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PRESSURE REGULATING VALVE FOR REBREATHING APPARATUS

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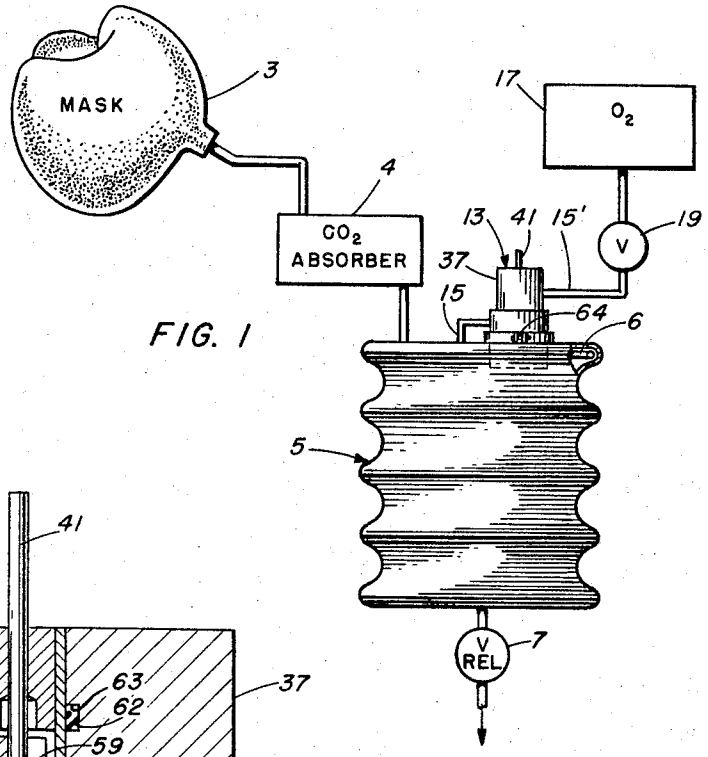


FIG. 1

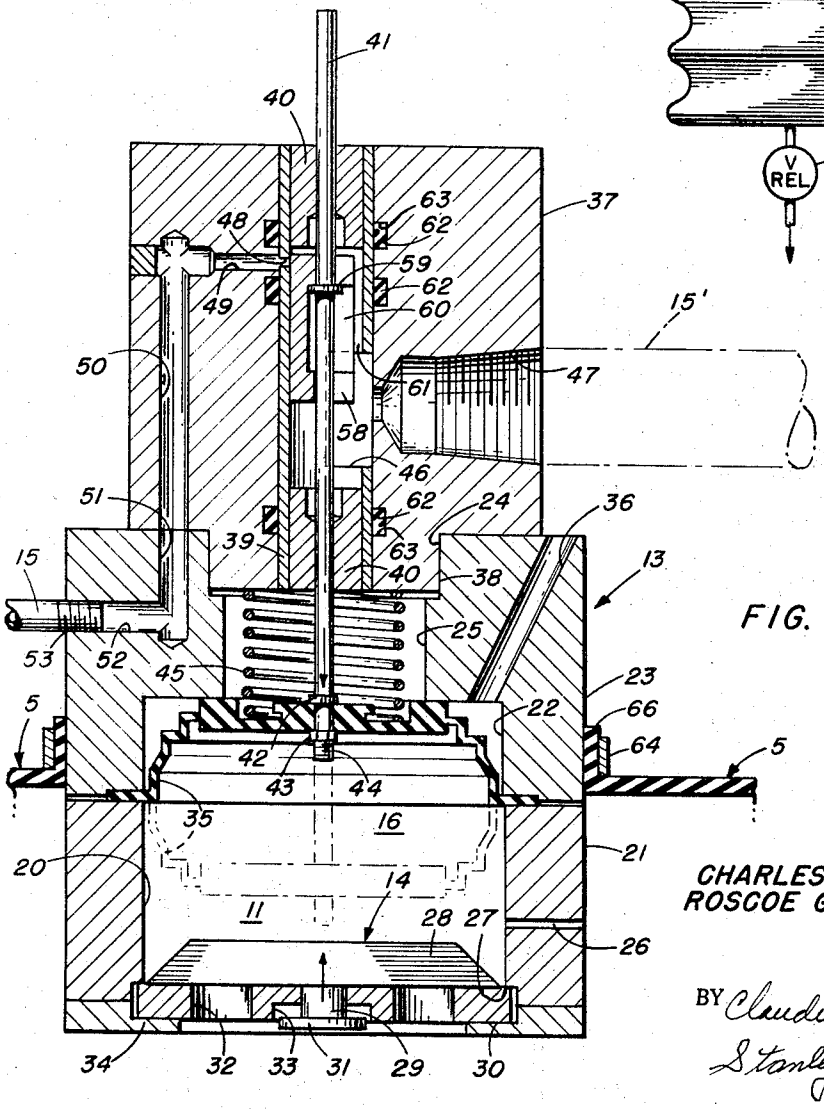


FIG. 2

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PRESSURE REGULATING VALVE FOR REBREATHING APPARATUS

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The present invention relates to a rebreathing apparatus and, more particularly, to a device which will extend the time a limited amount of oxygen may be used in an artificial respiration system.

Prior art respiration systems allow a fixed amount of oxygen to be inhaled during inspiration and thereafter exhaled to the atmosphere. Since less than the full amount of the available oxygen inhaled is consumed by human lungs during each breath, a portion of the usable oxygen is wasted when exhaled directly to the atmosphere. If the exhaled air could be repeatedly used, removing the carbon dioxide therefrom and replacing the oxygen as needed, the amount of oxygen consumed could be substantially reduced.

It is, therefore, an object of the present invention to provide a rebreathing apparatus which will extend the time a fixed quantity of oxygen is capable of supporting the breathing needs of a person.

Another object is the provision of an improved valve for use in the rebreathing apparatus of the present invention.

A further object of the present invention is to provide an improved valve incorporating a delay actuation mechanism.

Yet another object of the present invention is to provide a rebreathing apparatus which is light and compact and may be easily carried.

Still another object of the present invention is to provide a rebreathing apparatus which is characterized by simplicity of construction, low cost, and ease of operation and use.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

FIG. 1 is a schematic representation, showing the components of the present invention; and

FIG. 2 is an enlarged side elevation view, partly in section, showing the elements of the valve unit.

Briefly, the rebreathing device of the present invention is comprised of an oxygen mask connected through a carbon dioxide absorber to a rebreathing bag. The rebreathing bag is equipped with two valves, i.e., a relief valve which exhausts to the atmosphere when the pressure in the bag exceeds a predetermined limit, and a unidirectional valve which communicates with a sensing chamber in a master valve unit. A diaphragm within the master valve unit sensing chamber is attached to a valve stem which, in turn, is attached to a slide valve adapted to open and close an oxygen line between the rebreathing bag and an oxygen supply. As the oxygen within the rebreathing bag is depleted, an accompanying decrease in pressure is reflected by the collapse of the diaphragm within the sensing chamber. The diaphragm movement opens the slide valve, through the connecting valve stem, thereby allowing oxygen to pass through the oxygen line and replenish the depleted oxygen within the rebreathing bag. The introduction of oxygen into the rebreathing bag increases the pressure on the diaphragm closing the slide valve.

Referring now to the drawings, FIG. 1 shows a face

mask 3, such as is well known in the art, connected to a carbon dioxide absorber 4, also well-known in the art. The carbon dioxide absorber 4 is connected to a semi-rigid rebreathing bag 5 made of an elastomeric material, such as silicone rubber, which may be reinforced by a plurality of internal circular ribs 6. A spring loaded relief valve 7, attached to the lower portion of the rebreathing bag 5, opens at a predetermined pressure for venting the bag to the atmosphere, thereby preventing an excessive pressure buildup. A master valve unit 13 is located in an oxygen line 15 which connects an oxygen supply 17 to the rebreathing bag 5. A metering valve 19 is located in the oxygen line 15 between the valve unit 13 and the oxygen supply 17 for limiting the amount of oxygen flow through the valve unit 13 when said valve unit is opened.

As best illustrated in FIG. 2, the master valve unit 13 is provided with a unidirectional valve 14 disposed within a cylindrical bore 20 formed in a first housing 21. The unidirectional valve 14 is adapted to place the interior of the breathing bag 5 in communication with a sensing chamber 16 formed by the cylindrical bore 20 in the first housing 21 and a second cylindrical bore 22 in a second housing 23. The upper end of the second housing 23 is provided with a bore 24 which communicates with the interior of the sensing chamber 16 through the smaller stepped bore 25. A bleeder orifice 26 is located in the sidewall of the first housing 21 and communicates between the sensing chamber 16 and the interior of the rebreathing bag 5. The one-way valve 14 mounts in a relieved portion 27 formed in the inner surface of the housing 21 and is comprised of a disk portion 28 having a stem 29 extending from its center lower surface through a base portion 30 and terminating in a flange 31. The base portion 30 has a plurality of ports 32 surrounding a central counterbored opening 33 through which passes the valve stem 29. The unidirectional valve is attached to the housing 21 by a mounting plate 34.

Dividing the interior of the sensing chamber 16 into two sections is a diaphragm 35 which is clamped in position between the first housing 21 and the second housing 23. A port 36, in the second housing portion 22, vents the upper section of the divided sensing chamber 16 to the ambient atmosphere. A third housing 37 has a reduced lower portion 38 which fits tightly into the recess 24 in the second housing portion 23 thereby closing the upper section of the sensing chamber 16. The upper housing 37 is bored along its central axis to receive a tubular bearing seat 39 having a journal bearing 40 mounted in each end. A valve stem 41, slidably mounted within the bearing 40, is secured to the center of the diaphragm 35 by a shoulder 42 and a nut 43 threadedly engaging a threaded portion 44 on the lower end of the valve stem 41. A compression spring 45, mounted within the opening 25 and abutting the bottom surface of the upper housing 37, urges the diaphragm 35 towards a collapsed position, as shown in phantom.

The bearing housing 39 is opened at 46 to communicate with an internally threaded inlet port 47 to which is attached an oxygen line 15' leading from the oxygen supply 17. An orifice 48, located above and diametrically opposite the opening 46, communicates with a passageway 49, 50, 51 and 52 which terminates in an outlet port 53. Attached to the port 53 is the oxygen line 15 leading from the valve unit 13 to the rebreathing bag 5. Covering the orifice 48 is a slide valve 58 which is slidably attached to the valve stem 41 by a square clip ring 59 located in a centrally relieved space 60, of substantially square cross-section, thereby allowing the valve stem 41 to travel up or down a fixed distance before engaging the slide valve 58. One side of the slide valve 58 is segmented, as at 61, so as to form a passageway for the passage of oxygen from the inlet port to the orifice 48, while the

sides of the square clip ring **59** engaging the sides of the centrally relieved space **60** prevent rotation of the slide valve **58** on the valve stem **41**. A plurality of annular sealing rings **62** mount in grooves **63** between the axial bore in the upper housing **37** and the bearing housing **39** to prevent leakage. The valve unit **13** is secured in the rebreathing bag **5** by a mounting ring **64** clamped around the lip **66** of the bag **5** and the housing **23**.

In operation, air from the rebreathing bag **5** is inhaled through the carbon dioxide absorber **4** to the mask **3**. During the inspiration stage, valves **7** and **14** remain closed. When, however, the breath is exhaled into the rebreathing bag **5**, valve **14** opens thereby equalizing the pressure in the sensing chamber **16** with that in the bag **5**. As the oxygen within the rebreathing bag **5** is depleted by repeated respirations, the pressure therein drops. This pressure drop causes the diaphragm **35** to collapse under the combined urging of the ambient atmospheric pressure, communicated to the upper surface of the diaphragm **35** through port **36**, and the compression spring **45**. As the diaphragm **35** collapses, the valve stem **41** is drawn down with it until the clip ring **59** engages the lower surface of the centrally relieved space **60** within the slide **58**. After the slide valve **58** is engaged it is also drawn down by the collapsing diaphragm thereby exposing the orifice **48** and allowing oxygen to pass into the rebreathing bag **5**. When the incoming oxygen has increased the internal pressure in the rebreathing bag **5**, as well as in the sensing chamber **16**, the diaphragm **35** raises the valve stem **41** and closes the slide valve **58** over the orifice **48**. Due to the arrangement the pressure within the rebreathing bag **5** is maintained equal to or slightly greater than ambient pressure while an adequate supply of oxygen is available at all times for the person using the device.

There has thus been described a rebreathing device which permits more complete utilization of the oxygen content of an artificial respiration system. In addition, due to the unique construction of the master valve unit **13**, a high degree of reliability and safety is maintained by eliminating fatigue causing oscillations of the slide valve **58** through the use of a lost motion actuation system.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A rebreathing apparatus comprising:

an oxygen mask;

a carbon dioxide absorber connected to said mask;

a rebreathing bag connected to said carbon dioxide absorber, said bag having a pressure relief valve thereon;

an oxygen supply; and

a valve unit having an orifice therein for providing communication between said oxygen supply and said rebreathing bag, said valve unit comprising a housing having a sensing chamber therein, one-way valve means connecting said sensing chamber to said rebreathing bag, said housing being provided with a bleeder orifice interconnecting said sensing chamber and said rebreathing bag, a diaphragm secured within said sensing chamber, a valve stem secured to said diaphragm, a slide valve slidably connected to said valve stem for movement relative to and with said valve stem for opening and closing said orifice, means biasing said slide valve toward the open position;

whereby a reduction of pressure within said rebreathing bag caused by depletion of the oxygen therein causes the slide valve, through the movement of the valve stem and diaphragm, to uncover the orifice thereby allowing oxygen to enter said bag.

2. A rebreathing apparatus in accordance with claim **1** wherein:

said slide valve is centrally relieved so as to form an interinal cavity of substantially square cross-section; and

said valve stem is provided with a square clip ring disposed within internal cavity of said slide valve, thereby providing a delay in the actuation of said slide valve.

3. A rebreathing apparatus in accordance with claim **2** wherein:

said one-way valve means comprises a disk portion overlying an apertured base, said base forming the lower end wall of said housing, thereby permitting oxygen flow from said bag into said sensing chamber.

4. A valve unit for use in a rebreathing apparatus having an oxygen mask, a carbon dioxide absorber, an oxygen supply and a rebreathing bag, said valve unit comprising:

a housing having a passageway therethrough and a sensing chamber therein, said passageway providing communication between said oxygen supply and said rebreathing bag;

a unidirectional valve means providing communication between said sensing chamber and said rebreathing bag, said housing being provided with a bleeder orifice interconnecting said sensing chamber and said rebreathing bag;

a diaphragm dividing said sensing chamber into two sections;

a valve stem secured to said diaphragm, said valve stem having a square clip ring secured thereto; and

a slide valve slidably connected to said valve stem and adapted to open and close said passageway, means biasing said slide valve toward the open position, said slide valve having an internal cavity of substantially square cross-section, said square clip ring being disposed within said cavity to prevent rotation of said slide valve on said valve stem.

5. A rebreathing apparatus for use in an artificial respiration system including a mask, a carbon dioxide absorber, and an oxygen supply, said rebreathing apparatus comprising:

a rebreathing bag connected to said mask through said carbon dioxide absorber;

a relief valve attached to said rebreathing bag for venting excess pressure therein;

a valve unit having a housing with a sensing chamber therein;

a unidirectional valve connecting said sensing chamber to said rebreathing bag, said housing being provided with a bleeder orifice interconnecting said sensing chamber and said rebreathing bag;

a diaphragm within said sensing chamber;

a valve stem connected to said diaphragm;

a slide valve mounted within said valve housing and connected to said valve stem, said slide valve adapted to open and close an orifice in said valve unit housing, means biasing said slide valve toward the open position;

a first oxygen line connecting said oxygen supply to one side of said orfice; and

a second oxygen line connecting said rebreathing bag to the other side of said orifice, whereby pressure within said bag causes said diaphragm to shift, thereby shifting said slide valve and allowing oxygen to enter said bag through said orifice.

6. A rebreathing apparatus in accordance with claim **5** wherein:

said slide valve and valve stem are provided with a lost motion relay actuation means.

7. A rebreathing apparatus in accordance with claim 6 wherein:

said lost motion delay actuation means comprises an internal cavity within said slide valve in which said valve stem reciprocates; and

a clip ring secured to said valve stem and disposed within said cavity.

8. A rebreathing apparatus in accordance with claim 7 wherein:

said internal cavity and clip ring are of substantially square cross-section.

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