 are placed to indicate elevations or altitudes in thousands of feet and of course reflect the extent of outer movement of the end plate 205 of aneroid 201 and in effect the degree of opening of the volume valve controlled by the valve rod 213. Observation of the altimeter gauge 216 made in conjunction with observation of the flow valve 112 gives visibly to the aviator or other occupant of an ascending plane the actual elevation at any time, and by comparison of that elevation with the elevations shown on the flow meter calibration plate 111 will inform of whether the delivery of oxygen at any indicated elevation is such as it should be.

As shown in Fig. 13, instead of a single gas delivery chamber such as 88 in block 89 a wider block 228 may be employed having a second (or larger number) gas delivery chamber 229 and a gas inlet chamber 230 connected with gas inlet chamber 91 by a passageway 232 and having a valve opening 231 into gas delivery chamber 229. A second (or larger number) gas tube 232 receives gas from chamber 229 through a connection 233 identical with the connection 86. In this manner a plurality of individuals (in the example shown two) may be simultaneously served with automatically controlled added oxygen gas.

The above recited instrumentalities provide means for automatically controlling flow of oxygen to one or more aviators or other occupants of an airplane at varying altitudes. Since, however, from various causes such automatic devices sometimes fail I have provided in conjunction with the flow valve which shows the volume of gas going to the wearer of the mask at designated elevations, a second and independent means comprising a hand valve and connections for controlling the flow of gas to the mask. This hand valve is the needle valve 53—56 heretofore described. As shown in Fig. 2, gas passes through the valve passageway 52 and past the needle valve 53, adjustable by the hand screw 56, into a chamber 235 from which it passes from a connection 236, Fig. 2, to a delivery pipe 237, shown in full and dotted lines in Fig. 1.

Pipe 237, as clearly shown in Figs. 2 and 16, delivers to the passageway 100 through block 99 and tube 101 to passageway 104 and thence through passageway 105, Fig. 3, to passageway 106 in flow valve tube 112 and from there through pipes 117 and 121 to the mask 124. Thus the gas controlled by the needle valve 53—56 passes through the flow valve to the pipe 117 in the same manner as gas which is automatically regulated by the aneroid and thermostat heretofore described, and a perfect safety arrangement is provided for the use of mask wearers at high altitudes if and when the automatic control should fail.

As shown in Figs. 14 and 15 a modified support may be employed which is quite practical for somewhat larger gas tanks than can be conveniently assembled in the support of Fig. 1. This support comprises side bars 239, 240 connected by transverse bars 241, 242 and 243. Feet 244, preferably of rubber, are secured to the bars 239 and 240. Spanners 245 and 246 are positioned to permit the tank 247 to be inserted through them so as to rest upon transverse bars 241, 242 and 243. Vertical posts 248 and 249 extend on either side of the tank 247 and are provided with threaded upper ends 250 and 251 and with shoulders 252 and 253 supporting compression springs 254 and 255. Upon the threaded ends 250 and 251 of posts 248 and 249 is mounted a movable cross bar 256 which engages the springs 254 and 255 and also engages the center of tank 247. An ordinary nut 257 screwed on the post 250 holds one end of the cross bar 256 and a hand nut 258 similarly holds the other end of cross bar 256 on the end 251 of post 249. By screwing down on the hand nut 258 the tank 247 may be held firmly by cross bar 256. A bolt 259 extends between ends 260 and 261 of spanners 245 and 246 and supports a handle 262.

The tank 247 so far as its gas outlet valve ar-

rangement is concerned is identically the same as the tank 28 comprising a neck 36, a valve handle 38, and a connecting nut 41 and nipple 41'. In practice the nut and nipple of the construction of Fig. 1 will lie parallel with the bottom plate 20 and thus be held normally horizontal while the nut and nipple 41—41' of Fig. 14 will be extended transversely to the plane of its support and therefore extend normally vertical. The parts shown in Figs. 14 and 15 are the same in operative arrangement as the parts of Figs. 1 to 13 and make their connection with the nipple 41' in the same way, so showing of the details of their manner of support is eliminated as unnecessary.

The advantages of my invention have appeared quite fully in connection with the detailed description thereof heretofore given. Some of these advantages, as is readily understood, reside in the fact that a complete oxygen delivery unit for aviation purposes, including a tank of oxygen at suitable pressure, is assembled in a compact manner upon a single simple support which can be transferred from place to place and taken into any airplane, whether for military or commercial purposes, which it is desired to take into altitudes so high that the administration of oxygen becomes necessary.

Another advantage resides in the fact that the unit provides automatic aneroid and thermostatic control for varying flow of oxygen to meet conditions at varying elevations and pressure and at varying temperatures, and also manual means for controlling the flow of oxygen independently of the automatic means if and when that should fail. Further, the unit provides a system of gauges and a flow valve positioned and adapted to be positioned to be easily observed wherever the unit may be set relative to an aviator or occupant of the plane, which gauges will at all times inform the wearer of the mask, or the operator of the airplane, of the volume of oxygen which he is receiving whether from the automatic control means or the hand controlled means, and which will advise him of any failure or tendency of failure of the automatic control means so that he can meet the danger resulting from such failure by employing the hand controlled means.

Further, the invention provides a highly efficient flow valve construction jointly operated for variations of air pressure (altitude) and temperature by an aneroid and a thermostat to produce exceptionally effective and dependable control of the flow of oxygen through automatic variation of the extent of port opening to control the volume of flow as shown by the flow gauge, and as required by conditions of atmospheric pressures and temperatures.

A further very great advantage of my invention resides in the fact that the arrangement for accurately opening the flow valve more or less according to elevation and temperature by the joint operation of an aneroid and bimetallic thermostat member not only accomplishes correct increase and decrease of flow of oxygen for different elevations at different temperatures, but also, through the same movement of the valve operating means so effected, operates the needle of an altimeter to show with extraordinary accuracy the actual elevation of the plane at any time. This altimeter is thus operated with a high degree of accuracy for elevation through the aneroid with compensating bodily adjustment for temperature by the thermostat.

A further advantage of the invention resides in the fact that the aforesaid altimeter and flow gauge may be observed simultaneously. The altimeter shows correctly the elevation, and the flow gauge indicates what volume of gas should be delivered at that elevation and of course will show to the operator whether in fact delivery of oxygen gas is taking place at the rate called for for the actual elevation shown.

I claim:

1. In a portable oxygen aviation unit an oxygen tank and means for supporting it, a mask and means for conveying oxygen from the tank to the mask including an aneroid and a variable flow gauge, a valve adapted to cooperate with said aneroid comprising two chambers separated by a web having a valve opening therethrough connecting the chambers, a valve rod carried through one of said chambers and said opening and having a circumferential diameter adapted to seal said opening gas-tight, said valve rod being progressively cut away from zero to a maximum depth along one side thereof, so that expansion of the aneroid will move the rod through said opening and first produce a minimum flow opening which will then be progressively and uniformly increased as the aneroid expands from going into higher elevations and lower pressures.

2. In a portable oxygen aviation unit an oxygen tank and means for supporting it, a mask and means for conveying oxygen from the tank to the mask including an aneroid and a variable flow gauge adapted to cooperate with said aneroid, said valve comprising two chambers separated by a web having a valve opening therethrough connecting the chambers, a valve rod carried through one of said chambers and said opening and having a circumferential diameter adapted to seal said opening gas-tight, said valve rod being progressively cut away from zero to a maximum depth along part of one side thereof, so that expansion of the aneroid will move the rod through said opening and first produce a minimum flow opening which will then be progressively and uniformly increased as the aneroid expands because of going into higher elevations and lower pressures.

3. In a portable oxygen aviation unit an oxygen tank and means for removably supporting it, a mask and means for conveying oxygen from the tank to the mask including a variable flow valve, an aneroid adapted to operate said valve, a thermostat rigidly mounted on said supporting means, means connecting the aneroid with said thermostat adapted to move the aneroid bodily, and a connection from said aneroid forming part of said variable flow valve whereby the aneroid and the thermostat in moving the same bodily jointly effect opening of the variable flow valve to a greater or less degree according to enveloping conditions of air pressure and temperature.

4. In a portable oxygen aviation unit an oxygen tank and means for removably supporting it, a mask and means for conveying oxygen from the tank to the mask including a variable flow valve, an aneroid adapted to operate said valve, a thermostat rigidly mounted on said supporting means, means connecting the aneroid with said thermostat adapted to move the aneroid bodily, a connection from said aneroid forming part of said variable flow valve whereby the aneroid and the thermostat in moving the same bodily jointly effect opening of the variable flow valve to a greater or less degree according to enveloping

conditions of air pressure and temperature, a gauge calibrated to show elevations in thousands of feet including a gauge needle, and a connection from said aneroid whereby joint action of the aneroid and of the thermostat moving the aneroid bodily will operate the needle to provide a temperature compensated altimeter.

5. In an oxygen aviation unit an oxygen tank and means for removably supporting it, a mask and means including a regulating valve and a flow gauge for connecting the mask to the tank, said flow gauge carrying indications of volume of oxygen being delivered for indicated altitudes, means for automatically controlling the flow of oxygen from the regulating valve through the flow gauge to a mask at varying altitudes and temperatures, and an altimeter operated by said automatic controlling means for indicating elevations, whereby the operator by inspection of the altimeter and flow gauge will be informed as to whether the correct volumes of oxygen are being delivered for the altitude indicated on the altimeter.

6. In a portable oxygen aviation unit a casing forming a support adapted to be transported by hand into or out of an airplane, a tank of oxygen removably mounted in the casing, means in the casing including a system of conduits and a mask for conveying and delivering oxygen to an aviator, a variable flow valve in the casing for controlling the rate of flow or volume of gas going to the mask, an aneroid having an operator member for automatically operating the flow valve in response to changes of external pressures at different elevations, a thermostat mounted on the aneroid and adapted to move it and the operator member on the aneroid member bodily when changes of temperature occur to compensate for variations of gas expansion in the aneroid due to such changes of temperature, and an altimeter with connection therefrom to the aneroid whereby the joint action of aneroid and thermostat moving it bodily will cause the altimeter to show correct temperature-compensated altitudes.

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