Oct. 19, 1937. W. H. FREYGANG 2,096,612

ALTITUDE BREATHING SUIT

Filed March 30, 1935 2 Sheets-Sheet 1

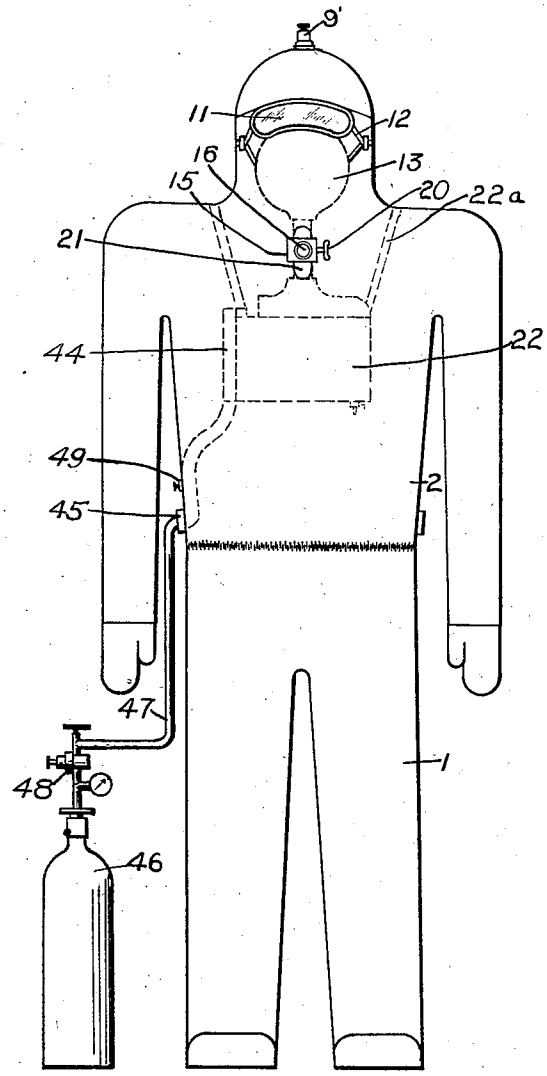


FIGURE 1

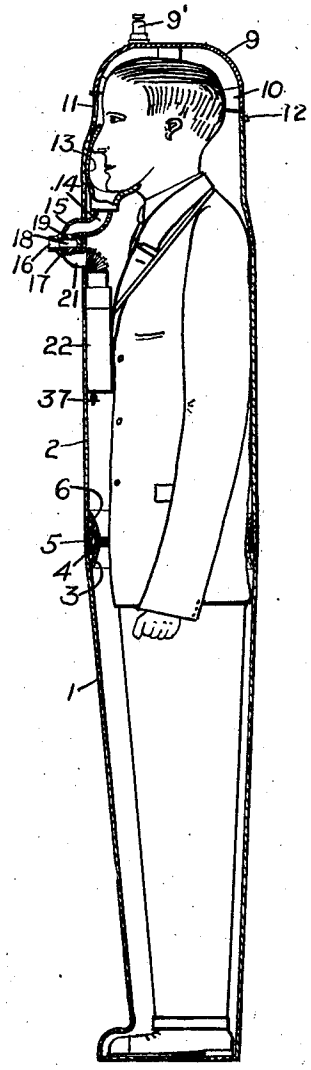


FIGURE 2.

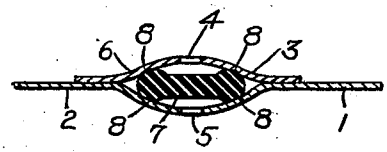


FIGURE 3.

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ALTITUDE BREATHING SUIT

Filed March 30, 1935 2 Sheets-Sheet 2

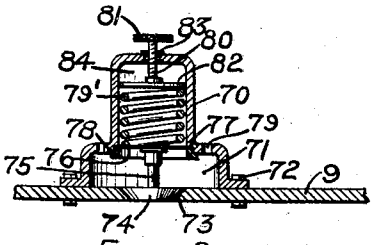


FIGURE 8

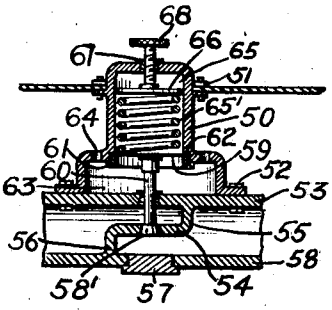


FIGURE 7

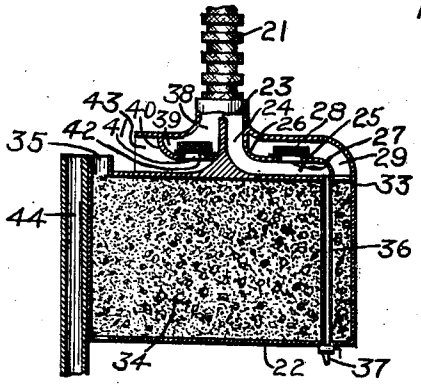


FIGURE 4

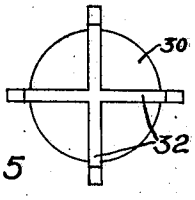


FIGURE 5

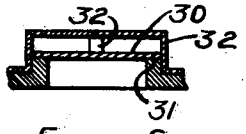


FIGURE 6

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ALTITUDE BREATHING SUIT

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Application March 30, 1935, Serial No. 13,846

8 Claims. (Cl. 128—144)

The present invention relates to aviators' suits for use at high altitudes and, more particularly, it relates to a suit which envelopes the aviator completely and permits him to secure the air necessary for breathing from within the suit.

A person entering a rare atmosphere, such as is encountered at high altitudes, must employ some artificial means in order to maintain normal respiration. The necessity for some artificial breathing aid arises from the fact that the oxygen content of the air at high altitudes is very much lower than that of air at sea level and it usually is insufficient to support life. It is therefore necessary to supply the breather with the deficiency of oxygen that occurs in the air and this has, in the past, been accomplished by furnishing the breather with pure oxygen in small quantities. There have been a great many disadvantages to this method and it has been found that it is preferable to mix the oxygen with the air which is to be used, in quantities sufficient to maintain the oxygen content of that air high enough to permit normal respiration.

It is accordingly an object of the present invention to provide a leakage proof suit enveloping the person completely and in which a pressure different from the pressure of the surrounding atmosphere may be automatically maintained.

A further object is to provide means which allow the wearer of the suit to breathe the external air as long as it is suitable for breathing purposes and to thereafter permit the wearer to breathe the air in the suit.

Another object of the invention is to provide means whereby the air in the suit may be recirculated and thus permit rebreathing, thereby conserving the supply of oxygen. An aviator is thus enabled to make longer sustained flights with the same quantity of oxygen which it is now customary to carry for shorter flights.

It is a further object to provide means to remove the obnoxious carbon dioxide, moisture, and other deleterious matter from the air and to replace the removed matter by pure oxygen.

It is another object to provide a means to automatically relieve the pressure in the suit when it rises above a predetermined pressure.

It is still a further object to automatically regulate the introduction of pure oxygen into the suit by permitting the reduction in pressure within the suit due to the removal of the carbon dioxide, etc. to control means to admit more oxygen.

These and many other objects as will appear from the following disclosure are secured by means of this invention.

This invention resides substantially in the combination, construction, arrangement, relative location of parts, steps and series of steps all as will be set forth in detail in the following specification in connection with the attached drawings and defined in the appended claims.

Referring to the drawings:

Figure 1 is an elevational front view of one form of device embodying the principles and construction of this invention;

Figure 2 is a side cross-sectional view of the suit of Figure 1;

Figure 3 is a cross-sectional view of the sealed suit joint of Figure 1;

Figure 4 is a cross-sectional view of the air purifier of Figure 1;

Figure 5 is a top elevational view of one of the flutter valves of Figure 4;

Figure 6 is a side cross-sectional view of the flutter valve of Figure 5;

Figure 7 is a cross-sectional view of the valve 49 of Figure 1;

Figure 8 is a cross-sectional view of the valve 9' of Figure 1.

Similar reference numerals indicate like parts in all the figures where they appear.

With reference to Figure 1, the suit of the present invention comprises a pair of trousers 1 and a shirt 2. Both the trousers and the shirt are made of some impervious fabric through which air cannot pass. The trousers are provided with feet which fit over the wearer's shoes and thus prevent any air leakage into the trousers at the wearer's feet. At the waist line of the trousers is an inner flap 3 shown in Figure 2. The lower end of the shirt 2 has an inner flap 6 corresponding to the flap 3 of the trousers. The free end of the flap 3 has attached thereto one part of a zipper 4. The other part of the zipper is attached to the free end of the corresponding flap 6. These two parts of the zipper may be joined to secure the trousers to the shirt. The end of the fabric at the waist line of the trousers and the edge of the shirt fabric have coacting parts of a zipper 5 attached thereto, and this zipper likewise serves to secure the trousers to the shirt.

The function of the zippers 4 and 5 is to aid in securing an airtight joint between the trousers and the shirt. The method of forming this sealed joint is best illustrated by reference to Figure 3. When the wearer desires to wear the suit he puts on the shirt 2, pulls up the trousers 1, and joins

the flaps 3 and 6 by means of the zipper 4. In the pocket formed by the union of the flaps and the outer ends of the shirt and trousers is placed a gasket 7 which is made of rubber or some other springy material impervious to air. The gasket has enlarged ends, the purpose of which will be readily apparent. The zipper 5 on the outside of the suit is next closed to enclose the gasket. The gasket is normally made somewhat larger than the space into which it is forced by closing of the zippers and consequently compresses and makes air tight seals against the fabric of the suit and of the flaps, at the points 8, thus forming a suit enclosing the wearer from all undesired contact with the external air.

The shirt 2 is loose fitting and is joined to a headpiece 9, which may be of aluminum or some other light weight material. The headpiece is supported by the wearer's head through the use of rests 10 which prevent the headpiece from directly contacting the head.

Directly below the front of the headpiece and as part of the suit are the goggles 11, through which the wearer may see. The goggles are held close to the wearer's face by the external straps 12. Inside of the suit and positioned so as to cover the wearer's nose and mouth is a mouthpiece 13, which is likewise held in position by the straps 12. The mouthpiece is designed to fit over the wearer's nose and cheeks and under his chin in a manner which will effectively seal off this portion of the wearer's face from the remaining air space in the suit.

Extending from the bottom of the mouthpiece, is a passage 14 which leads to the external atmosphere through a fitting 15. In the fitting 15 is a passage 16, through which communication with the external air may be had. The passage 16 and the passage 14 may be put into communication through the medium of an ordinary three-way valve 17 having passages 18 and 19 and equipped with a handle 20. The handle 20 furnishes the means whereby the wearer can control the source of his air supply for breathing. The valve may be placed in the positions shown in Figure 2, and the wearer will then breathe the external air. If, however, the external air is not desirable for breathing, the handle 20 need only be turned so that the passage 18 is vertical and the passage 19 faces towards the inside of the suit. The air in the suit will then be supplied directly to the wearer of the suit.

When the valve is turned in the last named direction, the passage 14 through the fitting 15 is in direct communication with the flexible tube 21, which is in turn secured to the breath purifying apparatus 22. The purifying apparatus 22 is carried on the wearer's chest and is supported by the shoulder straps 22a.

The breath purifying apparatus 22 is illustrated in detail by Figure 4. The flexible tube 21 connects with the passage 23, in the apparatus 22, which is divided into two branches. One branch 24 leads into a chamber 25. In the wall 26 forming the chamber 25 is a port 27, which is normally closed by the flutter valve 28, which prevents communication between the chamber 25 and a chamber 29.

The flutter valve 28 may be better understood by reference to Figures 5 and 6. The valve consists of an ordinary gravity operated diaphragm 30. The diaphragm 30 normally rests on the seat 31 due to the force of gravity. However, if a greater pressure should be placed on the under side of the diaphragm than there is on the upper side, the diaphragm will lift from its seat 31. In order that the valve shall return to its seat upon a decrease in pressure, guides 32 are provided so that the diaphragm will be restrained and guided to its seat again.

Referring again to Figure 4 it will be noted that the chamber 29 is connected through an opening 33 with the purifier proper of the apparatus 22. The latter is merely a container for a substance 34, such as caustic soda, caustic potash or a mixture of both, which will remove carbon dioxide from air. At the opposite end of the apparatus 22 from the opening 33 is another opening 35, which opens directly into the suit.

It should also be noted that the chamber 25 is provided with a drain tube 36 and a drain cock 37, which will permit the withdrawal of any moisture which may have collected in the chamber.

The other branch 38 with which the flexible tube 21 communicates opens into a chamber 39, wall 40 of which has a port 41, which in turn is provided with a flutter valve 42, similar to the flutter valve 28, to close the port. Below the chamber 39 is a chamber 43, with which the port 41 communicates. The chamber 43 communicates directly with the air in the suit at a point which is close to the opening 35 in the purifier 22.

After the air in the suit has been used and purified a few times, most of the oxygen in the air will have been removed. In order to overcome this deficiency and keep the oxygen content of the air up to normal, more oxygen must be added. This is accomplished by introducing pure oxygen into the suit through the tube 44, whose discharge end is located adjacent the opening 35 from the purifier, in order that the purified air and oxygen may mix before being drawn in through the chamber 43.

The tube 44 enters the shirt 2 through an air tight fitting 45. Leading from a container of pure oxygen 46 is a tube 47, which connects the container and the tube 44. Interposed between the container and the tube 47 is a pressure regulating valve 48 of the usual commercial type. The valve 48 permits the extremely high pressure in the container 46 to be reduced to a pressure of a few pounds, so that it may be fed slowly into the suit.

Located in the tube 44 is a valve 49 which automatically opens to admit oxygen when it is needed, but which otherwise is maintained closed. The valve 49 is shown in an enlarged view in Figure 7.

The valve comprises a casing 50, which has appropriate flanges 51 to attach it to the fabric of the suit. The casing is also secured by the bolts 52 to a fitting 53, which is placed in the line of the tube 44. A valve seat 54 is formed by the walls 55 and 56 of the fitting 53. Just below the valve seat in the outer wall 58 of the fitting 53 is a plug 57, through which the valve 58' may be removed from or placed in cooperation with the valve seat 54. The valve 58' is maintained on the seat 54 by the action of the pressure in the suit on the diaphragm 59, which is secured to the valve stem 60. The bushing 61 retains the diaphragm 59 in a recess 62 of the casing 50, thus forming a closed chamber above the diaphragm.

It will be noted that the fitting 53 is so mounted that the wall 56 will be nearest the tube 47 leading from the oxygen supply container 46. The high pressure of the supply oxygen will thus act on the top of the valve 58'. Another chamber 63 is formed below the diaphragm, to which

chamber the air in the suit has free access through holes 64. The diaphragm is therefore at all times subject to the pressure of the air in the suit.

In the chamber 65 is a spring 65' which rests on the diaphragm 59. The opposite end of the spring 65' rests on a piston 66, in the chamber 65, which has attached to it a rotatable threaded stem 67. A handle 68 is fastened to the end of the stem, which is outside the chamber 65, and is the means whereby the stem may be turned. The spring compression is controlled by the position of the piston 66 with respect to the diaphragm 59 and, as will be apparent, this distance may be varied at will by turning the handle 68.

As the oxygen is taken from the air within the suit by the wearer, changed to carbon dioxide, which is removed by the purifier, the pressure in the suit will fall. This will reduce the pressure on the diaphragm 59 which, under the action of the spring, will push the valve 58' down and open the passage, so that oxygen from the container 46 will be admitted to the suit. When the pressure has returned to a predetermined amount by the increase of oxygen in the suit, it will act on the diaphragm to close the valve. It will thus be seen that as the oxygen is used, this valve will automatically replenish the amount in the suit.

From the foregoing description it is readily apparent that when the wearer has turned the valve 17 so that he is communicating with the interior of the suit, he will breathe the air therein. When he inhales, the flutter valve 42 is lifted by suction from its seat and allows the breather to communicate directly with the interior of the suit. The flutter valve 28 on the other hand will remain tightly closed, since it is pulled down on its seat by any suction in the chamber 24.

Upon exhalation, however, the opposite will be true. The flutter valve 42 will then be closed and the flutter valve 28 opened. The breath coming through the passage 14 passes through the valve 17 into the chambers 38 and 24. The valve 42 is closed, and therefore none of the exhaled air can pass through the chamber 39, and it therefore passes through the port, past the flutter valve 28, which is held open by the pressure of the exhaled air, into the chamber 29, and thence through the purifying substance 34 where all the deleterious matter exhaled by the wearer is removed; and the purified air is then discharged through the opening 35. It should be noted that any condensed moisture or saliva in the breath, which collects in the chamber 24, may be drained out through the drain cock 37. Thus there are two circuits, one for exhaled air, and one for inhaled air.

At the side of the shirt 2 opposite to the fitting 45, an air tight fitting similar to the fitting 45 is provided, in order that electric wires may be introduced into the suit for such purposes as supplying heat to the wearer, heat to defrost the goggles, radio connections for ear phones, etc.

The suit may conceivably through some misadventure tend to become over-inflated, so as to make it difficult for the wearer to breathe. In order to prevent such an occurrence a safety valve 9', which is placed on the top of the headpiece 9, is provided.

With reference to Figure 8 it will be seen that this valve is similar to the valve in Figure 7. The valve 9' consists of a casing 70 having an enlarged section 71, which is secured to the headpiece 9 by the bolts 72. The wall of the headpiece 9 has a valve seat 73. A cooperating valve 74 having a stem 75 engages this seat. At the end opposite to the valve end of the stem is a diaphragm 76, which is held securely in a recess 77 in the casing 70 by a bushing 78.

The casing 70 has a series of holes 79 around the circumference of the enlarged section 71. These holes are necessary in order that any air which is discharged from the suit through the valve 74, may escape into the atmosphere. The effect of the outside air pressure on the valve 74 is counteracted by designing the diaphragm 76 of such area that it is exactly equal to the area of the valve 74 which is exposed to the external air pressure. The pressure of the atmosphere is then so balanced that it has no effect on the valve.

The spring 79' which rests on the diaphragm 76, serves to govern the pressure at which the opening of the valve occurs. The pressure may be regulated by the rotatable screw threaded stem 80, which is controlled by a handle 81 and which moves the piston 82 up and down. The stem passes through the casing 70, and a packing bushing 83 serves to prevent the entry of air into the chamber 84. It will be noted that the manner of regulating the valve is similar to that employed for the oxygen regulating valve.

When the wearer has put on his suit and has begun to use the incorporated breathing apparatus, the oxygen which is utilized is automatically replenished by pure oxygen. If the pressure in the suit should rise above a predetermined point, the valve 9' will automatically relieve the excess pressure so that the wearer will not be uncomfortable. On the return of the pressure to the desired amount, the valve will close and so maintain the air in the suit at a pressure which is comfortable for the wearer.

From the foregoing it will readily be seen that the present invention provides a suit for altitude flying which maintains the wearer in an atmosphere of a predetermined pressure, which atmosphere is constantly being purified and replenished with fresh oxygen, which is automatically supplied. It will also be apparent that this invention resides in certain principles of construction which may be employed in other physical forms of apparatus without departure therefrom. It is apparent, therefore, that the form of apparatus illustrated in the drawings for the purpose of disclosure has been given solely in an illustrative sense and not in any limiting sense. The scope of this invention is best defined by the appended claims.

I claim:

1. The combination with an altitude breathing suit comprising an envelope impervious to air and adapted to retain a pressure greater than that of the surrounding atmosphere, of a source of oxygen, means to convey oxygen from said source to said suit, pressure reducing means associated with said means, automatic means to control the admission of oxygen to said suit, means to purify the exhaled air in the suit, means to relieve any excess pressure in the suit, means to lead the exhaled air to said purifying means, and a flutter valve in said last named means normally preventing communication with said purifying means.

2. The combination with an altitude breathing suit comprising an envelope impervious to air and adapted to retain a pressure greater than that of the surrounding atmosphere, of means to relieve any excess pressure in the suit, a source of oxygen, means to convey oxygen from said source to said suit, pressure reducing means in said

means, automatic means to control the admission of oxygen to said suit, means to purify the exhaled air in the suit, means to lead the exhaled air to said purifying means, a flutter valve in said last named means normally preventing communication with said purifying means, and a second flutter valve in said last named means normally preventing communication with the air in the suit.

3. The combination with an altitude breathing suit comprising an envelope impervious to air and adapted to retain a pressure greater than that of the surrounding atmosphere, of means to relieve any excess pressure in the suit, a source of oxygen, means to convey oxygen from said source to said suit, pressure reducing means associated with said means, automatic means to control the admission of oxygen to said suit, means to purify the exhaled air in the suit, means to lead the exhaled air to said purifying means, and means in said last means to permit communication with the external atmosphere.

4. The combination with an altitude breathing suit comprising an envelope impervious to air and adapted to retain a pressure greater than that of the surrounding atmosphere, of means to relieve any excess pressure in the suit, a source of oxygen, means to convey oxygen from said source to said suit, pressure reducing means associated with said means, automatic means to control the admission of oxygen to said suit, means to purify the exhaled air in the suit, means to lead the exhaled air to said purifying means, a flutter valve in said last named means normally preventing communication with said purifying means, and means in said last means to permit communication with the external atmosphere.

5. The combination with an altitude breathing suit comprising an envelope impervious to air and adapted to retain a pressure greater than that of the surrounding atmosphere, of means to relieve any excess pressure in the suit, a source of oxygen, means to convey oxygen from said source to said suit, pressure reducing means associated with said means, automatic means to control the admission of oxygen to said suit, means to purify the exhaled air in the suit, means to lead the exhaled air to said purifying means, a flutter valve in said last named means normally preventing communication with said purifying means, a second flutter valve in said last named means normally preventing communication of the air in the suit therewith, and means in said last means to permit communication with the external atmosphere.

6. In combination with an altitude breathing suit adapted to envelope the wearer and maintain him under a greater pressure than that of the surrounding atmosphere, a container of oxygen, a conduit connecting said container and said suit, a pressure reducing valve associated with said conduit and said container, a pressure operated valve in said conduit and adapted to control the admission of oxygen to the suit, an air purifier to remove carbon dioxide, a moisture trap and drain in said purifier, and an adjustable pressure valve to permit the escape of the air in the suit.

7. In combination with an altitude breathing suit adapted to envelope the wearer and maintain him under a greater pressure than that of the surrounding atmosphere, a container of oxygen, a conduit connecting said container and said suit, a pressure reducing valve associated with said conduit and said container, a pressure operated valve in said conduit and adapted to control the admission of oxygen to the suit, an air purifier to remove carbon dioxide, a moisture trap and drain in said purifier, an adjustable pressure valve to permit the escape of the air in the suit, a mouth and nose cover for said wearer, a tube connecting said cover with said purifier, a three-way valve in said tube, and an opening on said three-way valve to permit communication with the exterior atmosphere.

8. In combination with an altitude breathing suit adapted to envelope the wearer and maintain him under a greater pressure than that of the surrounding atmosphere, a container of oxygen, a conduit connecting said container and said suit, a pressure reducing valve associated with said conduit and said container, a pressure operated valve in said conduit and adapted to control the admission of oxygen to the suit, an air purifier to remove carbon dioxide, a moisture trap and drain in said purifier, an adjustable pressure valve to permit the escape of the air in the suit, a mouth and nose cover for said wearer, a tube connecting said cover with said purifier, a three-way valve in said tube, an opening on said three-way valve to permit communication with the exterior atmosphere, a flutter valve in said tube to normally prevent communication with the purifier, and a second flutter valve normally preventing communication with the air in the suit.

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