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EMERGENCY EXHALATION VALVE

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Fig. 1.

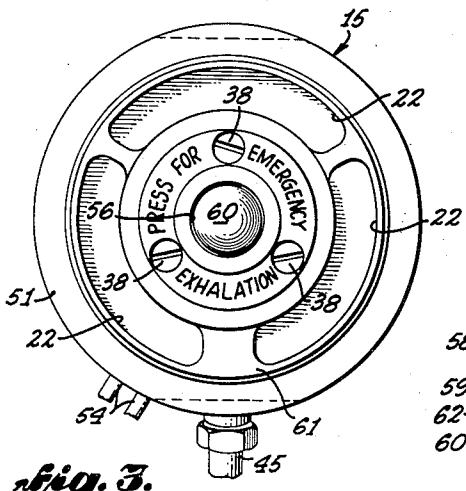


Fig. 3.

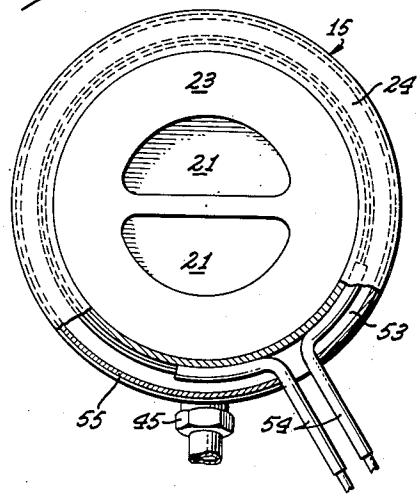


Fig. 4.

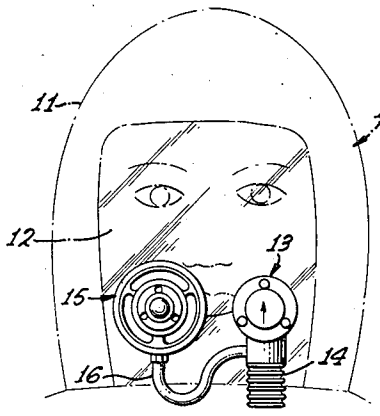
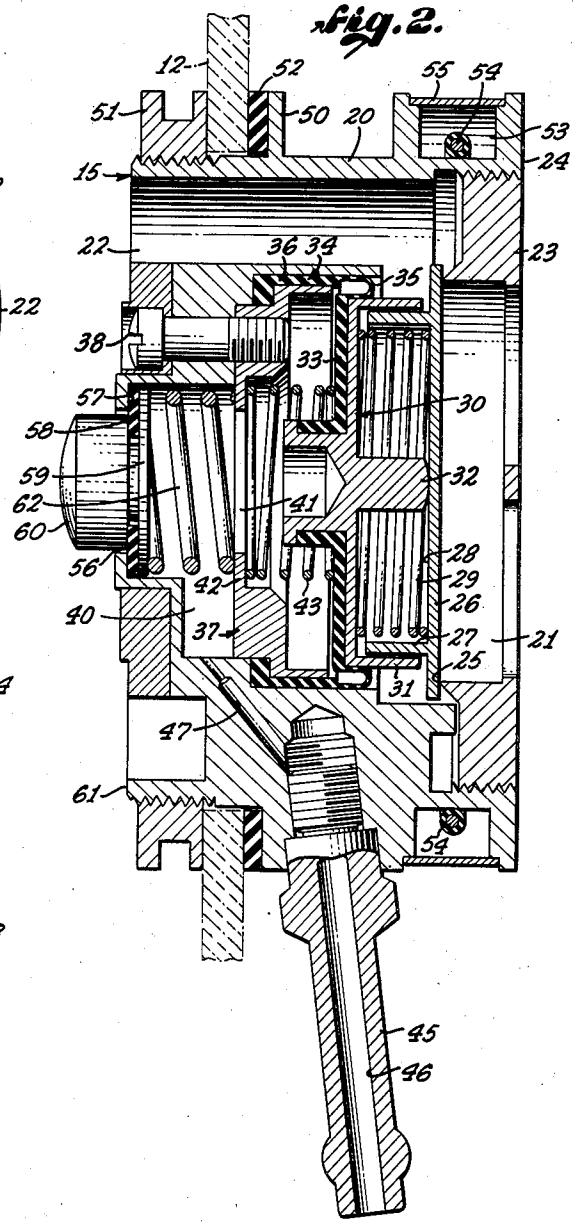


Fig. 2.



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EMERGENCY EXHALATION VALVE

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6 Claims. (Cl. 128—142)

The invention relates to high altitude breathing equipment and has particular reference to the valving of a pressure helmet or an oro-nasal breathing mask by means of which the pilot is enabled to exhale from the breathing equipment in the event of a pressure blockage of the exhalation valve.

Recent progressive improvements in the design of various types of airplanes have resulted in very materially increasing the altitude range at which planes can operate. As high altitude levels are reached, demands upon breathing equipment for pilots have given rise to a series of new and serious problems because of the extreme rarity of air at those levels. The valving system commonly used with the high altitude breathing helmet or oro-nasal mask here considered consists essentially of an inhalation valve and an exhalation valve. The exhalation valve is dependent upon the inhalation valve for proper functioning. Serious backleakage past the inhalation valve will cause a pressure blockage of the exhalation valve and make it impossible for the pilot to exhale without removing the face-piece from the helmet. At low altitudes removal of the helmet face-piece might be an acceptable solution. At higher altitudes, however, removal of the helmet face-piece might well be fatal because of an inadequate cabin pressure to prevent a rapid onset of anoxia. Failure of the inhalation valve can occur from freezing of the valve components or from the lodging of some foreign object in the valve. The threat to the pilot's life of this type of equipment failure becomes more acute as higher operating altitudes become more common for both civilian and military aircraft. Although considerable improvements have been wrought in breathing equipment in anticipation of operation at low temperatures and at high altitudes, little attention has been given to providing emergency relief in the event of the type of failure described above.

It is therefore among the objects of the invention to provide a new and improved valving system for breathing apparatus in the nature of pressure helmets and oro-nasal masks which will enable the pilot to voluntarily relieve the pressure in the system and thus permit exhalation in the event of an inhalation valve failure and its resultant pressure blockage of the exhalation valve.

Still another object of the invention is to provide a new and improved exhalant valve device capable of use with equal effectiveness on a pressure helmet or oro-nasal mask wherein a voluntary button adjustment is provided for relieving any troublesome high pressure in the system, the button relief being conveniently and naturally located in an area readily accessible to manual manipulation by the pilot with any portion of a heavily protected hand or arm.

Still further among the objects of the invention is to provide a new and improved emergency exhalation valve device which is light in weight, small and compact, thereby making it easy to mount and be carried by a breathing mask or helmet and which is sufficiently positive in

the arrangement and action of a relatively few moving parts that the valve device is dependable under all expected conditions.

With these and other objects in view, the invention consists in the construction, arrangement and combination of the various parts of the device whereby the objects contemplated are attained, as hereinafter set forth, pointed out in the appended claims and illustrated in the accompanying drawings.

In the drawings:

Figure 1 is a front elevational view of the exterior of the valve device.

Figure 2 is a longitudinal sectional view of the valve device drawn to a larger scale.

Figure 3 is a rear elevational view of the valve device.

Figure 4 is a front elevational view of a pressure helmet incorporating the valve system of which the emergency exhalation valve is a part.

In an embodiment of the invention chosen for the purpose of illustration a breathing system is shown for enabling a pilot 10 to breathe effectively when equipped with a pressure helmet 11 provided with a suitable transparent face plate 12.

Mounted on the face plate is an inflow check valve device 13 of the customary sort which is currently conventional in breathing apparatus of the kind herein described. An oxygen supply line 14 connected to a suitable source of oxygen (not shown) attaches to the check valve device 13. The check valve device is conveniently mounted on the face plate adjacent the mouth of the pilot but usually at a location slightly to one side, as shown.

Also mounted at a corresponding location on the other side of the pilot's mouth is an emergency exhalation valve device 15 which is connected to the supply line 14 by a pressure compensating line 16 wherein the pressure condition is static. In a system such as that shown pressure within the helmet and the supply line 14 is greater than the cabin pressure.

The emergency exhalation valve device is contained within a housing 20 provided at the right-hand side, as viewed in Figure 2, with an exhalation passage 21 and on the left-hand side, as viewed in the same figure, with a series of exhalation outlet passages 22. A valve seat element 23 threadedly mounted at an inner face 24 of the housing provides an annular valve seat 25 and at the same time defines the area of the exhalation passage 21 through its center. A plate 26 provides an outflow check valve element or exhaust check valve element, the plate having on the face opposite from the valve seat an annular flange 27 which defines a recess 28 for a spring 29. A guide 30 forms a cover for the recess 28 and at its perimeter is provided with an annular flange 31 which has a free sliding telescoping relationship to the flange 27. A post 32 defines the minimum depth of the recess 28 within which the spring 29 acts.

The guide 30 also provides a means for mounting a disc portion 33 of a diaphragm 34. At the outer perimeter of the disc portion is an annular fold 35 which permits movement of the disc portion 33 relative to an annular rim 36. The annular rim in turn is confined by means of a flange indicated generally by the reference character 37, the flange being held in position by a series of screws 38.

The area within the housing to the left of the diaphragm may be defined as constituting a pocket 40, there being provided a central aperture 41 in the flange 37 which serves as a communication between opposite sides of the pocket 40, as those sides are defined by the flange 37.

The flange 37 also provides a spring keeper 42, one end of a spring 43 abutting against the keeper 42 and the opposite end is adapted to press against the disc portion 33 of the diaphragm 34 and guide 30. Inasmuch

as the post 32 on the guide 30 is mounted to press against the plate 26, it will be clear that the spring 43 normally acts to hold the outflow check valve element closed.

A nipple 45 is adapted to have attached thereto the compensating pressure line 16. Within the nipple is a compensating pressure passage 46 which communicates with an offset passage 47 and thence with the pocket 40. By this communication pressure is provided on the downflow side of the downflow check valve exemplified by the plate 26 by pressure exerted against the diaphragm 34 which is equal to the pressure in the supply line 14 under normal conditions. As the pilot exhales, exhaling pressure will be sufficient to overcome the tension in spring 43, thereby permitting the outflow check valve to unseat allowing exhalant to flow from the passage 21 through the passages 22 to the exterior.

As will be noted, there is an annular rim 50 around the exterior of the housing 20 and a nut 51 threadedly mounted on the exterior of the housing so that by means of a sealing washer 52 the face plate 12 of the pressure helmet can be sealed with relation to the valve housing when the emergency exhalation valve device is mounted in place on the pressure helmet. It will be clear, therefore, that the compensating pressure line lies within the helmet as does also a heater cavity 53 within which is a heating coil 54 surrounded by a heater cover 55. By this means the emergency exhalation valve device may be kept at a proper temperature to insure effective working of all parts free from the effects of cold and moisture.

To provide an emergency relief for the pocket 40 there is provided a vent passage 56 in axial alignment with the pocket 40 and exhalant passage 21. Surrounding the vent passage is a valve seat 57 upon which is mounted a seal or sealing valve 58. On the inner face of the sealing valve is a plate 59 which in turn carries a button 60. The button protrudes outwardly through the vent passage and extends a substantial distance beyond the exterior face 61 of the housing so as to be easily accessible to manipulation by the pilot. A relatively heavy spring 62 acts between the spring keeper 42 on the face opposite from the spring 43 and the plate 59 thereby tending by strong spring pressure to keep the vent passage 56 closed.

To guard against an accidental vacuum condition or exceptionally low pressure condition in the compensating pressure line or oxygen supply line the spring 29 is provided. Should such a condition prevail there would immediately be a tendency for the diaphragm 34 to move from right to left, as viewed in Figure 2. In the absence of the mechanism here present the effect would be to hold the outflow check valve open and if there should chance to be harmful ingredients present in the surrounding atmosphere, the pilot upon inhaling would draw portions of the surrounding atmosphere inwardly through the outflow check valve as well as inhaling portions of the oxygen in the supply line. To prevent this the spring 29 acts under those circumstances to hold the plate 26 in position against the valve seat 25, thereby closing the outflow check valve except when subject to exhaling pressure by the pilot. The spring 29 being of lesser tension than the spring 43, permits the lighter spring to act only under these circumstances inasmuch as normally the lighter spring will be collapsed sufficient to have the plate 26 press against the post 32.

Under normal high altitude flying conditions, the pressure in the cabin often is not great enough to sustain life. To supply adequate pressure for breathing, oxygen is furnished through the supply line 14 at a pressure level considerably greater than the cabin pressure. The chamber 40 of the exhalation valve is interconnected with the supply line 14 through the passages 46 and 47 and pressure compensating line 16. The pressure level in the chamber 40 is thus equal to that in the supply line 14. The pressure in the pocket 40 acts upon the flexible diaphragm 34 and induces a force upon the guide 13 and the plate 26 so as to press upon the annular valve seat 25 and thus close the passage 21. To exhale the pilot must exert sufficient pressure in the helmet to overcome the pressure in the pocket 40 and force the plate 26 away from the annular valve seat 25. As the pilot increases the pressure in the helmet to accomplish exhalation, the flow of oxygen from supply line 14 is stopped because of this higher pressure in the helmet. A unidirectional check valve 13 prevents the exhaled air from flowing out of the helmet and into the supply line 14.

Occasionally, however, the inlet check valve 13 becomes lodged in an open position because of some foreign object or because of freezing. In this case, pressure exerted by the pilot to accomplish exhalation feeds back into the supply line 14 and thus to the pocket 40 by way of passages 46 and 47. The greater the pressure exerted by the pilot, the greater the build-up of pressure in the pocket 40. The exhalation valve is thus blocked against opening and the pilot cannot exhale.

In this emergency, the pilot need only to depress the button 60 to momentarily relieve the pressure in the pocket 40 and provide an imbalance of forces on the valve so that it will open and permit exhalation. If necessary, the pilot can depress the button on each successive exhalation cycle until he can reach a lower altitude where it is safe to remove the face plate 12.

There has accordingly been described herein a compact, simply constructed emergency exhalation valve device wherein the active parts are in compact axial alignment and are in a relationship such as to guard against both an excessively high pressure in the compensating passages as well as an excessively low pressure in those passages. The valve device is one capable of being made light in weight so that it can be readily located without attendant inconvenience on the fore portion of the face plate and in a position where a pilot might naturally reach with his hand or arm should he feel an inability to properly exhale. Reflex requirements of the pilot have been therefore reduced to a minimum by the arrangement proposed and the continued effectiveness of the pilot is assured under all conditions to a maximum possible degree.

While I have herein shown and described my invention in what I have conceived to be the most practical and preferred embodiment, it is recognized that departures may be made therefrom within the scope of my invention, which is not to be limited to the details disclosed herein but is to be accorded the full scope of the claims so as to embrace any and all equivalent devices.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. An emergency exhalation valve comprising a valve body, an exhalation passage in said valve body, an outflow valve seat in said exhalation passage, an outflow check valve element on said seat, a movable diaphragm assembly comprising a plate, a spring between said plate and said valve element, and a post between said valve element and said plate adapted to limit movement in a collapsing direction, means forming a pocket, a diaphragm on said plate closing a side of said pocket adjacent the valve element, a spring of greater strength than said first spring acting between said diaphragm assembly and said body, a compensating pressure passage from said pocket to the exterior, a vent passage from said pocket to the exterior and a valve seat therein, a vent valve element for said seat, a spring of relatively greatest strength between said vent valve element and said body, and a manual release button on said vent valve element protruding through said body to a location beyond the exterior of said body.

2. An emergency exhalation valve comprising a valve body, an exhalation passage between said receptacle and said valve body, an outflow valve seat in said exhalation passage, an outflow check valve element on said seat, an annular flange on the downstream side of said valve ele-

ment, a diaphragm assembly comprising a flanged plate telescopingly engaging said annular flange, a spring between said plate and said valve element, means forming a pocket in axial alignment with the exhalation passage, a movable diaphragm on said plate closing a side of said pocket adjacent the valve element, a spring of greater strength than said first spring acting between said diaphragm assembly and said body, a compensating pressure passage from said pocket to the exterior, a vent passage from said pocket to the exterior in axial alignment with said exhalation passage and a valve seat therein, a vent valve element for said seat, a spring of relatively greatest strength between said vent valve element and said body, and a manual release button on said vent valve element protruding through said vent passage to a location beyond the exterior of said body.

3. An emergency exhalation valve for a pilot's breathing receptacle comprising a valve body attached to the receptacle, an exhalation passage between said receptacle and said valve body, exhalation outlet passages between said exhalation passage and the exterior, an outflow valve seat in said exhalation passage, an outflow check valve element on said seat, an annular flange on the downstream side of said valve element, a diaphragm assembly comprising a flanged plate telescopingly engaging said annular flange, a spring between said plate and said valve element, and a post between said valve element and said plate adapted to limit movement in a collapsing direction, means forming a pocket in axial alignment with the exhalation passage, a flexible diaphragm on said plate closing a side of said pocket adjacent the valve element, a spring keeper in the pocket, a spring of greater strength than said first spring acting between said diaphragm assembly and said keeper, a compensating pressure passage from said pocket to the exterior, a vent passage from said pocket to the exterior in axial alignment with said exhalation passage and a valve seat therein, a vent valve element for said seat, a spring of relatively greatest strength between said vent valve element and said keeper, and a manual release button on said vent valve element protruding through said vent passage to a location beyond the exterior of said body.

4. In a closed breathing system for aircraft pilots an oro-nasal pressure receptacle, an oxygen supply line connected to the receptacle having an inflow check valve therein, an exhalation check valve assembly attached to the receptacle, said valve assembly comprising a valve body, an outflow passage, an outflow check valve element in said passage, means forming a static pressure space behind said valve element, a flexible closure closing said space, a spring between said diaphragm and said valve element subject to depression under normal exhalation pressure, a compensating pressure line between said space

and said supply line, a vent passage between said space and the exterior of said valve body, a normally seated vent closure element closing said vent passage, spring means between the body and said closures adapted to move said valve closures in opposite directions whereby said vent closure is normally held in closed position, and a manually actuable button connected to said vent valve element extending to the exterior.

5. In a closed breathing system for aircraft pilots an oro-nasal pressure receptacle, an oxygen supply line connected to the receptacle having an inflow check valve therein, an exhalation check valve assembly attached to the receptacle, said valve assembly comprising a valve body, an outflow passage, a composite outflow check valve member in said passage, means forming a static pressure space behind said valve element, a movable diaphragm incorporated in said valve member and closing said space, a spring between the body and said valve element subject to depression under normal exhalation pressure, a compensating pressure line between said space and said supply line, a vent passage between said space and the exterior of said valve body, a vent valve element normally having a seated position closing said vent passage, a spring between said vent valve element and the body adapted to hold said vent valve element in seated position and a manually actuable button connected to said vent valve element extending through the valve body to the exterior.

6. In a closed breathing system for aircarft pilots a pressure helmet adapted to envelope a pilot's head, an oxygen supply line connected to the helmet having an inflow check valve therein, an exhalation check valve assembly attached to the helmet adjacent the area wherein the pilot's mouth is located, said valve assembly comprising a valve body, an outflow passage, an outflow check valve element in said passage, means forming a static pressure space behind said valve element, an axially shiftable diaphragm closing said space, a spring of relatively light pressure between said diaphragm on one side thereof and said valve element subject to depression under normal exhalation pressure, a spring of relatively heavier pressure between the valve body and said diaphragm on the opposite side thereof, a compensating pressure line between said space and said supply line, a vent passageway between said space and the exterior of said valve body, a vent valve element normally having a seated position closing said vent passage, a spring between said vent valve element and the body adapted to hold said vent valve element in closed position and a manually actuable button on said vent valve element extending through said vent passage to the exterior.

No references cited.