Aug. 21, 1962 L. JONES 3,050,054

BREATHING APPARATUS

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FIG. 1

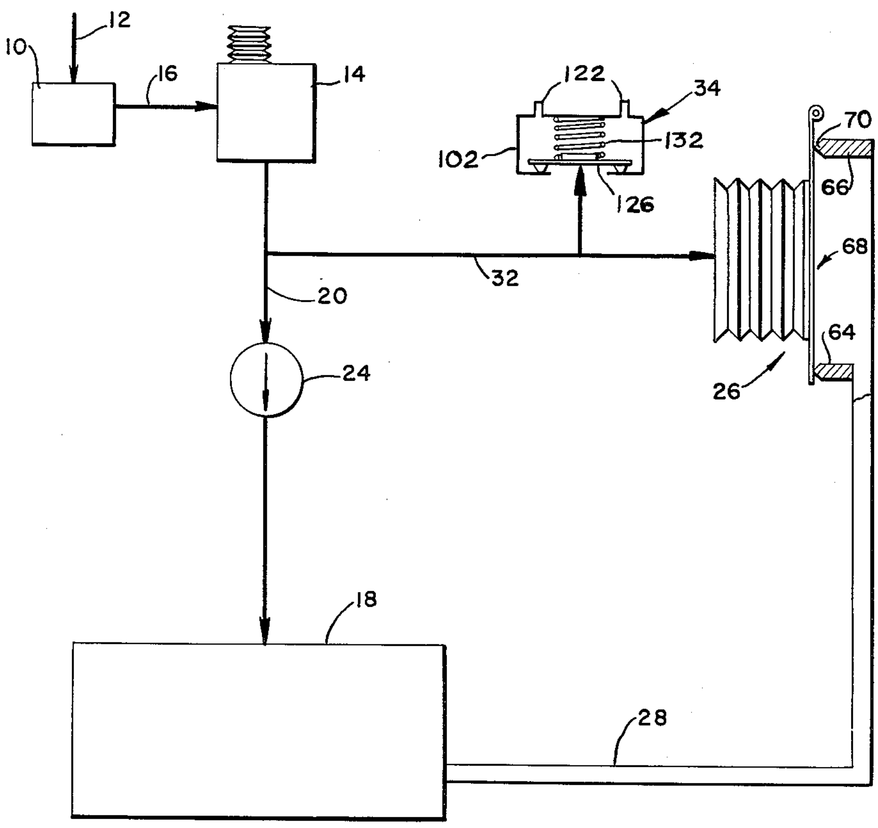

FIG. 2

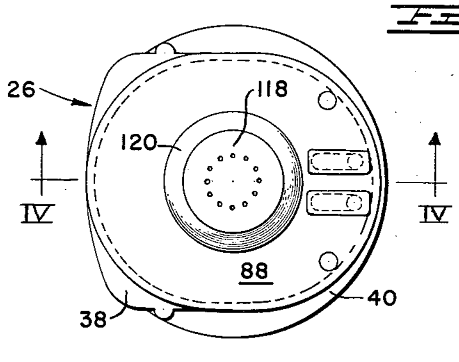

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FIG. 3

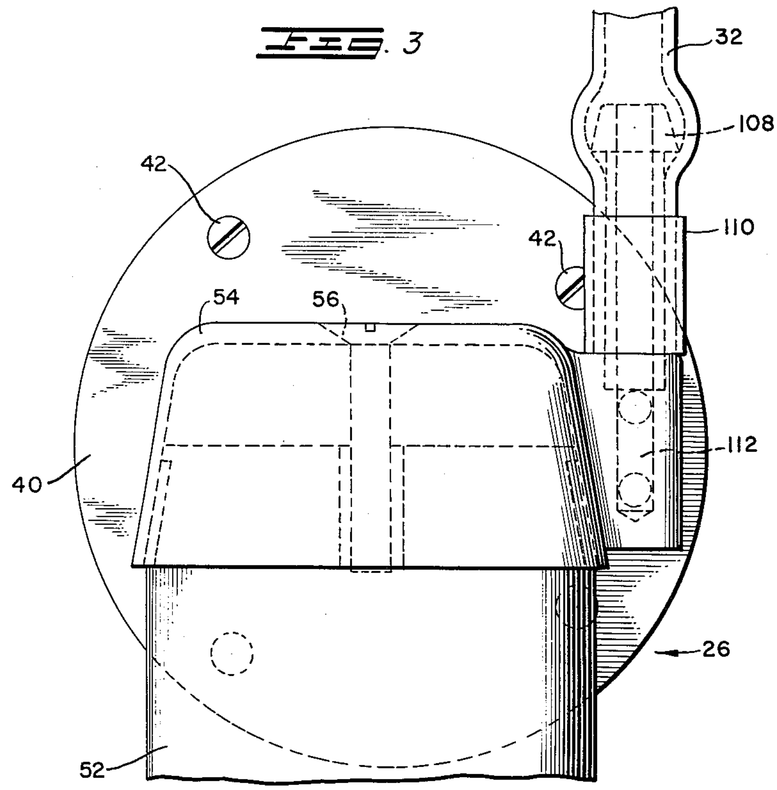
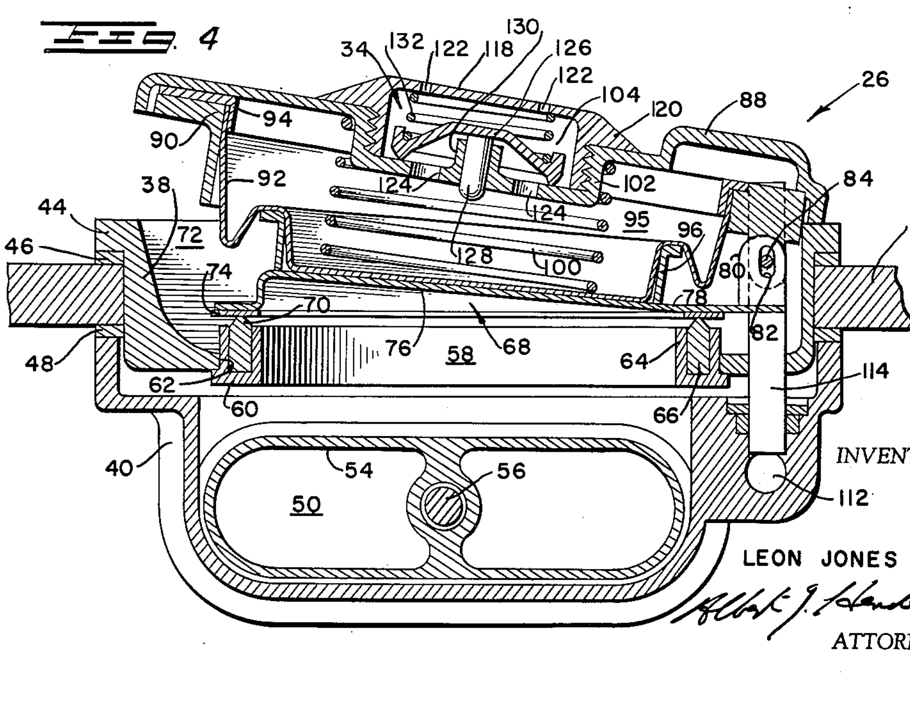


FIG. 4



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BREATHING APPARATUS

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9 Claims. (Cl. 128—142)

This invention relates to breathing apparatus and more particularly to breathing apparatus for use in high altitude flight.

For high altitude flying where the atmospheric air is rarefied, it is desired to normally maintain a predetermined pressure of oxygen within the pilot's face mask or helmet so a to provide a partial pressure of oxygen to meet physiological needs.

The most prominent disadvantage in current breathing apparatus is the effect of the oxygen pressure on the mask exhaust valve. The exhaust valve is generally positioned in the mask or helmet and comprises a balanced valve member biased into engagement with a valve seat by a spring. When the wearer of the mask exhales, the pressure within the mask will increase and move the valve member against its bias out of engagement with the seat. It is desired, of course, to maintain a minimum biasing force on the valve member whereby only a slight exhalation pressure is required to open the valve member.

Another disadvantage of current breathing apparatus is the fact that the exhaust valve tends to freeze when the moisture in the exhaled breath is transformed into ice. This results in the exhaust valve freezing in one position and becoming inoperative.

It is a principal object of this invention to compensate an exhaust valve employed in a breathing apparatus for variations in mask or helmet pressure.

Another object of the invention is to incorporate in an exhaust valve a safety device responsive to excessive mask or helmet pressure for venting the excessive fluid pressure to the atmosphere.

Another object of the invention is to arrange the components of an exhaust valve so as to effect minimum radiation of heat from the exposed surfaces thereof.

In the preferred embodiment of the invention, a casing, adapted to be mounted on a face mask or helmet, has mounted therein a valve member operative to be opened in response to an increase in pressure within the mask or helmet caused by exhalation by the user to vent exhaled air to the atmosphere. Means are provided for subjecting both sides of the valve member to the pressure of the oxygen supplied to the mask whereby the valve member is only responsive to an increase in pressure caused by exhalation. A relief valve is positioned within the casing for venting fluid pressure from the mask or helmet when the same becomes excessive during pressure breathing.

Other objects and advantages will become apparent from the following description taken in connection with the accompanying drawings wherein:

FIG. 1 is a schematic illustration of a breathing apparatus;

FIG. 2 is a front view of the exhaust valve shown in FIG. 1;

FIG. 3 is a rear elevation of the exhaust valve shown in FIG. 1; and

FIG. 4 is a section taken along the line IV—IV of FIG. 2.

Referring to FIG. 1, there is shown a breathing apparatus which includes a pressure reducing valve **10** connected to a suitable source of fluid or oxygen under pressure (not shown) by a conduit **12**. The reducing valve **10** may be of any suitable form and serves to deliver oxygen at workable pressure to a demand-type regulator valve **14** by means of a conduit **16**.

The regulator valve **14** is here shown schematically as connected to a mask or helmet **18** by means of a conduit **20**. The regulator valve **14** is operative in response to inhalation by the user of the apparatus to supply fluid or oxygen to the mask or helmet **18**. In addition, the regulator valve **14** is responsive to a decrease in atmospheric pressures as a result of an increase in altitude to maintain a predetermined pressure of oxygen within the conduit **20** and mask or helmet **18** to provide pressure breathing. Regulators responsive to changes in atmospheric pressure are well known in the art, any of which is suitable for use in the present invention. One such regulator is disclosed in United States Patent No. 2,685,288 issued to G. C. Fields et al.

A check valve **24** may be disposed within the conduit **20** to prevent flow of fluid from the mask or helmet **18** to the regulator valve **14** during exhalation by the user of the apparatus.

The mask or helmet **18** is provided with an exhaust valve indicated generally by the reference numeral **26** and which is illustrated schematically as in communication with the mask or helmet **18** by means of a conduit **28**. The exhaust valve **26** is adapted to be opened by an increase in pressure within the mask or helmet **18** as a result of exhalation by the user of the apparatus to exhaust exhaled air to the atmosphere.

A relief valve **34** is illustrated as connected to the conduit **32**, this valve being adapted to open if the predetermined pressure within the mask or helmet **18** should exceed a desired maximum amount to vent the excessive pressure to the atmosphere.

The regulator **14**, mask or helmet **18**, exhaust valve **26**, and check valve **24** have been illustrated as separate units connected by conduits in FIG. 1. It will be apparent, however, to those skilled in the art that such an illustration is for the purpose of description only and that these parts may be mounted directly on the mask or helmet **18** if desired.

Referring more particularly to FIGS. 2, 3, and 4 of the drawings and to the exhaust valve **26**, this valve comprises two major casing portions **38**, **40** (FIG. 4) which are mounted on the mask or helmet **18**. One casing portion **38** is inserted through a suitable opening in the wall of the mask from the outside thereof, and the other portion **40** is inserted over the end of the portion **38** and secured thereto by screws **42**. A flange **44** on the end of the portion **38** is drawn tightly into engagement with the wall of the helmet or mask **18** by the screws **42**. To provide a leak-proof installation, gaskets **46** and **48** are positioned on opposite sides of the helmet wall and are engaged by the portions **38**, **40**, respectively.

The portion **40** is provided with an inlet port **50** for exhaled air. The exhaled air is led to the port **50** through a plastic tube **52** which has one end clamped to the casing portion **40** by means of a wedge-shaped clamp **54** secured to the casing portion **40** by a screw **56**. The other end of the tube **52** terminates within the mask or helmet **18**.

The port **50** communicates with an interior chamber **58** defined by the casing portions **38**, **40**. A valve seating ring **60** of generally elliptical configuration is seated in opening **62** in the bottom wall of the casing portion **38** and defines a valve port **64** into which exhaled air may flow from the chamber **58**. A ring of sealing material **66** is fixed within the sealing ring **60** and has a knife edge **70** extending beyond the end of the ring **60**.

An exhaust valve member, indicated generally by the reference numeral **68**, is mounted on the casing portion **38** for cooperation with the knife edge **70** to control the flow of exhaled air from the valve port **64** to an exhaust port **72** in the casing portion **38**. The valve member **68** comprises a thin ring **74** of generally elliptical configuration which is fixed to a complemental flange formed on the underside of a recessed supporting member **76**. The support member **76** is of tapering thickness defining an upper wall disposed at an angle to the plane of the knife edge **70**.

The support member **76** is provided with an extended end portion **78** which has a pair of spaced ears **80** extending upwardly therefrom. Each of the ears **80** is provided with an elongated slot **82**, the slots **82** receiving a pin **84** fixed to the casing portion **38**.

The valve member **68** is pivotally mounted on the casing portion **38** by means of the pin **84**, and is thus adapted for pivotal movement on the pin **84** into and out of engagement with the knife edge **70**. In addition, the elongated slots **82** permit limited vertical displacement of the valve member **68** to render the same self-aligning with respect to the knife edge **70** in the closed position thereof.

The casing portion **38** is provided with a generally circular supporting wall **88** which is angularly disposed relative to the seating ring **60** and fixed at one side adjacent the pin **84**. The supporting wall **88** defines an annular shoulder **90** on the underside thereof to which an expansible and contractible diaphragm element **92** is fixed by means of an annular clamping member **94**, the diaphragm element **92** and wall **88** defining an expansible chamber **95**.

A circular retainer **96** is fixed to the upper side of the valve member **68** and extends upwardly to define a cylindrical recess for receiving the lower portion of the diaphragm **92**. The lower portion of the diaphragm **92** extends into the retainer **96** and has the end thereof engaging the upper side of the valve member **68** under the bias of a spring **100** mounted in compression between the end wall of the diaphragm **92** and the underside of the supporting wall **88**. The biasing force of the spring **100** serves to maintain the end portion of the diaphragm **92** in engagement with the valve member **68** and serves to bias the valve member **68** into engagement with the knife edge **70**.

The spring **100** encircles an inwardly projecting circular shoulder **102** of the supporting wall **88** formed by a cylindrical recess **104** in the upper side of the supporting wall **88**. The shoulder **102** serves to maintain the spring **100** in axial alignment with retainer **96**.

In the structure thus far described, the valve port **64** communicates with the interior of the mask or helmet **18** in order that exhaled air can flow thereto. Accordingly, the fluid pressure within the mask or helmet **18** acts on the underside of the valve member **68** tending to open the same in opposition to the biasing force of the spring **100**. Exhalation on the part of the user increases the fluid pressure within the mask or helmet **18** and valve port **64** to increase the fluid pressure acting on the underside of the valve member **68** sufficiently to overcome the biasing force of the spring **100** and effect opening of the valve member **68**. This opening of the valve member **68** will exhaust the exhaled air to the atmosphere through port **72**.

At higher altitudes where pressure breathing is used, the fluid pressure within the mask or helmet **18** may be sufficient alone to overcome the bias of the spring **100** prior to exhalation. The expansible chamber **95** serves as a means for equalizing the fluid pressure on both sides of the valve member **68** so that the same is only responsive to exhalation pressure. To this end, fluid under pressure from the oxygen demand valve **14** is supplied to the chamber **95** by means of the conduit **32** which is secured to an inlet fitting **108** on the casing portion **38** by a clamp **110**. An inlet passage **112** extends from the inlet fitting **108** and communicates with the chamber **95** by means of a conduit **114** having one end sealed within the casing portion **40** in communication with the passage **112** and the other end thereof sealed within the casing portion **38** in communication with the chamber **95**.

The relief valve **34** is positioned within the recess **104** to vent fluid pressure from the chamber **95** if the oxygen pressure therein should exceed a predetermined maximum value. To this end, the recess **104** is enclosed by a cap member **118** which is threaded within the recess **104** and has a flange **120** tightened into engagement with the upper surface of the supporting wall **88**. The upper end wall of the cap **118** is provided with a plurality of ports **122** which establish communication between the recess **104** and the atmosphere.

A plurality of ports **124** are provided in the bottom wall of the recess **104** to permit the flow of oxygen into the recess **104** from the chamber **95**. To control the flow of oxygen into the recess **104**, the valve member **126** is mounted in the recess **104** for movement into and out of engagement with the bottom wall thereof. A valve stem **128** extends from the lower side of the valve member **126** and is slidably received in a boss **130** formed in the center of the bottom wall of the recess **104**. A spring **132** is mounted in compression between the valve member **126** and the cap **118** and is seated in an annular recess in the valve member **126** which maintains alignment of the spring **132**.

The spring **132** exerts a biasing force on the valve member **126** tending to hold the same in engagement with the bottom wall of the recess **104**. As long as the biasing force of the spring **132** is greater than the pressure force acting on the underside of the valve member **126**, the valve member **126** will remain closed. However, if the fluid pressure within the chamber **95** should increase to cause the pressure force acting on the valve member **126** to exceed the biasing force on the spring **132**, the valve member **126** will be moved out of engagement with the bottom wall of the recess **104** to vent the fluid pressure in chamber **95** to the atmosphere.

In operation of the breathing apparatus, the fluid pressure within the port **50** and valve port **64** will equal the fluid pressure within chamber **95** if neither inhalation nor exhalation by the user is occurring since both port **64** and chamber **95** communicate with conduit **20**. Thus, the fluid pressure in valve port **64** will exert a force on the underside of the valve member **68** which is equal to the force of the fluid pressure within the chamber **95** exerted on the upper side of the valve member **68**. Accordingly, any fluid pressure in valve port **64** which is not the result of exhalation is compensated for by the fluid pressure in chamber **95**, and the only effective biasing force on the valve member **68** is that exerted by the spring **100** which holds the valve member in engagement with the knife edge **70**.

When the user of the apparatus exhales, the exhaled air flowing to the valve port **64** will increase the fluid pressure acting on the underside of the valve member **68** and establish a pressure differential between the valve port **64** and the chamber **95**. The spring **100** is preferably selected so that this pressure differential established upon exhalation is sufficient to overcome the biasing force of the spring **100**. Accordingly, when exhalation occurs, the valve member **68** will pivot clockwise on the pin **84** out of engagement with the knife edge 70 to exhaust the exhaled air to the port 72 and the atmosphere. Upon completion of exhalation, the pressure differential causing opening of the valve member 68 will be removed and the valve member 68 will engage the knife edge 70 under the bias of the spring 100. Alignment of the valve member 68 upon return movement thereof into engagement with the knife edge 70 is assured by the elongated slots 82 in which the pin 84 is positioned. Inhalation on the part of the user will decrease the fluid pressure within the valve port 64 and accordingly will not affect the position of the valve member 68.

If, in response to a decrease in atmospheric pressure, the demand regulator 14 should cause an increase in the fluid pressure within the mask or helmet 18, the fluid pressure in valve port 64 will increase accordingly. However, an equal increase in fluid pressure will also occur within chamber 95 to compensate for the increase of fluid pressure within port 64. Accordingly, the operation of the valve member 68 will be substantially unaffected by variations in pressure within the mask or helmet 18 caused by operation of the demand regulator 14, the valve member 68 being only responsive to the pressure differential established across the same upon exhalation by the user.

To substantially eliminate any possible tendency of the ring 74 to stick or freeze to the knife edge 70, the valve ring 74 is formed from "Teflon" or similar material and provided with a lapped surface on the underside thereof for engagement with the knife edge 70. In addition, the valve seating ring 66 is formed from resilient material, such as silicon rubber. The "Teflon" material of the ring 74 has the physical characteristic of resisting the adhering of water to its surface at low temperature and thus forms a seat that will resist freezing at low operating temperatures normally encountered. In addition, the silicon rubber seating ring 66 offers a soft resilient seating edge to seal the port 64 when the knife edge 70 is engaged by the ring 74. This permits a minimum force to be exerted by spring 100 to effect a tight seal. Also, since the seating ring 66 is of substantial volume, it offers a substantial path for heat loss and reduces the tendency for the valve member 68 to freeze to the knife edge 70.

The supporting portions 76 of the valve member 68 is made of metal, such as aluminum, which being a good conductor of heat absorbs a maximum amount of heat from the exhaled air. The heat thus absorbed is conducted to the valve ring 74 and tends to prevent freezing of the same in engagement with the knife edge 70. The parts of the exhaust valve 26 adjacent to the valve member 68 are formed from a material of low thermal conductivity to reduce the heat transfer from the valve member 68 to the atmosphere.

While only one embodiment of the invention has been herein shown and described, it will be apparent to those skilled in the art that many changes may be made in the construction and ararngement of parts without departing from the scope of the invention as defined in the appended claims.

I claim:

1. In an exhaust valve for exhausting exhaled air from a face mask or the like of a breathing apparatus having a regulator for supplying breathing fluid under pressure to the mask and for varying the pressure of the breathing fluid within the mask with variations in atmospheric pressure, the combination comprising a casing adapted to be supported on the mask with an inlet port in communication with the interior of the mask and an outlet port for exhausting air to the atmosphere, a valve seat intersecting said inlet and outlet ports, a valve member biased into engagement with said seat and being pivotally mounted at one end thereof for pivotal movement out of engagement with said seat against said bias in response to an increase in said fluid pressure within said inlet port acting on one side of said valve member and caused by exhalation by the user of the apparatus, and means defining an expansible chamber operatively interconnected to and exerting a force

on the other side of said valve member and adapted to be connected in communication with the regulator for compensating said valve member for variations in the pressure of the breathing fluid within the mask acting on said one side of said valve member.

2. In an exhaust valve as claimed in claim 1 wherein said expansible chamber comprises a wall of said casing having an expansible diaphragm sealed thereto, said diaphragm having end wall engaging said other side of said valve member for exerting a force on said other side in response to an increase in pressure within said chamber.

3. In an exhaust valve as claimed in claim 2 wherein said biasing means comprises a spring positioned in said chamber and mounted in compression between said wall of said casing and said end wall of said diaphragm.

4. In an exhaust valve for exhausting exhaled air from a face mask or the like of a breathing apparatus having a regulator for supplying breathing fluid under pressure to the mask and for varying the pressure of the breathing fluid within the mask with variations in atmospheric pressure, the combination comprising a casing adapted to be supported on the mask with an inlet port in communication with the interior of the mask and an outlet port for exhausting air to the atmosphere, a valve seat intersecting said inlet and outlet ports, a valve member engaging said seat and pivotally mounted at one end thereof for pivotal movement out of engagement with said seat in response to an increase in fluid pressure within said inlet port acting on one side of said valve member and caused by exhalation by the user of the apparatus, means for biasing said valve member into engagement with said seat, and means defining an expansible chamber operatively interconnected to and exerting a force on the other side of said valve member in communication with the regulator for compensating said valve member for variations in the pressure of the breathing fluid within the mask acting on said one side of said valve member.

5. In an exhaust valve as claimed in claim 4 wherein said valve member is pivotally mounted by means of a pair of spaced ears on said one end of said valve member, said ears having elongated slots therein for receiving a pin fixed on said casing.

6. An exhaust valve as claimed in claim 5 wherein said expansible chamber comprises a wall of said casing having an expansible diaphragm sealed thereto, said diaphragm having an end wall engaging said other side of said valve member for exerting a force on said other side of said valve member in opposition to the pressure force acting on said one side of said valve member.

7. In an exhaust valve as claimed in claim 6 wherein said biasing means comprises a spring positioned in said expansible chamber and mounted in compression between said wall of said casing and said end wall of said diaphragm.

8. In an exhaust valve for exhausting exhaled air from a face mask or the like of a breathing apparatus having a regulator for supplying breathing fluid under pressure to the mask and means for varying the pressure of the breathing fluid within the mask with variations in atmospheric pressure, the combination comprising a casing adapted to be supported on the mask and having an inlet port in communiciation with the interior of the mask and an outlet port for exhausting air to the atmosphere, a valve seat intersecting said inlet and outlet ports, a valve member biased into engagement with said seat and movable out of engagement with said seat against said bias in response to an increase in fluid pressure within said inlet port acting on one side of said valve member and caused by exhalation by the user of the apparatus, means defining an expansible chamber on the other side of said valve member including a wall of said casing overlying said valve member and an expansible diaphragm sealed to said wall and having an end wall engaging said other side of said valve member, said expansible chamber being adapted for connection in communication with said regulator for exerting

a pressure force on said other side of said valve member to compensate for variations in pressure in said inlet port caused by said regulator, and valve means associated with said wall of said casing for venting fluid pressure from said expansible chamber in response to the occurrence of a predetermined excessive pressure condition caused by the regulator.

9. In an exhaust valve as claimed in claim 8 wherein said valve means comprsies a valve port in said casing wall in communication with the atmosphere and said expansible chamber, and a valve member biased into engagement with said casing wall to control communication between

said expansible chamber and the atmosphere through said port, said valve member being moved out of engagement with said wall against said bias when the pressure within said chamber exceeds the biasing force of said valve member.

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2,685,288	Fields et al.	Aug. 3, 1954
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