DEMAND VALVE ASSEMBLY FOR USE WITH BREATHING OR RESUSCITATION EQUIPMENT

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ABSTRACT
A demand valve assembly for use with breathing or resuscitation equipment is disclosed. The valve assembly includes a first main valve controlling flow of pressurized gas, either oxygen or an air mixture, to the assembly and a second inhalation-exhalation valve controlling flow of the pressurized gas and the exhausted gas to and from a mask on the patient. A positive pressure button assembly provides for accurate pressure settings with only slight button travel.

16 Claims, 7 Drawing Figures
DEMAND VALVE ASSEMBLY FOR USE WITH BREATHING OR RESUSCITATION EQUIPMENT

BACKGROUND OF THE INVENTION

1. Field of the Invention
   The present invention relates to a demand valve for use with breathing or resuscitation equipment and more particularly to a valve apparatus which will be self-operating when a demand has been established.

2. Description of the Prior Art
   The known valve assemblies for resuscitation type equipment have suffered from a number of drawbacks including complex structural arrangements and a large number of parts. Examples of the known valve assemblies may be found in U.S. Pat. No. 3,285,261 to Chaney, owned by a common assignee, and U.S. Pat. No. 3,435,839 to Elder. An assembly combining the devices of the Chaney and Elder patients is also known.

SUMMARY OF THE PRESENT INVENTION

It is an object of the present invention to provide an improved valve assembly for use in breathing or resuscitation equipment which will be self-regulating when demand is established.

It is another object of the present invention to provide an improved demand valve assembly in which a single elastomeric member performs functions previously requiring two elements, namely a diaphragm and a check valve.

It is also an object of the present invention to provide an improved button assembly which can be used for accurate pressure setting of a demand valve assembly in spite of relatively short button travel.

It is yet another object of the present invention to provide a demand valve assembly which may be readily and economically produced.

The present demand valve assembly has, in a single housing, a first or main valve controlling flow of pressurized gas from a source to the assembly, a pilot valve controlling the opening and closing of the main valve and which is responsive to both mechanical actuation and to pressures developed in the assembly, and an inhalation-exhalation valve controlling the passage of the pressurized gas to a patient and the venting of exhausted air to the ambient atmosphere. The main valve diaphragm is normally biased closed by a projection and held closed by equalization of pressures on opposite sides of the valve diaphragm. This equilibrium condition is unbalanced by the opening of the pilot valve in response to either a mechanical actuation through a button assembly or by diaphragm movement in response to pressure changes. The inhalation-exhalation valve controls the flow of the pressurized gas to a patient and vents the exhausted air by means of a single elastomeric member performing the functions previously requiring both a diaphragm and a check valve.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing objects and other advantages of the present invention will become apparent from the following detailed description taken in connection with the accompanying drawings, in which:

FIG. 1 is a perspective view of the demand valve assembly;

FIG. 2 is a partially exploded, perspective view of the demand valve assembly;

FIG. 3 is a longitudinal sectional view of the demand valve assembly shown in the exhaust or exhale condition;

FIG. 4 is a longitudinal sectional view of the demand valve assembly shown in the inhale condition;

FIG. 5 is an exploded perspective view of the inhalation-exhalation valve assembly;

FIG. 6 is a transverse section through the demand valve assembly taken along line 6-6 of FIG. 3; and

FIG. 7 is a transverse section through the demand valve assembly taken along line 7-7 of FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The subject demand valve assembly comprises a housing 10 having a first cavity 12 formed in one end and a second opposing cavity 14 formed in the other end. A first bore 16 and a second larger bore 18 are formed in the housing and provide communication between the first and second cavities.

In the first cavity there is a paddle assembly 20. The paddle assembly includes a paddle member 22 one end of which is fixed to the housing by screw 24. A second screw 26 adjustably positions the other end of the paddle member with respect to the surface 28 of the first cavity. Pilot lever 30 is pivotably mounted on the free end of the paddle member 22 by pivot pin 32. A spring 34 biases the pilot lever so that pad 36 normally closes the bore 38 of the pilot valve 40 which is fixedly mounted in the first communicating bore 16. A sensing diaphragm 42 is positioned in the first cavity to define a sensing chamber and has a peripheral enlargement 44 engaging in an annular recess 46 in housing 10. A metal plate 48 is attached to the diaphragm for improving the wear characteristics where the diaphragm engages the pilot level member.

A button assembly 50 closes the first cavity. The button assembly includes a button support ring 52, first button 54, second button 56, retaining ring 58, first coiled spring 60 and second coiled spring 62, the buttons 54 and 56 being coaxially and slidably arranged to permit the button 56 to move within the button 54 to provide an override for the button assembly 50. The retaining ring 58 includes annular flanges 64 and 66 and is snap fastened together with the first button 54. The first spring 60 is mounted in compression between buttons 54 and 56 and normally biases an annular shoulder of the second button 56 into engagement with flange 64 while the second spring 62 normally biases the first button 54 and retaining ring 58 to bring flange 66 into engagement with annular flange 68 on the button support ring 52. The button assembly 50 is mounted on the housing by the engagement of an annular flange 70 on the button support ring with a corresponding recess 72 in the housing.

An inlet bore 74 is provided in the housing 10 and includes a main passage 76 and a by-pass passage 78. The main passage 76 makes a right angle turn at approximately the longitudinal axis of the housing and terminates in a truncated conical seat 80.

A main or first valve assembly 82 is mounted in the second cavity and includes a valve body 84 having in one surface thereof a first outer annular groove 86, a second inner concentric annular groove 88, and a valve recess 90 which is concentric with both the first and second annular grooves. An axial projection 92 is fixed in
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the center of the valve recess. A radial bore 94 connects the outer groove 86 to the valve recess 90. A bore 96 is formed in valve body 84 and is aligned with bore 18 in the housing 10. Bore 98 are provided for mounting screws 100 to hold the body in the housing. Arcuate slots 102 provide communication between the second groove 88 and the remainder of the second cavity 14. A main valve diaphragm 104 is positioned in the valve recess to define an operating chamber and has one side normally biased by the projection 92 into engagement with the truncated conical seat 80. A retaining member 106 holds the diaphragm 104 in the recess 90. A seal is provided between the housing 10 and the first annular groove 86 by O-rings 108 and 110.

An outlet adapter 112 closes the second cavity 14 and is connected to a face mask (not shown). The adapter includes an outlet passage 114, a valve seat 116, and at least one arcuate ambient or exhaust outlet 118. The outlet adapter is attached to the housing 10 by any suitable means, such as the illustrated screw threads 120. A second or inhalation-exhalation valve assembly 122 is positioned in the second cavity 14 between the main valve assembly and the outlet adapter and includes, see FIG. 5, a first seat member 124, a second seat member 126 and the grid or spider member 128. The second seat member 126 and the grid member 128 are composed of fairly rigid material while the first seat member 124 is made out of flexible elastomeric material. The first seat member 124 is an integral member which includes an annular skirt portion 130, an outwardly extending radial flange 132, a radial web 134 extending inwardly until it forms a cylindrical portion 136 concentric with the skirt 130. A bridge 138 is formed across the opening at one end of the cylindrical portion and has first and second flat valve portions 140 and 142 radially therefrom, and a centering projection 144 extends axially from the bridge. The grid member 128 includes an annular ring portion 146 and intersecting radial grid arms 148. The ring portion 146 when assembled, engages in an annular recess 150 in the cylindrical portion 136 of first seat member 124. The second seat member includes a depending skirt 152 and first and second radial flanges 154 and 156, respectively. The skirt 152 has an inner diameter which is almost the same as the outer diameter of the cylindrical portion 136. When the inhalation-exhalation valve is assembled, the grid or spider member 128 is held tightly in the groove 150 of the first seat member 124 by the engagement of the skirt 152 of the second seat member 126 with the cylindrical portion 136.

The valve assembly is connected to a source of pressurized gas (not shown), which is preferably either oxygen or an air mixture by a fitting 158 having a bore 160 therein. A filter 162 is mounted in the bore 74 of the valve housing. A hose fitting (not shown) is connected to the fitting 158 to feed the pressurized fluid to the assembly. Additional filters (not shown) may be provided in the hose or the hose fitting.

The operation of the device is as follows: pressurized gas, for example oxygen or an air mixture, is fed from a source (not shown) through a connecting hose and filters (also not shown) to the inlet fitting of the demand valve apparatus. The gas passes through bores 160 and 76, by-pass passage 78, first annular groove 86 and radial bore 94 to the operating chamber defined by valve recess 90. Thus the pressure on both sides of the main valve diaphragm 104 will be equal causing the equilibrium condition shown in FIG. 3 with the diaphragm 104 engaging conical valve seat 80 due to the biasing force of axial projection 92.

When operation of the valve assembly is desired, first button 54 is depressed against the bias of spring 62. Spring 60 will cause second button 56 to move with the first button until it contacts and depresses sensing diaphragm 42. The sensing diaphragm 42 will move into engagement with the pilot lever 30 and cause it to pivot about pin 32 until pad 36 clears the bore 38 of pilot valve 40. When the pilot 40 opens, pressurized gas will flow from the valve recess 90, through radial bore 94, outer groove 86, first bore 16, the sensing of chamber in first cavity 12, second bore 18, second cavity 14, flat valves 140 and 142 to the outlet passage 114. When this flow begins there will no longer be equal pressures acting on main valve diaphragm 104 and the main valve will open allowing direct passage of pressurized gas from inlet 74 through the open valve, second annular groove 88, arcuate slots 102, second cavity 14, flat valves 140 and 142 to outlet passage 114. The pressurized gas flowing through pilot valve 40 will increase pressure on the sensing diaphragm 42 and tend to move it back against the force applied by second button 56. When the force of the gas pressure reaches a predetermined level, it will overcome the force exerted by spring 60 to drive the second button 56 backward despite continued pressure on the first button 54. This movement of the sensing diaphragm 42 out of contact with pilot lever 30 which will then pivot under the influence of spring 34 to close the pilot valve 40 and thus restore the equilibrium of the main valve.

When the pressure in the second cavity 14, from either the pilot or main valves opening, exceeds the pressure in the outlet passage 114, flat valves 140 and 142 will open, as shown in FIG. 4, allowing free passage of the pressurized gas. When the pressure in the outlet passage 114 exceeds the pressure in the second cavity 14, as shown in FIG. 3, the inhalation-exhalation valve will open by the central portion of this valve assembly moving away from seat 116 to provide passage for the exhausted air to atmosphere through outlet ports 118. The opening and closing movement of the inhalation-exhalation valve assembly is enabled by the flexibleness of the web 134.

As mentioned above, the main valve 82 will open only when there is a difference in the pressures applied to each side of the diaphragm 104, the valve being normally biased closed. A pressure differential can be created either by actuation of the button assembly 50 and the resultant opening of the pilot valve 40, as previously described, or by the patient beginning to breathe normally. In the latter case, each time the patient inhales the flap valves 140 and 142 and the main valve will be opened since the inlet pressure to the assembly will exceed the outlet pressure. Likewise the flat valves and the main valve will be closed and the valve assembly 122 unscrewed from seat 116 when the patient exhales thus allowing the exhausted air to be vented to the atmosphere.

From the foregoing it is quite clear that the present demand valve assembly has eliminated the previous need for a separate check valve and a diaphragm and provides this function with a simplified inhalation-exhalation valve assembly. The present valve has many other features and advantages which will be apparent to the skilled artisan and may be embodied in other
specific forms without departing from the spirit of the invention. Therefor the present specification should be considered as merely illustrative and not restrictive.

What is claimed is

1. In a breathing apparatus, a demand valve assembly adapted to control gas flow from a source of pressurized gas to a person using said apparatus, said demand valve assembly comprising

a substantially cylindrical housing having an inlet opening and an outlet opening; normally closed, differential pressure actuated main valve means in said housing adapted to control flow from said inlet opening to said outlet opening, said main valve means including

a valve body fixedly mounted in said housing and having an outer annular groove, an inner concentric annular groove, at least one concentric arcuate slot communicating with said inner annular groove, a central concentric valve recess, and a radial bore connecting said outer annular groove with said valve recess, an axial bore in said housing terminating in a valve seat disposed in opposition to said valve recess, an inlet passage in said housing connecting said bore to said inlet opening, diaphragm means mounted in said valve recess spanning said valve seat, fixed means in said valve recess normally biasing said diaphragm means against said valve seat, and

a by-pass passage in said housing providing communication between said inlet passage and an operating chamber defined by said valve recess and said diaphragm means whereby pressure on opposite sides of said diaphragm means is normally equalized to maintain said main valve means closed; control means for opening said main valve means by reducing pressure in said operating chamber; and outlet valve means for passing pressurized gas out through said outlet opening and venting to atmosphere back pressure at said outlet opening.

2. A demand valve assembly according to claim 1 wherein said control means includes

pilot valve means having an element movable from a closed pilot valve position to an opening pilot valve position, and

means biasing said movable element to a normally closed position, said pilot valve means operating in said open pilot valve position to relieve pressure in said operating chamber to open said main valve means.

3. A demand valve assembly according to claim 2 and further comprising

means to actuate said movable element of said pilot valve means including button means for manually moving said element, and

sensing diaphragm means responsive to pressures developed in said demand valve assembly for overriding said button means.

said button means including

first and second coaxial buttons, first spring means biasing said first and second buttons axially apart, and

second spring means biasing said first and second buttons away from said sensing diaphragm, whereby movement of said sensing diaphragm overrides said button means by compressing said first spring means despite continued pressure on said first button.

4. A demand valve assembly according to claim 1 wherein said outlet valve means includes

an outlet member attached to said housing and defining said outlet opening, said outlet member including a first passage adapted for communication with a person using said apparatus, a second passage venting to atmosphere and a valve seat formed between said passages, and an inhalation-exhalation valve assembly mounted in said housing and having a unitary elastomeric flexible member forming an annular diaphragm portion cooperating with said outlet member valve seat to control communication between said first and second passages and a flap valve portion permitting flow only out of said housing and through said first axial passage,

a rigid spider membermounted on said flexible member to support said flap valve portion, and

a rigid annular seat member mounted on said flexible member to provide positive engagement with said outlet member valve seat and to hold said spider member in position.

5. A demand valve assembly according to claim 4 wherein said flexible seat member has

an annular skirt, a radial web connected to said skirt forming said diaphragm portion, an annular opening in said web having a bridge extending across the diameter thereof, and a pair of flaps radially extending from said bridge forming said flap valve portion.

6. A demand valve assembly for controlling a flow of pressurized gas comprising

a housing having inlet means and outlet means; an inhalation-exhalation valve assembly disposed at said outlet means responsive to inhalation by a user to permit flow out of said outlet means and responsive to exhalation by a user to provide a passage to the atmosphere; main valve means disposed in said housing and operated in response to pressure in an operating chamber to control flow between said inlet means and said outlet means; pilot valve means controlling the pressure in said operating chamber and having a first position for opening said main valve means and a second position for closing said main valve means; and control means for operating said pilot valve means in response to manual actuation and pressure at said outlet means including sensing diaphragm means disposed in said housing to define a sensing chamber and movable to place said pilot valve means in said first and second positions, passage means communicating with said outlet means and said sensing chamber, and a button assembly having a member movable to contact and move said sensing diaphragm means to place said pilot valve means in said first position when said button assembly is depressed, and override means permitting movement of said member and said sensing diaphragm means to place said pilot valve means in said second position while said button assembly is depressed whereby said pilot valve means can be placed in said first position to open said main valve means in response to depression of said button assembly or
inhalation by a user to decrease pressure in said sensing chamber and said pilot valve means can be placed in said second position to close said main valve means in response to exhalation by a user to increase pressure in said sensing chamber even while said button assembly is depressed.

7. A demand valve assembly according to claim 29 wherein said main valve means includes a valve body having an outer annular groove, an inner concentric annular groove, at least one concentric inner arcuate slot communicating with said inner annular groove, a concentric valve recess, and a radial bore connecting said outer annular groove to said valve recess, an inlet bore in said housing terminating in a valve seat disposed opposite said valve recess of said valve member, a by-pass passage in said housing connecting said inlet bore to said outer annular groove, a main diaphragm mounted in said valve recess to define said operating chamber, means biasing said main diaphragm against said valve seat, and conduit means formed in said housing connecting said outer annular groove to said pilot valve means.

8. A demand valve assembly according to claim 7 wherein said pilot valve means includes a pilot valve element movable in response to movement of said sensing diaphragm means from said second position closing off said conduit means to said first position, and spring means biasing said pilot valve element towards said second position.

9. A demand valve assembly according to claim 6 wherein said inhalation-exhalation valve assembly includes an outlet member having a first axial passage and a second coaxial passage separated by a valve seat, and a flexible member mounted in said housing and having an annullar diaphragm portion cooperating with said outlet member valve seat to control communication between said first and second passages and a flat valve portion permitting flow only out of said housing and through said first axial passage.

10. A demand valve assembly according to claim 6 wherein said button assembly includes a button coaxially mounted with said member, first spring means biasing said button and said member apart and second spring means biasing said member away from said sensing diaphragm means.

11. A demand valve assembly according to claim 10 wherein said button has an inwardly extending flange, said member has a shoulder slidable in said button limited by abutment of said shoulder with said inwardly extending flange, and said first spring means includes a coiled spring mounted in compression between said button and said member to bias said shoulder against said inwardly extending flange.

12. A demand valve assembly according to claim 11 wherein said button assembly includes support means for mounting said button assembly on said housing including an inwardly extending flange, said button has an outwardly extending flange, and said second spring means includes a coiled spring mounted in compression between said support means and said button to bias said button assembly to an inoperative position with said outwardly extending flange of said button assembly abutting said inwardly extending flange of said support means and said member spaced from said sensing diaphragm means.

13. A breathing demand valve assembly for controlling the flow of gas from a source of pressurized gas to a user comprising a housing having an inlet passage and an outlet passage, a differential pressure actuated main valve for controlling gas flow through said inlet passage, pilot valve means adapted to control operation of said main valve including a pilot valve element movable one position to another control pressure at said main valve and means to actuate said pilot valve element, and a second valve means adapted to control flow of the gas through said outlet passage and to vent to atmosphere exhaust gas from a user, said second valve means including an outlet member attached to said housing and having a first axial passage adapted for communication with a user, a second coaxial passage venting to atmosphere and an annular valve seat formed between said passage, and an inhalation-exhalation valve assembly mounted in said housing and having a unitary elastomeric flexible member forming an annular diaphragm portion cooperating with said outlet member valve seat to control communication between said first and second passages and a flat valve portion permitting flow only out of said housing and through said first axial passage, a rigid spider member mounted on said flexible member to support said flat valve portion, and a rigid annular seat member mounted on said flexible member to provide positive engagement with said outlet member valve seat and to hold said spider member in position.

14. A demand valve assembly according to claim 13 wherein said unitary flexible member has an annular skirt, a radial web connected to said skirt forming said diaphragm portion, an annular opening in said web having a bridge extending across the diameter thereof, and a pair of flaps radially extending from said bridge forming said flap valve portion.

15. A demand valve assembly according to claim 18 wherein said means to actuate said pilot valve element includes manully actuable button means adapted to move said element to the open position, spring means biasing said element to the closed position.

16. A demand valve assembly according to claim 26 wherein said button means includes, first and second concentric, oppositely acting buttons, first spring means biasing said first and second buttons axially apart, and second spring means biasing said first and second buttons to a position with said second button out of contact with said sensing diaphragm.

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