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(54) Abstract Title
A MOUTHPIECE VALVE FOR CLOSED-LOOP SELF-CONTAINED BREATHING APPARATUS

(57) A mouthpiece valve for closed-loop self-contained breathing apparatus comprises a body (12) having an interior chamber with an inhalation port (38) an exhalation port (39) and a mouthpiece port (31) leading to a mouthpiece (35) for the user. Upon inhalation, a breathable gas from a closed-circuit is drawn into the interior chamber of the body (12) through the inhalation port (38) and passes out through the mouthpiece port (31), and upon exhalation gas is exhaled through the mouthpiece port (31) into the said interior chamber and passes therefrom through the exhalation port (39). The mouthpiece valve further includes valve means (50, 51, 52), which may operate automatically, to allow the introduction of a breathable gas from a separate source. The mouthpiece also includes manually operable valve means for diluent addition such that all three valves, namely automatic diluent addition valve, manual diluent addition valve and emergency open-circuit breathing valve, are combined in a single unit.

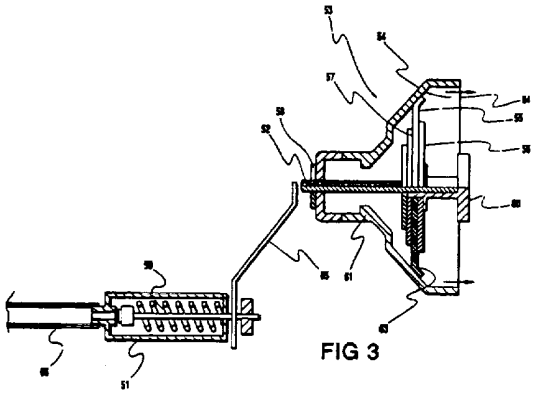

FIG 3

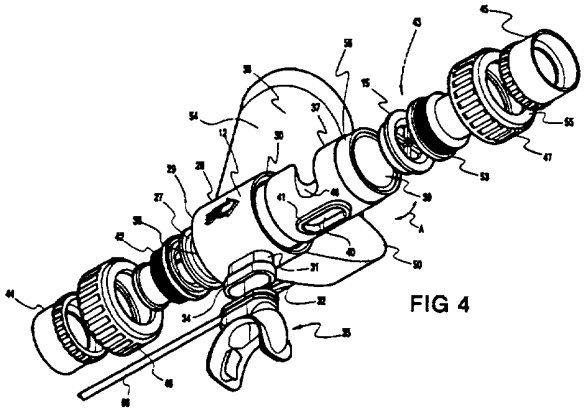

FIG 4

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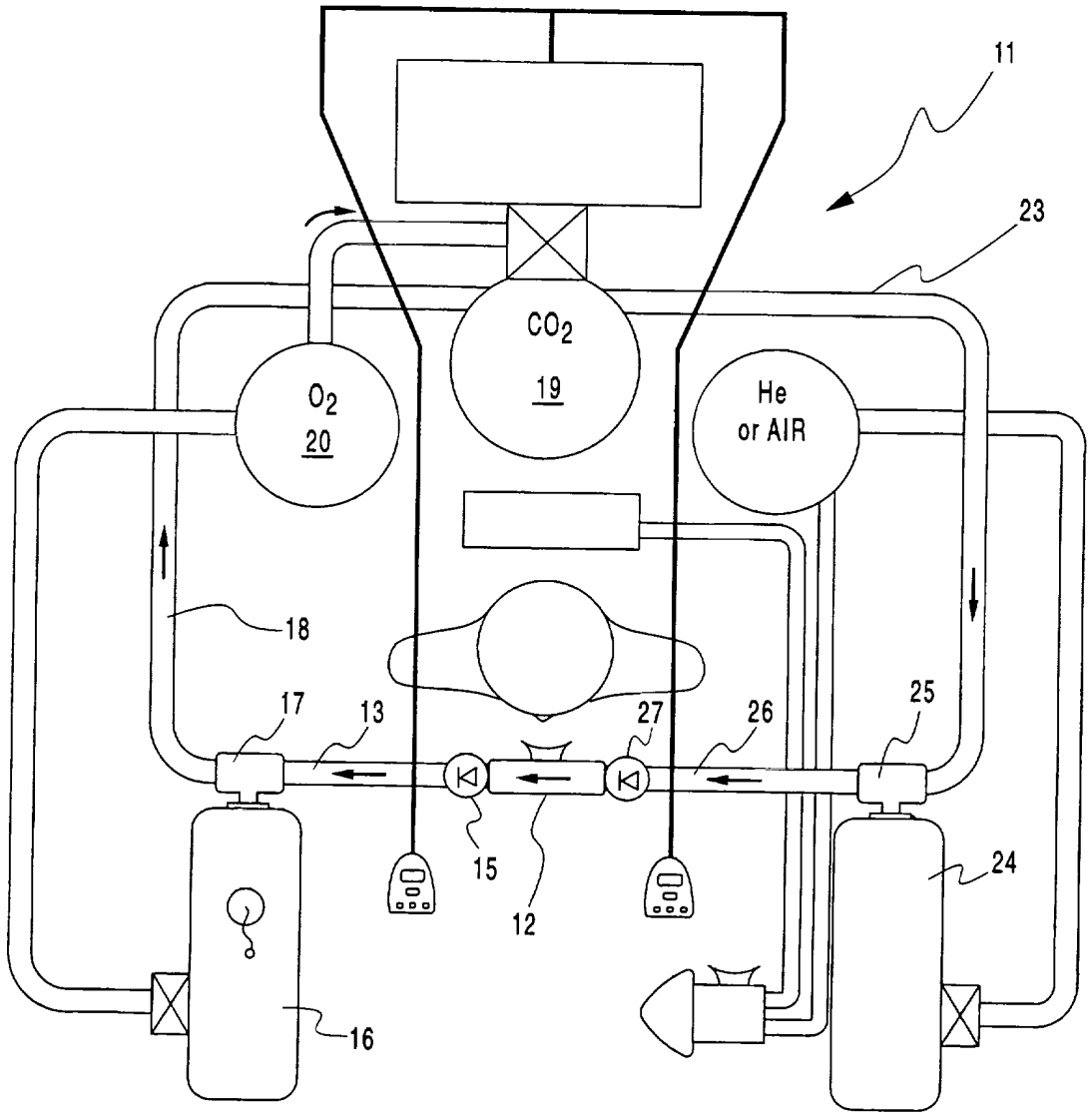

FIG 1

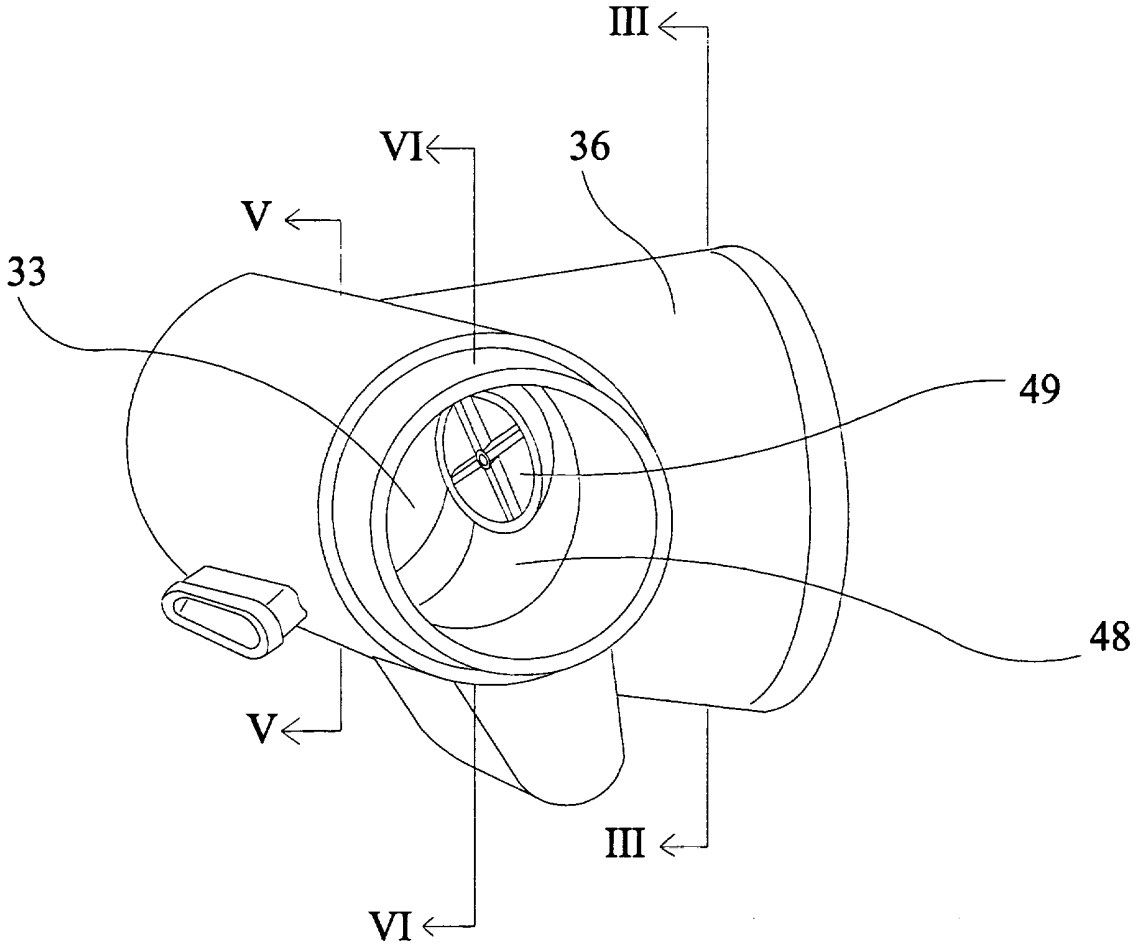

Fig 2

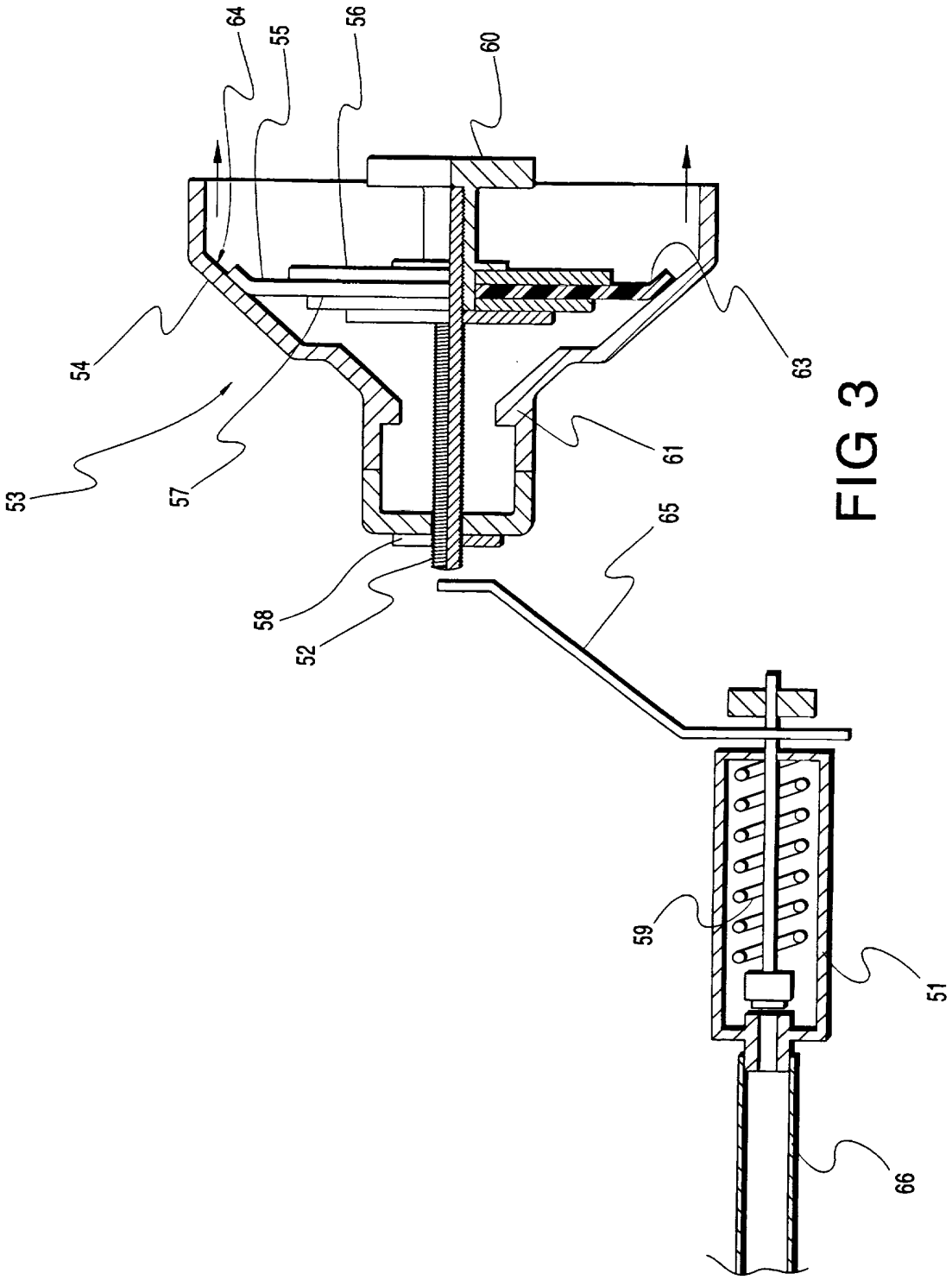

FIG 3

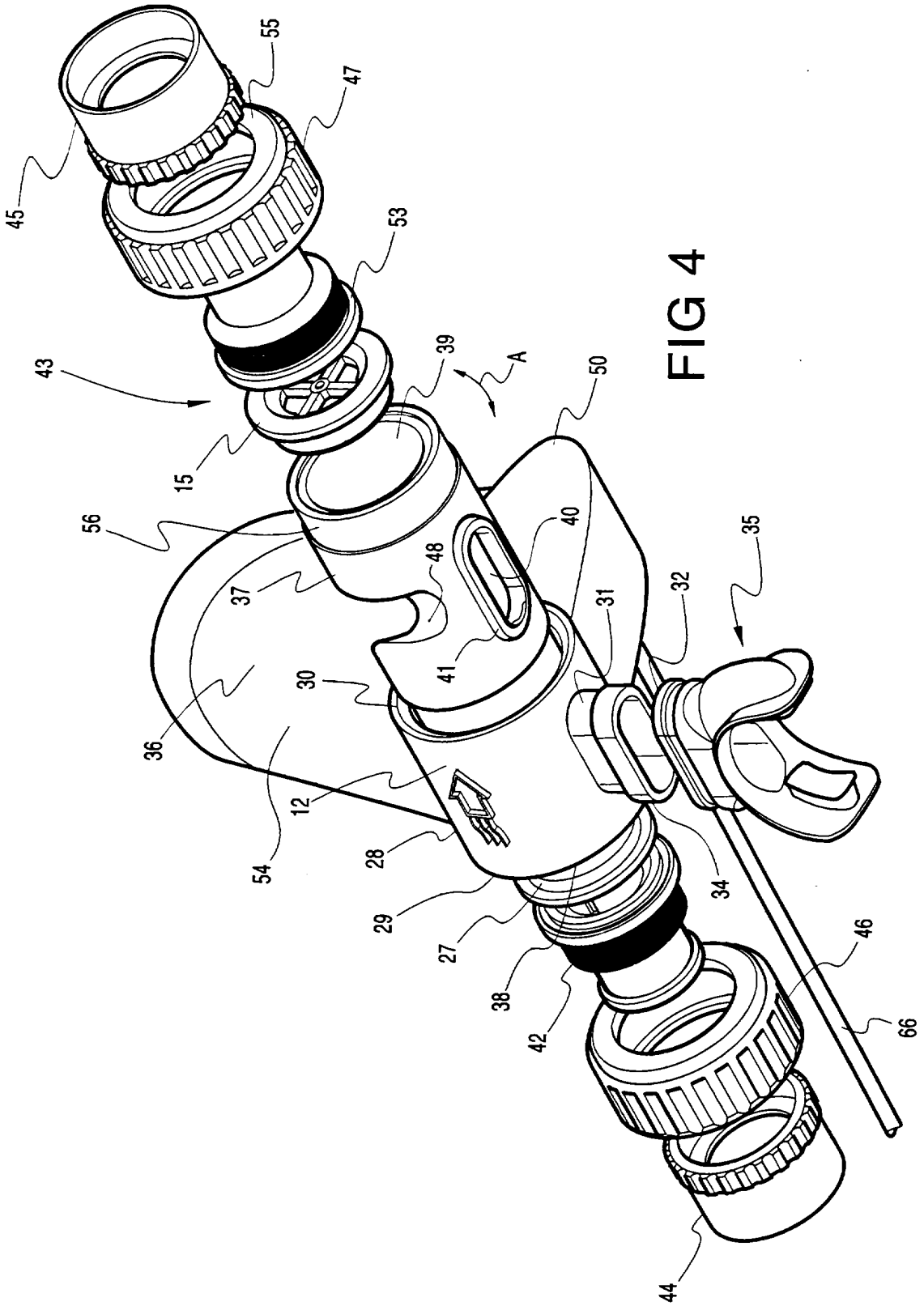
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FIG 4

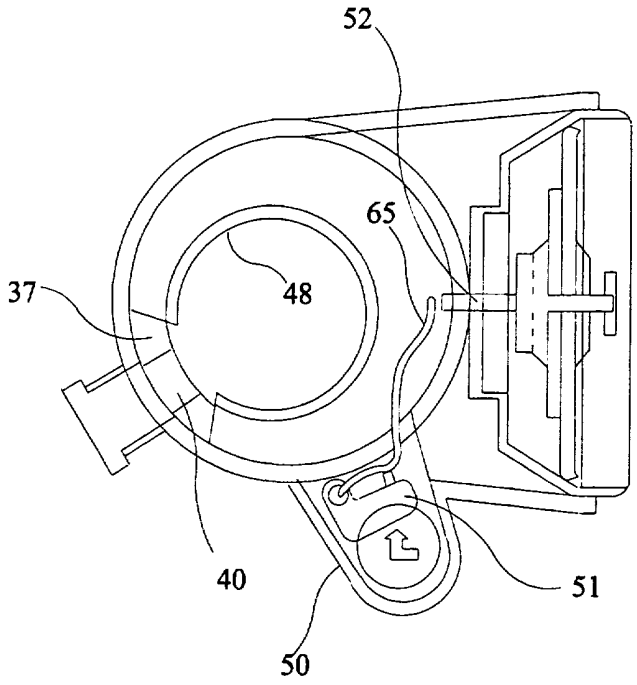

Fig 5

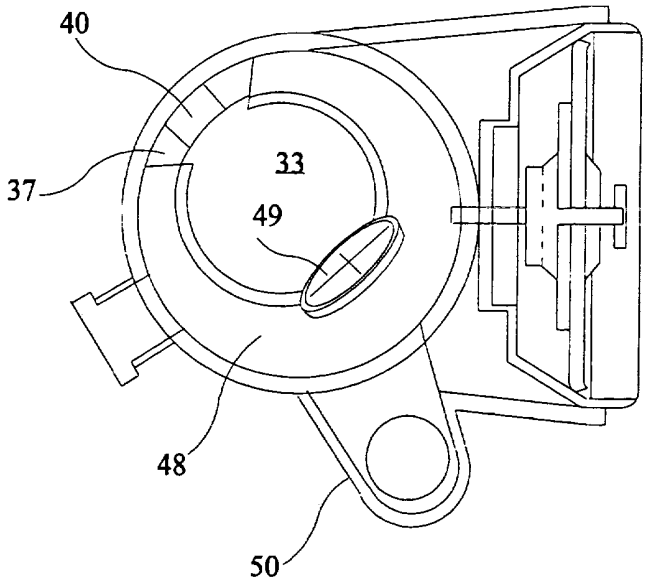

Fig 6

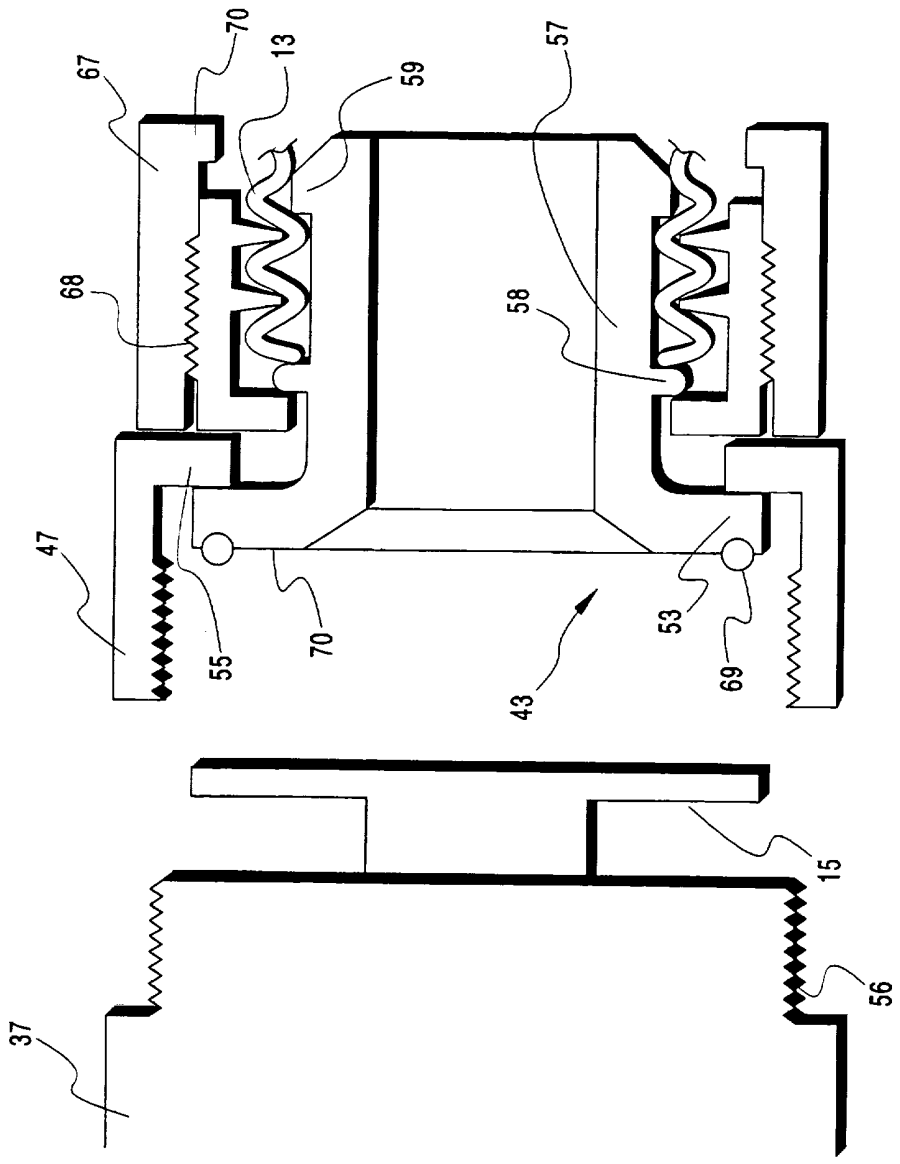

FIG 7

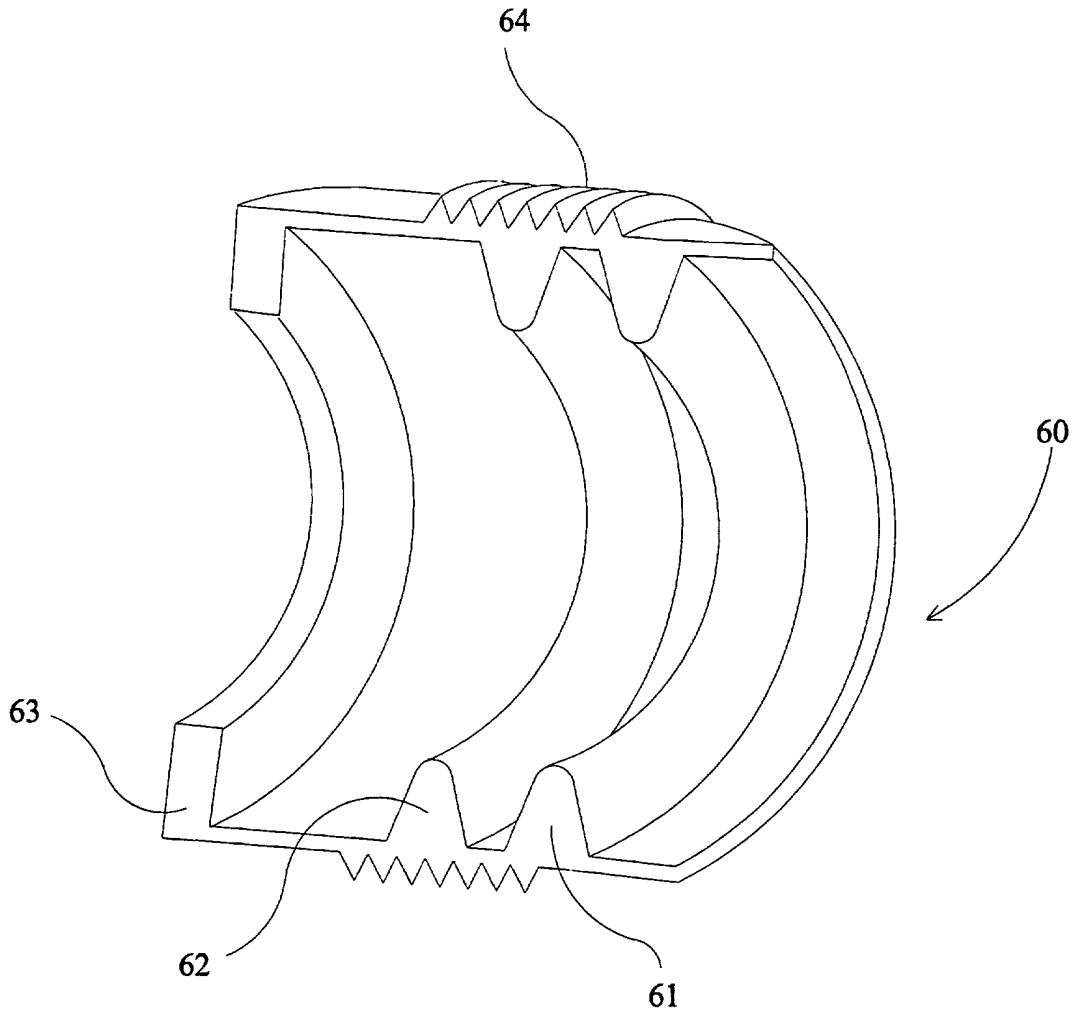

Fig 8

A MOUTHPIECE VALVE FOR CLOSED-LOOP SELF-CONTAINED BREATHING APPARATUS

The present invention relates generally to closed-loop self-contained breathing apparatus, and in particular to a mouthpiece valve suitable for use with such apparatus.

Self-contained breathing apparatus may be used for under water diving or in other hostile environments in which a user may need a supply of breathable gas. Such uses include fire fighting, where the atmosphere may be heavily polluted with combustion products and noxious gases, or other industrial environments where the atmosphere may be polluted or otherwise unbreathable. Breathing apparatus may also be used at high altitude where the atmosphere itself is insufficient to support life. Although applicable to a wide range of uses the present invention will be particularly described hereinafter with reference to its application to underwater breathing apparatus for diving applications. It is to be understood, however, that reference to this particular application is provided without prejudice to the generality of the invention or its range of applications.

An improved-closed circuit self-contained breathing apparatus is described in the applicant's own British patent application number 9719824.6 the contents of which

are incorporated herein by reference. This earlier application describes the difference between so-called open-circuit breathing apparatus, widely used for sport diving, and the closed-circuit or "rebreather" type of apparatus in which the carbon dioxide content of exhaled air is removed, after exhalation, within the apparatus and fresh oxygen introduced to replace that consumed. This earlier application also describes the advantages of extended capacity which can obtained using rebreather apparatus therefore allowing sport (and other) divers to remain reliant on the breathing apparatus for much longer periods than were available using the stored gas open circuit systems.

One of the requirements of a rebreather system, however, is that the materials used for removing the carbon dioxide from exhaled air, typically soda lime, must be kept dry in order to preserve its ability to absorb carbon dioxide. The mouthpiece through which the diver breathes, however, represents a potential source of flooding of the interior of the rebreather system since it has to have an opening through which the user can inhale reconditioned air from the inhalation counterlung and into which exhaled air can be delivered. Should it be necessary or desirable during the course of a dive underwater for the diver to remove the mouthpiece from his or her mouth, however, the opening (hereinafter referred to as the breathing port) in the mouthpiece

structure will allow the ingress of water, which can flow at least through the exhalation ducting towards the exhaled air reconditioning apparatus. Various measures are taken to restrict the progress of water in this way, the most important of which is to provide some form of closure valve by which the mouthpiece port can be sealed against the ingress of water when the mouthpiece is taken out of the mouth of the user. The present invention seeks to provide an improved mouthpiece valve. One embodiment of the invention comprises a mouthpiece valve having an improved closure means.

In order to provide an emergency breathing source to allow the diver to cope with circumstances in which the rebreather apparatus may be malfunctioning during a dive, and in particular to enable the diver safely to regain the surface, rebreather apparatus may be supplemented by a small emergency container of breathable gas. This container may also be used to top up the contents of the rebreather circuit during descent when the increasing pressure requires additional volume to maintain balance.

In prior art rebreather systems this container of breathable gas has been connected to one of the two couterlungs or to a separate flexible bag or bellows, allowing the introduction thereto of gas, in some cases via a manually-controlled valve, such as to increase the volume of gas within the rebreather circuit. It may also

be appropriate to introduce the breathable gas as a diluent if, during the dive, the oxygen introduced after carbon dioxide removal should become too concentrated in the overall volume of gas for the conditions experienced at the time. This may arise, for example, if the diver should change depth too rapidly, or if the oxygen-introduction apparatus should malfunction in such a way as to introduce too much oxygen.

It will be appreciated that oxygen itself is toxic at the pressures beyond a certain depth. For this reason, and also in order to maintain the overall volume of gas roughly constant, it has been necessary in prior art systems for the diver to introduce diluent gas manually during descent.

In circumstances where the gas within the rebreather circuit may not be sufficient, or may not be properly reconditioned, therefore, the user may make an emergency ascent by manually introducing this diluent gas into the rebreather circuit, inhaling it through the circuit and exhaling through the nose or by allowing the air to pass around the outside of the mouthpiece, between the mouthpiece and his or her lips. Both of these emergency techniques require practice, however, in order to be performed successfully and difficulties may be encountered in properly conducting these techniques during an emergency when the diver's mind may be

overloaded with other concerns.

One prior art system includes open circuit breathing apparatus as an alternative for emergency use. An open circuit second stage breathing valve and mouthpiece is located on the apparatus sometimes close to the closed circuit breathing valve, and connected to a small supply of breathable gas. In an emergency the two mouthpieces are changed over, or a manually operable valve allows the same mouthpiece to be used to breathe from the closed circuit system or an open circuit system in dependence on the position to which the diver sets the valve.

The present invention seeks to provide a mouthpiece suitable for use with closed circuit rebreather apparatus. Embodiments of the invention may have means by which diluent gas may be breathed automatically without requiring the use of the emergency techniques described above, and without requiring the mouthpiece to be removed from the mouth. Embodiments of the present invention may also provide means by which the diluent gas can be introduced to the closed circuit automatically upon change of depth whereby to balance the volume of gas within the closed circuit, as well as permitting closure of the mouthpiece port should the diver, for other reasons, wish to remove the mouthpiece from his or her mouth under water.

According to one aspect of the present invention, therefore, a mouthpiece valve for a closed-loop self-contained breathing apparatus comprises a body having an interior chamber with an inhalation port, an exhalation port and a mouthpiece port leading to a mouthpiece for the user such that, upon inhalation, a breathable gas from the closed circuit is drawn into the interior chamber of the body through the inhalation port and passes out through the mouthpiece port, and upon exhalation gas is exhaled through the mouthpiece port into the said interior chamber and passes therefrom through the said exhalation port, in which there are further provided valve means for the introduction into the mouthpiece valve of a breathable gas from a separate source thereof.

The valve means for the introduction of a breathable gas from a separate source may be manually operable. Alternatively the valve means for the introduction of a breathable gas from a separate source may be automatically operable and, in this respect, may comprise a normally-closed valve and valve control means sensitive to the pressure within the said interior chamber and operable to open the said valve means when the pressure difference between the said interior chamber and the exterior environment exceeds a threshold value.

There may also be provided closure means for selectively

closing the mouthpiece port.

A mouthpiece valve formed as an embodiment of the present invention may include unidirectional valves associated with the said inhalation and exhalation ports whereby to ensure the unidirectional flow of the circulation gas within the closed circuit of the breathing apparatus. The valve means for introduction of a breathable gas from a separate source may be or may also be manually operable.

The closure means for selectively closing the mouthpiece port may comprise an internal baffle or guard housed within the interior chamber of the said body and movable between a first position in which communication between the mouthpiece port and the said interior chamber is established, and at least one second position in which communication between the mouthpiece port and the interior chamber is obstructed.

Preferably the interior chamber of the body is substantially cylindrical and the said closure means comprise a substantially cylindrical member coaxially located within the said substantially cylindrical interior chamber so as to be relatively turnable with respect thereto between two angularly separated opposite end positions about the common axis.

The said first position of the said baffle may lie intermediate between the said two opposite end positions in each of which the communication between the interior chamber of the said body and the mouthpiece port is obstructed.

Embodiments of the invention may be formed in such a way that the said means for the introduction of a breathable gas from a separate source includes a gas port into the said main body and unidirectional valve means for allowing the said breathable gas from a separate source to pass from the said gas port into the said interior chamber of the body.

For this purpose there may be provided duct means selectively positionable within the said body to establish direct communication between the said gas port and the said mouthpiece port. This duct may exclude the interior cavity of the body whereby to permit the user to breathe the said breathable gas in open circuit conditions without involving the gas within the said closed circuit. Such duct means may comprise a channel formed in the said baffle or guard in the form of a part-circumferential groove in the outer cylindrical surface thereof.

The said unidirectional valve means preferably allows the passage of gas across the said baffle or guard when this

is in a certain range of positions, and is closed at least when the said duct means is in a position establishing direct communication between the mouthpiece port and the said gas port for the said breathable gas.

There may further be provided means for allowing exhalation of the breathable gas direct to the external environment when the baffle or guard is oriented to allow direct communication between the mouthpiece port and the said gas port for the said breathable gas.

The present invention also comprehends self-contained closed-circuit breathing apparatus including a mouthpiece valve substantially as hereinbefore defined.

Embodiments of the present invention will now be more particularly described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a general schematic view of a closed circuit breathing apparatus incorporating a valve formed as an embodiment of the invention;

Figure 2 is a perspective view of a mouthpiece valve formed as an embodiment of the present invention showing the main components thereof;

Figure 3 is a partial sectional view taken on the line III-III of Figure 2 showing a part of the mouthpiece valve;

Figure 4 is an exploded perspective view of the

embodiment with certain parts removed for clarity;

Figures 5 and 6 are simplified sectional views of the embodiment on the line V-V to V1-V1 of Figure 2 respectively illustrates the mouthpiece valve in two different conditions of use;

Figure 7 is a sectional view through a hose fastener usable with the breathing apparatus incorporating a valve formed as an embodiment of the invention; and

Figure 8 is a perspective view of a threaded collett forming part of the fastener of Figure 7.

Referring first to Figure 1, self-contained rebreather apparatus generally indicated with the reference numeral 11 comprises a closed circuit leading from a mouthpiece 12 along an air hose 13 within which is located a unidirectional valve generally indicated 15 and connected to an exhaled-gas counterlung 16 by a T-coupling 17. From the T-coupling 17 of the exhaled gas counterlung 16, which in use contains oxygen-depleted exhaled gas, extends a connector hose 18 leading to a gas reconditioning unit 19 in which carbon dioxide in the exhaled gas is removed and oxygen from a reservoir 20 is introduced under the control of a control system described in the applicant's earlier British application number 9719824.6. The reconditioned gas is drawn from the unit 19 via an air hose 23 and delivered to a second counterlung 24 in the form of a flexible sac joined to the hose 23 by another T-coupling 25 which, like the T-

coupling 17, may be swivellable to allow free movement of the air hose during use and for ease of assembly. From the T-coupling 25 a breathing hose 26 leads to the mouthpiece 12 via a further unidirectional valve 27 shown schematically in Figure 1.

In use of the apparatus, therefore, it will be seen that the user withdraws gas from the counterlung 24 by inhalation, this causing the counterlung 24 to collapse due to the reduction in pressure and causing gas within the circuit to flow from the counterlung 16 through the gas reconditioning unit 19 to balance the pressure differential caused by the removal of gas from the circuit by the inhalation. Upon subsequent exhalation into the mouthpiece valve 12 the user drives exhaled gas into the counterlung 16 increasing its pressure and further drives gas in the circuit through the gas conditioning unit 19 to refill the counterlung 24 ready for a fresh inhalation thereafter.

As can be seen in Figures 2 to 4 the mouthpiece valve 12 comprises a main cylindrical body 28 open at opposite ends to provide an inhalation port 29 and exhalation port 30, and having an opening in its cylindrical wall surrounded by an oval-section spigot 31 to define the mouthpiece port. The interior of the mouthpiece port constituted by the spigot 31 communicates with the interior chamber 33 within the cylindrical body 28. The

spigot 31 has a surrounding rim 34 to allow a resilient elastomeric mouthpiece generally indicated 35, and of conventional shape, to be fitted thereto. The spigot 31 may be coupled to a full-face mask or a half-mask.

Projecting from the cylindrical body 28 radially with respect thereto is a housing 36 for a pressure sensitive valve which will be described in more detail in relation to Figure 3. Within the interior chamber 33 of the cylindrical body 28 is a cylindrical baffle 37 having open opposite ends 38, 39 and an intermediate opening 40 which in the orientation of the baffle 37 shown in Figures 4 and 5 is in alignment with the mouthpiece port 31 and has a surrounding resilient grommet 41 which seals against the cylindrical interior surface of the chamber 33 such that when the baffle 37 is rotated about its longitudinal axis in a direction shown by the double arrow of Figure 4 the interior chamber 33 of the baffle 37 is sealed from the mouthpiece port 31.

At each end of the body 28 are located respective unidirectional valves 27, 15 corresponding to those schematically indicated in Figure 1 by the same reference numerals. These are held in place by gland fittings 42, over which are engaged internally threaded annular coupling members 46, 47 having external surface workings such as grooves or splines to facilitate gripping by a user's fingers.

The rings 46, 47 in turn couple via the gland fittings 42, 43 with the end portions of the cylindrical baffle 37 to enable this to be turned in the directions shown by the double arrow A with respect to the body 28 whilst the user holds the mouthpiece 35 in his or her mouth.

As can be seen in Figures 5 and 6, the baffle 37 has a part-circumferential groove 48 in its outer cylindrical surface forming an external part-circumferential channel diametrically opposite the opening 40. An opening (not shown) in this groove 48 is closed by a unidirectional valve 49 oriented to allow the flow of gas from the channel defined by the groove 48 radially inwardly towards the interior chamber 33.

The channel defined by the groove 48 communicates with a diluent gas inlet coupling 50 housing a valve 51 (see Figure 5) normally resiliently biased to a closed position, but openable by displacement of a stem 52 of a pressure-sensitive unit generally indicated 53 located in the housing 36.

As can be seen in Figure 3 the pressure-sensitive unit 53 comprises a conical housing 54 which locates a flexible diaphragm 55 secured between two reinforcing discs 56, 57 on the stem 52 having an enlarged head 60. A lever 65 of the valve 51 urges the stem 52 to the right as viewed in Figure 3, the travel of the stem 52 being limited by a

nut 58.

The perimeter of the diaphragm 55, identified 63 in Figure 3 seals against the conical surface 64 on inhalation preventing water entering, but allows air out on exhalation.

The end of stem 52 of the pressure-sensitive valve 53 engages an operating lever 65 of a valve 51 housed in the housing 50. The valve 51 is connected to a hose 66 leading to a diluent source such as a bottle of compressed air (see Figure 4). When the valve 51 is opened, in open circuit mode of the apparatus, by movement of the stem 52 of the pressure-sensitive valve, to the left as viewed in Figures 3 and 5, it allows diluent gas under pressure from the line 66 to enter the housing 50 which, as can be seen in Figures 5 and 6, communicates with the part-annular space between the sleeve 37 and the outer casing 28 defined by the part-circumferential groove 48 in the sleeve 37.

The apparatus is set up for normal closed circuit use by appropriate setting of the strength of the spring in the unidirectional valve 49 and of the value of the spring 59 in the valve 51 (Figure 3) such that, in normal closed circuit use of the apparatus, as the diver inhales and exhales through the mouthpiece 35 through the chamber 33, the pressure variations do not cause the pressure

sensitive valve 53 to open the valve 51. As the diver descends, however, such that the pressure on the outside increases and, correspondingly, the volume in the rebreather system falls due to the external compression of the counterlungs, the diaphragm 55 experiences a force which overcomes the resistance of the spring 59 the spring (not shown) in the valve 49 and causes the stem 52 to move towards the left as viewed in the drawings, thereby acting on the arm 65 to open the valve 51 and allow some diluent gas to enter the part-annular space defined between the groove 48 and the outer casing 12. Gas in this chamber can pass through the unidirectional valve 49 into the interior chamber 33 to add to the gases in the rebreather circuit. This can also be achieved, should the diver desire to introduce diluent manually, by depressing the head 60 which is in the form of a push button which can be easily located, being in line with the user's mouth. Even in conditions of limited visibility, therefore, it is not difficult for the user to locate by feel the button for introducing diluent. The rubber disc 57 seals against the inside surface of body 54 preventing air escaping around the outside of the diaphragm 55.

If the rings 46 and 47 are gripped whilst the mouthpiece is still in the user's mouth, the internal sleeve 37 can be turned through an angle of approximately 30 degrees, which displaces the port 40 from the mouthpiece opening

31 thereby isolating the rebreather circuit from the external environment. If the user should now take the mouthpiece 35 out of his or her mouth the maximum volume within the mouthpiece valve which can be subject to flooding is the part-circumferential chamber defined by the groove 48 in the sleeve 47. This can be purged simply by exhaling or partially pressing the button 60 to allow diluent gas into the chamber 48 from which it would be expelled around the perimeter 63 of the diaphragm 55. The diver must, of course prevent water or air from going down his throat when pressing the purge button and water is forced out of the exhaust port. This is a common technique when using such purge arrangements and should not present any difficulty. Likewise if in an emergency the rebreather circuit fails, the user can breathe diluent gas simply by turning the inner sleeve 37 to the position as shown in Figure 6, which allows the chamber 48, the mouthpiece 35 and the pressure sensitive valve 53 all to be in communication such that, on inhalation, the diaphragm 55 is drawn into the conical casing displacing the stem 52 against the lever 65 opening the valve 51 to allow diluent into the chamber 48 and then to the mouthpiece. Upon exhalation the exhaled gas passes between the perimeter 63 of the diaphragm 55 and the conical housing 54 in a known way.

One of the important factors in using a rebreather apparatus such as described above, by which it differs

from open circuit breathing apparatus, is the need to maintain sterility in the cavities and passages which are continually flushed with exhaled air and which could, if not properly maintained, become a source of potential infection from colonies of bacteria. For this reason the hose fasteners have to be releasable and replaceable as well as providing a secure seal against escape of gas or ingress of water under pressure at depth. Figures 7 and 8 illustrate in more detail the hose fastenings by which the flexible breathing hoses 13 and 26 are coupled to the mouthpiece valve 12. It should be appreciated, however, that similar such fastenings can be used to make the hose couplings to any other component of the system to which a hose is coupled.

Referring specifically to Figures 7 and 8, the hose 13 is engaged over a cylindrical spigot 57 of a gland fitting 43. The spigot 57 has an enlarged annular rib 59 at its end, and an intermediate circumferentially extending radially projecting annular rib 58 defining a shoulder against which the end of the corrugated hose 13 is engaged when the spigot 57 is fully inserted. In this position two full corrugations of the corrugated hose 13 are engaged on the cylindrical surface of the spigot 57.

The hose 13 is retained in position securely by two half-shells annular colletts 60 each having two radially inwardly projecting circumferentially extending ribs 61,

62 which engage in the externally concave circumferential grooves of the corrugations of the corrugated hose 13 as illustrated in Figure 7. The colletts 60 also have a radially inwardly projecting peripheral flange 63 at one end the radially inner rim of which has a smaller diameter than the radially outer rim of the annular rib 58 such that the peripheral flange 63 can engage behind the rib 58 when the two ribs 61, 62 are engaged in the corrugations of the hose 13.

The cylindrical outer surface of the colletts 60 has a screw threaded portion 64 so formed that when two colletts 60 are placed together over the hose 13 the threading on the external cylindrical surface is effectively continuous. This threaded portion 64 is engaged by a correspondingly internally threaded portion 68 of an annular sleeve 67 having a small radially inwardly projecting terminal flange 70. The part-annular colletts 60 are made of such a dimension that, when fitted on the corrugated hose 13 they define an encircling annular band which does not materially compress the corrugated hose although the manufacturing tolerances are chosen such that a light compression may be exerted as it is undesirable for there to be any clearance due to manufacturing tolerances. The spigot 57, on the other hand, and particularly the radially outwardly projecting peripheral flange 59 which, as can be seen in Figure 7, is taper to assist its introduction

into the hose 13, is selected of such dimensions that it is a tight fit within the hose 13 and, in particular, causes a small expansion of the hose 13 as it is fitted into it. The threaded engagement of the sleeve 67 onto the colletts 60, therefore, firmly joins the hose 13 onto the gland fitting 43, and in particular the ribs 61, 62 have a radially inner periphery which is smaller in diameter than the radially outer periphery of the flange 59 so that any compression of the hose 13 is compression of the material of which it is made rather than compression of the corrugations.

The gland fitting 43, as discussed in relation to Figure 4, also has a radial flange 53 engaged by a radially inwardly directed flange 55 of a ribbed annular coupling member 47 by which the gland fitting 43 is secured to the body of the mouthpiece, for which purpose the ring 47 is internally threaded for engagement on a threaded end portion 56 of the mouthpiece body (see Figure 4) with the gland fitting 43 trapped between the flange 55 and the unidirectional valve 15 located between the radially outwardly projecting flange 53 and the end face of the mouthpiece body. In order to make a watertight seal the end face 70 of the flange 53 of the gland fitting 43 is provided with a circular groove housing an O-ring seal 69 which projects partly from the face 70 to be engaged on the face of the unidirectional valve 15 and compressed to form a watertight seal when the ring 47 is threaded onto

the threaded end part 56 of the valve body. By unscrewing the rings 47 and 67 the fitting can be readily released to allow cleaning and disinfecting of the hoses and the mouthpiece whilst, when screwed up firmly, the hose coupling thus formed is secure and watertight, being capable of withstanding considerable loads without applying undue stress on the hose itself.

CLAIMS

1. A mouthpiece valve for a closed-loop self-contained breathing apparatus comprising a body having an interior chamber with an inhalation port, an exhalation port and a mouthpiece port leading to a mouthpiece for the user such that, upon inhalation, a breathable gas from the closed circuit is drawn into the interior chamber of the body through the inhalation port and passes out through the mouthpiece port, and upon exhalation gas is exhaled through the mouthpiece port into the said interior chamber and passes therefrom through the said exhalation port, in which there are further provided valve means for the introduction into the mouthpiece valve of a breathable gas from a separate source thereof.

2. A mouthpiece valve as claimed in Claim 1, in which the valve means for the introduction of a breathable gas from a separate source are manually operable.

3. A mouthpiece valve as claimed in Claim 1, in which the valve means for the introduction of a breathable gas from a separate source are automatically operable.

4. A mouthpiece valve as claimed in Claim 3, in which the said automatically operable valve means for the introduction of a breathable gas comprise a normally-closed valve and valve control means sensitive to the

pressure within the said interior chamber and operable to open the said valve means when the pressure difference between the said interior chamber and the exterior environment exceeds a threshold value.

5. A mouthpiece valve as claimed in any preceding claim, in which there are further provided closure means for selectively closing the mouthpiece port.

6. A mouthpiece valve as claimed in any preceding claim, including unidirectional valves associated with the said inhalation and exhalation ports, operable to determine unidirectional flow of the circulation gas within the closed circuit of the breathing apparatus.

7. A mouthpiece valve as claimed in any preceding claim, in which the valve means for introduction of a breathable gas from a separate source is or is also manually operable.

8. A mouthpiece valve as claimed in any preceding claim, in which the closure means for selectively closing the mouthpiece port comprise an internal baffle or guard housed within the interior chamber of the body and movable between a first position in which communication between the mouthpiece port and the said interior chamber is established, and at least one second position in which communication between the mouthpiece port and the

interior chamber is obstructed.

9. A mouthpiece valve as claimed in any preceding claim, in which the interior chamber of the body is substantially cylindrical and the said closure means comprise a substantially cylindrical member located within the said substantially cylindrical interior chamber and relatively turnable with respect thereto, between two angularly separated opposite end positions.

10. A mouthpiece valve as claimed in Claim 8 or Claim 9, in which the said first position of the said baffle lies between the said two opposite end positions in each of which the communication between the interior chamber of the said body and the mouthpiece port is obstructed.

11. A mouthpiece valve as claimed in any preceding claim, in which the said means for the introduction of a breathable gas from a separate source includes a gas port into the said main body and unidirectional valve means for allowing the said breathable gas from a separate source to pass from the said gas port into the said interior chamber of the body.

12. A mouthpiece valve as claimed in Claim 11, in which there are provided duct means selectively positionable within the said body to establish direct communication

between the said gas port and the said mouthpiece port.

13. A mouthpiece valve as claimed in Claim 12, in which the said duct means excludes the interior cavity of the body whereby to permit the user to breath the said breathable gas in open circuit conditions without involving the gas within the said closed circuit.

14. A mouthpiece valve as claimed in Claim 13, in which the said duct means comprise a channel formed in the said baffle or guard in the form of a part-circumferential groove in the outer cylindrical surface thereof.

15. A mouthpiece valve as claimed in any of Claims 11 to 14, in which the said unidirectional valve means allow the passage of gas across the said baffle or guard when this is in a certain range of positions, and is closed at least when the said duct means is in a position establishing direct communication between the mouthpiece port and the said gas port for the said breathable gas.

16. A mouthpiece valve as claimed in any preceding claim, in which there are further provided means for allowing exhalation of the breathable gas direct to the external environment when the baffle or guard is oriented to allow direct communication between the mouthpiece port and the said gas port for the said breathable gas.

17. A mouthpiece valve substantially as hereinbefore described with a reference to, and as shown in, the accompanying drawings.

18. Self-contained closed-circuit breathing apparatus including a mouthpiece valve as claimed in any of Claims 1 to 17.

19. Self-contained closed-circuit breathing apparatus substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

Application No: GB 9901459.9 **Examiner:** Mrs Susan Chalmers
Claims searched: 1-19 **Date of search:** 9 April 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): A5T: TBA TV

Int Cl (Ed.6): A62B 7/02, 7/04, 9/02, 18/10; B63C 11/24

Other: ONLINE: EPODOC, WPI, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2298141 A	(PRESSURE PRODUCTS) see valves 29 and 36 in Figure 2, page 14 line 23 to page 17 line 2 and page 20 lines 7-27	1, 2, 6, 7, 11, 18
X	US 5368018	(CIS-LUNAR DEVELOPMENT LABORATORIES) see valve 68 in Figures 1-4	1 ,2, 6, 7, 11-13, 16, 18
X	US 5127398	(CIS-LUNAR DEVELOPMENT LABORATORIES) see valve 68 in Figures 1-4 and 7	1, 2, 6, 7, 11-13, 16, 18
X	US 3957043	(SHELBY) see valve 24 in Figures 1 and 3	1, 2, 6, 7, 18

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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