(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 782 954 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 158(3) EPC

(43) Date of publication:
09.07.1997 Bulletin 1997/28

(21) Application number: **95927975.3**

(22) Date of filing: **03.08.1995**

(51) Int. Cl.[6]: **B63C 11/24**

(86) International application number:
PCT/JP95/01559

(87) International publication number:
WO 97/06054 (20.02.1997 Gazette 1997/09)

(84) Designated Contracting States:
DE ES FR GB GR IT SE

(71) Applicant: **GRAND BLEU INC.**
Shinagawa-ku, Tokyo 141 (JP)

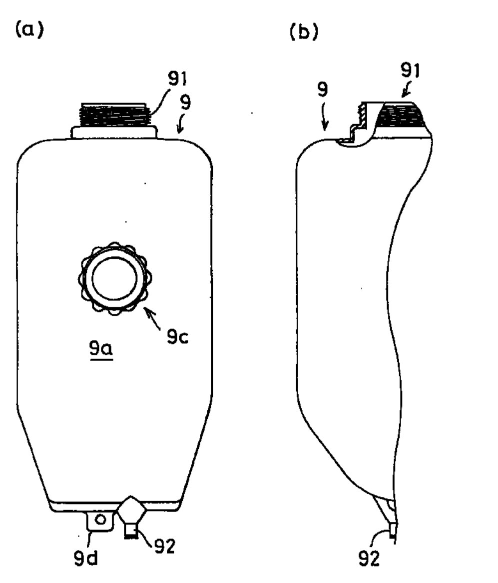
(72) Inventors:
- **YOSHIKAWA, Yukio**
Saitama-ken 354 (JP)
- **MATSUOKA, Shunsuke**
Chiba-shi Chiba-ken 262 (JP)

(74) Representative: **Klunker . Schmitt-Nilson . Hirsch**
Winzererstrasse 106
80797 München (DE)

(54) AIR BAG FOR A HALF-CLOSED TYPE BREATHING DEVICE

(57) An air bag (9) for a half-closed type breathing device (1) is a seamless integrally molded piece which is blow molded from urethane resin. An opening of this air bag (9) is constructed so as to be screwed into the main body of the half-closed type breathing device (1) for fixation, whereby replacement work can easily be performed. Since there is no seam formed in the air bag according to the present invention, there is no need to inspect the strength of a seam, facilitating the production control. Since the air bag (9) is molded from urethane resin, the durability and the like thereof can be improved. In addition, since the air bag (9) is blow molded, uniform size and high productivity can be realized.

Fig. 3



EP 0 782 954 A1

Description

Technical Field

This invention relates to a semiclosed-circuit breathing apparatus constituted such that exhaled air recovered from a mouthpiece is passed through a carbon dioxide adsorption apparatus and regenerated, and a mixture of said regenerated gas and a constant flow of new gas for inhalation supplied from a breathing gas cylinder is supplied to the mouthpiece as the gas for inhalation. More specifically, this invention relates to air bags arranged in such apparatus as a buffer for breathing and that accumulates breathing gas.

Background Art

Underwater breathing apparatus can generally be divided into two types: open-circuit breathing apparatus and closed-circuit or semiclosed-circuit breathing apparatus. In an open-circuit breathing apparatus, gas that has been breathed once is all expelled from the apparatus, but a closed-circuit or semiclosed-circuit breathing apparatus includes an apparatus by which gas that has been breathed can be breathed again.

During dives using open-circuit breathing apparatus, the same volume of gas is breathed regardless of the ambient pressure or depth. Therefore, as the ambient pressure becomes larger the consumption of breathing gas increases. In the case in which a gas cylinder is used, namely the case in which the amount of gas that can be breathed is limited to a fixed volume, the diving time decreases as the depth increases.

In contrast, with a closed-circuit or semiclosed-circuit breathing apparatus, while compressed gas is the source of breathing air in the same manner as the open-circuit type, the same weight of gas is breathed regardless of the ambient pressure. Therefore, with the closed-circuit or semiclosed-circuit type, the consumption of breathing gas is constant regardless of depth. For this reason, the amount of breathing gas that must be carried is much less than that required for the open-circuit type, and also, by varying the mixing ratio of breathing gas, long dives to depths that cannot be reached with open-circuit apparatus become possible.

In this manner, closed-circuit or semiclosed-circuit breathing apparatus has the advantages of being lighter than open-circuit breathing apparatus and permitting longer dives to deeper depths. However, conventional closed-circuit or semiclosed-circuit breathing apparatus was developed for purposes of specialized types of diving or military use, so it provided only a minimum of safety mechanisms, and had no mechanisms for handling emergency situations that occur relatively easily. For this reason, extremely thorough training was required in order to use this type of apparatus, and thus it could not be used easily by the leisure diver.

Yet with the increase in diving aficionados, demand increased for this type of closed-circuit or semiclosed-circuit breathing apparatus that can be used for diving without the need to master complex operation. Closed-circuit breathing apparatus is equipped with oxygen concentration sensors and the like, thus requiring considerable training in its handling, control and monitoring. In contrast, semiclosed-circuit breathing apparatus has no such equipment and therefore there is no need for training in its operation, so it can be handled relatively easily by even a non-expert. This type of semiclosed-circuit breathing apparatus has become simpler than in the past, can be used easily and is extremely convenient.

In consideration of these points, the present inventors have previously proposed, in Japanese Patent Application No. 5-274843, semiclosed-circuit breathing apparatus that can be handled relatively easily by even a non-expert.

The problems that the present invention addresses are improvements to the air bags placed in such semiclosed-circuit breathing apparatus as a buffer for breathing and that accumulates breathing gas, along with simplification of its manufacture and method of replacement.

Disclosure of the Invention

In order to solve the aforementioned problems, the air bags for underwater breathing apparatus of the present invention are characterized in that they are seamless one-piece moldings molded from synthetic resin. By means of the present invention, the air bags have no seams like those present in the prior art, so there is no need for inspection of the strength of seams, simplifying production management.

In addition, the breathing gas circulation openings of the air bags have a screw-in type removable structure. Therefore, the work of replacing the air bags can be performed simply. In other words, in the event that mold or the like should form, necessitating its replacement, the air bag, can be easily replaced with a new one. In addition, replacement is simple, so by preparing air bags of different volumes depending on differences in the lung capacity of the user, it is possible to attach optimal air bags that are matched to the user.

Moreover, in the present invention, the air bags are molded from polyurethane resin. By using polyurethane resin, its tear strength is higher than that of the conventional ones made of rubber that are in general use, so durability and the like can be increased.

Moreover, in the present invention, the air bags are molded by means of the blow molding method. By adopting this molding method, stability of sizes and good suitability to mass production can be achieved.

Brief Description of Drawings

Figure 1 is a view of the outside of a semiclosed-circuit breathing apparatus to which the invention is applied.

Figure 2 is a schematic cross-sectional view showing the internal structure of the apparatus of Figure 1.

Figure 3 is a diagram showing an inhalation air bag incorporated into the apparatus of Figure 1, where (a) is a front view and (b) is a partial side view when seen from a perpendicular direction.

Figure 4 is a diagram showing a regulator attached to the apparatus of Figure 1, where (a) is a side view and (b) is a longitudinal cross-sectional view.

Figure 5 is a schematic longitudinal cross-sectional view of a conventional regulator.

Best Mode for Carrying out the Invention

A preferred embodiment of the present invention will be explained with reference to the drawings.

Figures 1 and 2 show the overall structure of a semiclosed-circuit breathing apparatus into which is incorporated the air bags, of the present invention. As shown in Figure 1, the semiclosed-circuit breathing apparatus 1 of this example is equipped with a hollow housing 2 and the component parts of the device to be described later are built into this hollow housing 2. One side of this hollow housing 2 forms the back-resting surface 2a which rests against the back of the diver, and in the center of the opposing surface is formed an opening used for replacing the breathing gas cylinder, and attached to the opening is a removable cover 2b. Attached to the top edge of the hollow housing 2 is a canister 3 with a built-in horizontal carbon dioxide adsorption apparatus. This canister takes an overall cylindrical shape, and connected to its exterior on either side are two flexible hoses, an exhalation air hose 4 and an inhalation air hose 5. Connected to the ends of the exhalation air hose 4 and the inhalation air hose 5 is a mouthpiece unit 6.

We will now describe the main structural components of the apparatus 1 of this embodiment in reference to Figure 2. As shown in this figure, the inhaled/exhaled air circulation chamber 61 within the mouthpiece unit 6 communicates with the exhalation air hose 4 and inhalation air hose 5. The other ends of the exhalation air hose 4 and inhalation air hose 5 communicate with either side of the cylindrical canister 3 with a built-in carbon dioxide adsorption apparatus 7. In other words, the carbon dioxide adsorption apparatus 7 with an annular cross-section is built into the center of this canister 3 and an exhalation air passage 31 and inhalation air passage 32 are formed on either side. A breathing gas cylinder 8 is placed vertically in the center of the hollow housing 2 below the canister 3 with the built-in carbon dioxide adsorption apparatus 7, and on either side of the cylinder are placed an exhalation air bag 9 and an inhalation air bag 11. The exhalation air bag 9 communicates with the exhalation air passage 31 of the canister 3 and the inhalation air bag 11 communicates with the inhalation air passage 32 of the canister 3.

The breathing gas cylinder 8 is arranged such that its gas discharge outlet 81 is positioned at the bottom, and this gas discharge outlet 81 is connected via an on/off valve 82 to a regulator 83. The regulator 83 reduces the gas pressure to roughly 8 to 9 kg/cm^2. Connected to the regulator 83 are six gas supply lines, and of these, three are used for the remaining-pressure gage, the buoyancy compensator and the octopus rig (not shown). One of the remaining three lines, gas supply line 84, passes through the inhalation air passage 32 of the canister 3 with built-in carbon dioxide adsorption apparatus and through the inhalation air hose 5, extending to the interior of the mouthpiece. At an intermediate position is interposed a flow rate adjustment orifice 84a, by which the flow rate is adjusted to 4 to 5 liters/minute and supplied to the interior of the mouthpiece. Another of the lines, gas supply line 85, is a purge gas supply line used to purge water from the interior of the mouthpiece unit 6, extending to the interior of the mouthpiece unit 6 in the same manner as gas supply line 84 described above. The remaining line, gas supply line 86, is used to supply air during emergencies, and its end is positioned within the inhalation air passage 32 of canister 3.

Mounted to the end of the inhalation side of the canister 3 with built-in carbon dioxide adsorption apparatus is an auto-valve mechanism 12. This mechanism 12 controls the opening and closing of the gas supply line 86 and controls the automatic release of excess gas.

The overall flow of gas is as follows. Exhaled air from the mouthpiece 62 of the mouthpiece unit 6 passes through the exhalation air hose 4 and exhalation air passage 31 and accumulates in the exhalation air bag 9. At the time of the inhalation action, the exhaled air accumulated here is passed through the carbon dioxide adsorption apparatus 7 where carbon dioxide is removed and then the air is purified and flows into the inhalation air passage 32. The exhaled air thus purified accumulates in the inhalation air bag 11 and is also supplied to the interior of the mouthpiece unit 6 via the inhalation air hose 5 for use in inhalation. Inside the mouthpiece unit 6, a constant flow of new gas for inhalation is introduced from the cylinder 8 through the gas supply line 84, so a mixture of these gases is supplied as the gas for inhalation.

Figure 3 shows the exhalation air bag 9. This air bag 9 is an elastic bag molded from flexible raw materials, so it is able to expand and contract with the breathing action. Formed on the upper edge of the air bag 9 is a connector 91 that couples to the connector 312 formed on the canister 3 described above. This connector 91 is of the screw-in type, so it connects to the above connector 312 in such manner that it is removable. Therefore, the work of replacing the air bag 9 of this example can be performed simply.

Here, the air bag 9 of this example is a seamless one-piece polyurethane molding. In addition, the air bag 9 is molded by means of the blow molding method.

On the other hand, the inhalation air bag 11 is also a seamless one-piece polyurethane molding like the exhalation air bag 9. In addition, formed upon its upper edge is a screw-in type connector for the canister 3, so it is easily replaceable.

In this manner the air bags 9 and 11 of this example are seamless one-piece polyurethane moldings. In contrast, the air bags used conventionally consist of rubberized fabric, rubber moldings or nylon fabric with a coating of polyurethane or other material, molded into a bag shape by means of fusing or adhesion. However, if such seams are present, stable production management is difficult. This is because the strength of the seams must be inspected on each individual product, requiring large amounts of time. In the present invention, there are no seams, so quality control is simplified.

In addition, the air bags of this example are polyurethane moldings so they are provided with a high tear strength and thus their durability and other characteristics are superior to those of conventional air bags made of rubber or other materials. Moreover, since the air bags are conventionally presumed to be for semipermanent use, no consideration is made with regard to their replacement. However, in actual use over long periods, mold and the like begins to form, necessitating their replacement. In this case, in this example, the screw-on type air bags can be simply replaced.

In addition to this point, by preparing air bags of different volumes depending on the lung capacity of the user, it is possible to attach optimal air bags that are matched to the user. By preparing two sizes of air bags, an L size (2.1 liters) and an S size (1.6 liters), for example, it is possible to attach air bags that are matched to the lung capacity which differs according to the individual person.

Next, in the exhalation air bag 9 of this example, a water draining apparatus 130 used to expel water that collects at the bottom of the air bag is attached to its outside surface 9a. This water draining apparatus 130 has a pressure chamber 131 that is able to be compressed and expanded and that is attached to the outside surface 9a of the air bag 9, a tube 132a that communicates with this pressure chamber, and a tube that is connected to this tube 132a via a check valve 133, where the other end of this tube 134 is connected to an opening 92 in the bottom of the air bag 9. In addition, between this tube 132a and the check valve 135 is connected a tube 132 via check valve 133, and the external opening end 132b which is the tip of this tube 132 is open to the outside on the back side of apparatus 1 (namely, the side facing the back of the diver). Check valve 135 permits the passage of fluid only toward the side of the pressure chamber, while check valve 133 permits the passage of fluid only toward the side of the external opening end 132b.

In a water draining apparatus 130 of such constitution, with the expansion and contraction action of the exhalation air bag 9, the pressure chamber 131 attached to its outside surface 9a contracts and expands, performing a pumping action, thereby expelling the water that collects at the bottom of the air bag 9 through the external opening end 132b to the outside.

In the exhalation air bag 9 of this example, in order that the pressure chamber 131 of this water draining apparatus can be attached to the central portion of its outside surface 9a, a mounting 9c is also part of the one-piece molding. Moreover, a mounting 9d for attaching the exhalation air bag 9 to the main-unit housing 2 is also part of the one-piece molding.

Note that in this example, the air bag is molded from polyurethane resin, but instead, flexible polyethylene, polyvinyl acetate-polyethylene copolymer resin, flexible polyvinyl chloride, various elastomer resins, silicone rubber, rubber or other materials may be used.

(Structure of the Regulator)

The regulator 83 of the semiclosed-circuit breathing apparatus of this example, as described previously, reduces the pressure of the gas supplied from the breathing gas cylinder and supplies the gas at a constant pressure. Typically, the gas supplied from the breathing gas cylinder is lowered in pressure by a first-stage regulator to roughly 9 to 10 kg/cm^2, and then it is further lowered in pressure by a second-stage regulator.

A regulator of a structure such as that shown in Figure 5, for example, is used as this first-stage regulator. This regulator 100 is a non-pressure sensitive regulator, in that it functions to maintain a constant supply of gas even if the ambient pressure should change. In this regulator 100 is formed a communicating chamber 101 that communicates with the valve of the breathing gas cylinder (not shown). The high-pressure gas supplied from the cylinder to here passes through an on/off valve mechanism 104 consisting of a piston valve body 102 and a valve seat 103, through a communicating passage 105 formed within a piston rod 102a and is supplied to a pressure chamber 106. The pressure chamber 106 is partitioned by a piston head 107, and communicates via a low-pressure port 108 to the side of a second-stage regulator (not shown). The piston head 107 is pushed from behind by a coil spring 109 so that it always maintains a constant elastic force. An O-ring 110 is attached to the peripheral surface of the piston head 107, forming an air-tight seal with the pressure setting chamber 111 in which the coil spring 109 is mounted on its back side. In a similar manner, an O-ring 112 is also attached to the periphery of the tip side of the piston rod 102a in order to form an air-tight seal between the pressure setting chamber 111 and the communicating passage 105.

In the state in which the valve of the breathing gas cylinder is closed, as shown in Figure 5, the piston head 107 is pushed by the spring 109 toward the side of the pressure chamber 106, and the on/off valve mechanism 104 is open. When the valve is opened, high-pressure gas enters from the cylinder into the communicating chamber 101, passes through the on/off valve mechanism 104 and communicating passage 105 and enters the pressure chamber 106. Here, if the low-pressure port 108 is closed, the pressure within the pressure chamber 106 rises. As the pressure rises until it reaches the set pressure, the piston head 107 is pushed by the pressure within the pressure chamber in the direction of the pressure setting chamber, against the spring force, until the on/off valve mechanism 104 closes and the supply of high-pressure gas is halted. If the low-pressure port 108 is opened, the gas within the pressure chamber 106 is fed through here to the various parts of the external apparatus, so the pressure within this pressure chamber drops. When the pressure drops below the set pressure, the piston head 107 is pushed by the spring force toward the side of the pressure chamber, the on/off valve mechanism 104 opens and the supply of high-pressure gas resumes. In this manner, the interior of the pressure chamber is maintained at the set pressure, so gas of a pressure lowered to the set pressure is supplied via the low-pressure port 108 to the various parts.

In such a regulator, gas at a pressure higher than the set pressure may be supplied from the low-pressure port 108 to the various parts for the following reasons. To wit, if there is a flaw or the like on the piston valve body 102 or seat 103 that make up the on/off valve mechanism 104, or if there is a manufacturing or installation or other error in these components, even when the pressure within the pressure chamber exceeds the set pressure, there is a risk that this on/off valve mechanism 104 will not seal completely, and high-pressure gas will leak into the interior of the pressure chamber, resulting in gas of a pressure higher than the set pressure being supplied.

In addition, if the O-rings 110 or 112 are damaged or deformed, or if the inside surfaces that they contact are damaged or deformed, there is a risk that they will not form completely air-tight seals, and high-pressure gas will leak through them into the interior of the pressure setting chamber 111. If high-pressure gas enters the interior of the pressure setting chamber, the set pressure will be determined by the sum of the spring force of the coil spring and the pressure of the gas that has entered here, so the set pressure will increase and gas of a pressure higher than the set pressure will be supplied from the low-pressure port 108 to the various parts.

In order to avoid these ill effects, an underwater breathing apparatus regulator that reduces the pressure of high-pressure gas supplied from a breathing gas cylinder to a pressure that is set in advance before sending it out from a low-pressure port should adopt the following structure. To wit, it should adopt a regulator with a structure comprising: a partitioned chamber formed within a regulator housing, a piston movably disposed within this partitioned chamber such that it partitions said partitioned chamber into a pressure chamber and pressure setting chamber, a communicating passage formed in a state such that it penetrates this piston and permits the gas supply side of said breathing gas cylinder to communicate with said pressure chamber, pushing means that continually pushes said piston toward the side of said pressure chamber with a set elastic force, a valve mechanism that seals said communicating passage when said piston moves against said elastic force by a fixed amount of motion toward the side of said pressure setting chamber, and a relief valve that maintains the pressure within said pressure setting chamber at a pressure below the set pressure.

Here, it is further desirable that a second relief valve that communicates with said low-pressure port be provided, so that the pressure of the inhalation gas sent out from this low-pressure port is maintained below the pressure previously set.

In a regulator of this structure, a relief valve is attached to the pressure setting chamber in order to prevent an increase in the internal pressure. Therefore, in the event that high-pressure gas should enter within this pressure-setting chamber and the internal pressure exceeds the set value, the high-pressure gas is released to the outside through the relief valve. Thus, the set pressure is always maintained at the value determined by the pushing means without the pressure setting chamber reaching high pressure.

In addition, by providing a second relief valve on the low-pressure port side also, in the event that the high-pressure gas cylinder side should open suddenly, or should the low-pressure port side open suddenly so that high-pressure gas enters the interior of the pressure chamber, one can temporarily prevent the high pressure from acting unhindered on the various parts on the low-pressure port side. To wit, it is possible to prevent damage to various parts and the like due to the temporary sudden action of high-pressure gas.

Here follows a specific example of a non-pressure sensitive regulator provided with the above constitution, in reference to Figure 4. This regulator is incorporated into the semiclosed-circuit breathing apparatus 1 shown in Figures 1 and 2 as the regulator 83.

In the figure, 831 is a regulator housing in which is disposed a piston 834 consisting of a piston head 832 and piston rod 833. A partitioned chamber 835 formed within the housing is divided into two by means of the piston head 832, so that a pressure chamber 836 is formed in front of the head and a pressure setting chamber 837 is formed behind the head. These two chambers are partitioned in the air-tight state by means of an O-ring 838 attached to the peripheral surface of the piston head. Within the pressure setting chamber 837, a coil spring 840 is placed between the back surface of the piston head 832 and a spring seat 839 formed within the housing, such that the head is pushed toward the side of the pressure chamber. The pressure chamber 836 communicates via a low-pressure port 850 to the various supply lines 84, 85, 86, etc.

The piston rod 833 extends through a penetration hole 841 formed within the housing and its tip protrudes within a communicating chamber 842 that communicates with the gas discharge outlet 81 side of the breathing gas cylinder. A communicating hole 843 is formed in the interior of piston rod 833 along its axial direction, and this communicating hole 843 permits communication between the pressure chamber 836 and the communicating chamber 842. An air-tight seal is formed between the communicating chamber 842 and the pressure setting chamber 837 by means of an O-ring 844.

Within the communicating chamber 842, a valve seat 846 is held by a guide 845 that is held in such manner that it is able to move in its axial direction, and this valve seat 846 is supported by a seat receptacle 847. Here, an annular valve body 848 is formed on the tip of said piston rod 833, and this valve body 848 together with the valve seat 846 form an on/off valve mechanism 849. This on/off valve mechanism 849 is normally open, but when the piston head 832 moves toward the pressure setting chamber 837 against the spring force, it becomes closed. Note that attached within the communicating chamber 842 is a filter 852 supported by a filter bracket 851.

Note that 853 is a yoke and 854 is a yoke knob attached to it. The tip of the yoke 853 is attached to the outside surface of the housing 831.

Here, a relief valve 860 is attached to the side wall of the housing 831. This valve 860 consists of a communicating chamber 861 that communicates with the pressure setting chamber 837, a valve body 862 placed inside this chamber, a coil spring 863 that pushes the valve body, a valve cover 864 and an outside-communicating chamber 865 that is open to the outside. The valve body 862 is continually pushed by the coil spring 863 against a seat surface consisting of an O-ring 866, isolating the communicating chamber 861 from the outside-communicating chamber 865.

Next, attached to a communicating path 870 by which the low-pressure port 850 and pressure chamber 836 communicate is a second relief valve 880. This relief valve 880 also has the same structure as the relief valve 860 described above. To wit, it is provided with a valve body 882 that is pushed by spring force, and this valve body 882 isolates the outside-communicating chamber 885 from the side of the pressure chamber 836. When the valve body 882 moves against the spring force, the pressure chamber 836 communicates with the outside-communicating chamber 885, so the pressure within the pressure chamber is released into the outside.

Here follows an explanation of the regulator 83 of such structure. First, when the gas discharge outlet 81 is closed, the piston head 832 is pushed by spring force toward the side of the pressure chamber, so the on/off valve mechanism 849 is open. In addition, in the relief valve 860, the valve body 862 is pushed by spring force so that the outside-communicating chamber 865 is isolated from the side of the pressure setting chamber 837.

When the gas discharge outlet 81 is opened, high-pressure gas passes through the communicating chamber 842 and on/off valve mechanism 849 and enters the interior of the pressure chamber 836 via the communicating hole 843. Here, when the downstream side of the low-pressure port 850 is closed, the internal pressure of the pressure chamber 836 increases. When the internal pressure exceeds the set pressure, the piston head 832 is pushed toward the pressure setting chamber 837 and moves against the spring force. As a result, the on/off valve mechanism 849 is closed and the supply of high-pressure gas is halted. When the downstream side of the low-pressure port 850 opens and the supply of low-pressure gas begins, the internal pressure within the pressure chamber decreases, so the piston head 832 is pushed by spring force toward the pressure chamber and the on/off valve mechanism 849 again opens and the supply of high-pressure gas resumes. Through the repetition of this action, gas of the set pressure is supplied from the low-pressure port 850 to the various supply lines 84 through 86.

Here follows a description of the action in the event that a leak of high-pressure gas occurs, and the leaking high-pressure gas enters the interior of the pressure setting chamber 837. In this case, the internal pressure of the pressure setting chamber increases due to the gas that enters. When this internal pressure rises above a fixed value, the valve body 862 of the relief valve 860 is pushed by the rising pressure and moves against the spring force. As a result, the pressure setting chamber 837 and the outside-communicating chamber 865 are put into the communicating state. For this reason, the gas within the pressure setting chamber is released into the outside via the relief valve. when the internal pressure of the pressure setting chamber drops, the relief valve 860 again closes.

In this manner, in this example, a structure is adopted in which a relief valve 860 is attached to the regulator 83, so even if a leak of high-pressure gas occurs in the interior of the regulator, this will block the normal operation of the regulator, so gas at a pressure higher than the set pressure will not be supplied to the side of the supply lines 84 through 86.

In addition, in this example, a structure is adopted in which a second relief valve 880 is also placed on the side of the low-pressure port 850. Therefore, even if the pressure chamber 836 should be temporarily put into the high-pressure state, high-pressure gas is prevented from being sent out uncontrollably from the low-pressure port 850. In this case, the second relief valve 880 opens and the pressure of the pressure chamber 836 is lowered to a previously set pressure. Therefore, even when a valve is opened rapidly or other case in which high-pressure gas is supplied, it is possible to prevent high-pressure gas from temporarily acting on the side of the low-pressure port. In addition, even in the case in which the relief valve 860 does not function normally, this second relief valve 880 has the effect of maintaining the gas sent from the low-pressure port at a pressure below a fixed pressure.

Note that a regulator of the structure described above can also be applied to closed-circuit breathing apparatus, for example, or other breathing apparatus of a form other than semiclosed-circuit breathing apparatus.

As described above, a relief valve is placed in the regulator of a semiclosed-circuit breathing apparatus used to reduce the pressure of gas supplied from a breathing gas cylinder, so that high-pressure gas that leaks within the regulator passes through the relief valve and is released into the outside. Therefore, by means of the present invention, it is possible to avoid the ill effects caused by high-pressure gas leaking into the interior of the regulator and resulting in gas at a pressure higher than the set pressure being supplied to the downstream side of the breathing circuit. In addition, by placing a second relief valve such that it communicates with the side of the low-pressure port, the gas sent out from the low-pressure port will be reliably maintained at a pressure lower than the set pressure.

Industrial Applicability

As explained in the foregoing, the air bags for underwater breathing apparatus of the present invention are characterized in that they are seamless one-piece moldings molded from synthetic resin. By means of the present invention, the air bags have no seams like those present in the prior art, so there is no need for inspection of the strength of seams, simplifying production management.

In addition, the breathing gas circulation openings of the air bags have a screw-in type removable structure, so the work of replacing the air bags can be performed simply. In addition, replacement is simple, so by preparing air bags of different volumes depending on differences in the lung capacity of the user, it is possible to attach optimal air bags that are matched to the user.

Moreover, in the present invention, the air bags are molded from polyurethane resin. By using polyurethane resin, its tear strength is higher than that of the conventional air bags, so durability and the like can be increased.

Moreover, in the present invention, the air bags are molded by means of the blow molding method. By adopting this molding method, stability of sizes and good suitability to mass production can be achieved.

Claims

1. Air bags for semiclosed circuit breathing apparatus that are breathing air bags for semiclosed circuit breathing apparatus, characterized in that said breathing air bags are seamless one-piece moldings molded from synthetic resin.

2. Air bags according to claim 1, wherein the breathing gas circulation openings of the air bags have a screw-in type removable structure with respect to the main unit side of the semiclosed circuit breathing apparatus.

3. Air bags according to claims 1 or 2, wherein the one-piece moldings are molded of polyurethane resin.

4. Air bags according to claims 1, 2 or 3, wherein the molding is performed by means of the blow molding method.

Fig. 1

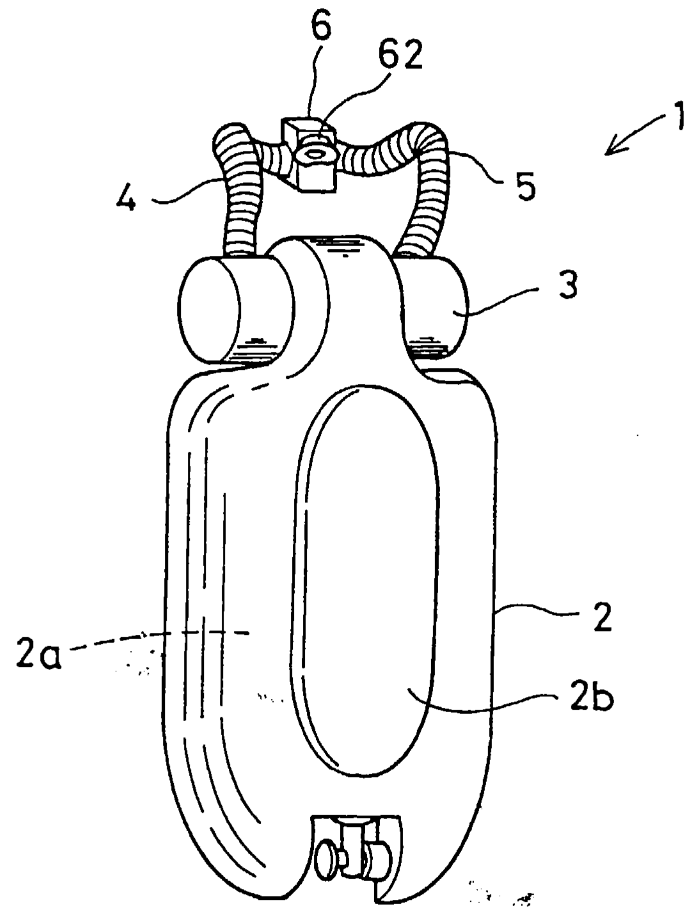
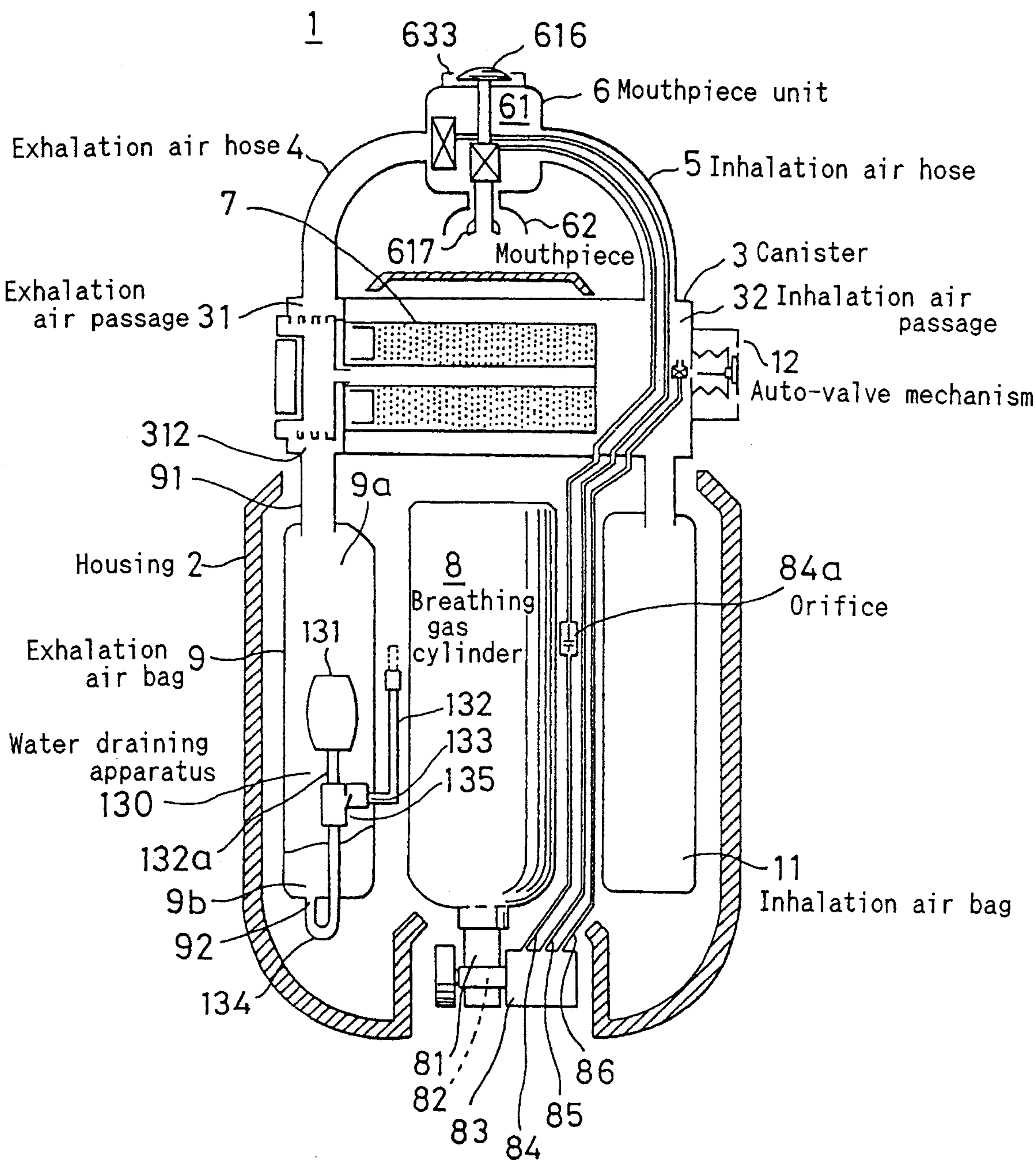


Fig. 2



1
633
616
61
6 Mouthpiece unit
Exhalation air hose 4
5 Inhalation air hose
7
62
617
Mouthpiece
3 Canister
Exhalation
air passage 31
32 Inhalation air
passage
12
Auto-valve mechanism
312
91
9a
Housing 2
8
Breathing
gas
cylinder
84a
Orifice
131
Exhalation
air bag 9
132
Water draining
apparatus
130
133
135
132a
11
Inhalation air bag
9b
92
134
81
82
83
84
85
86

Fig. 3

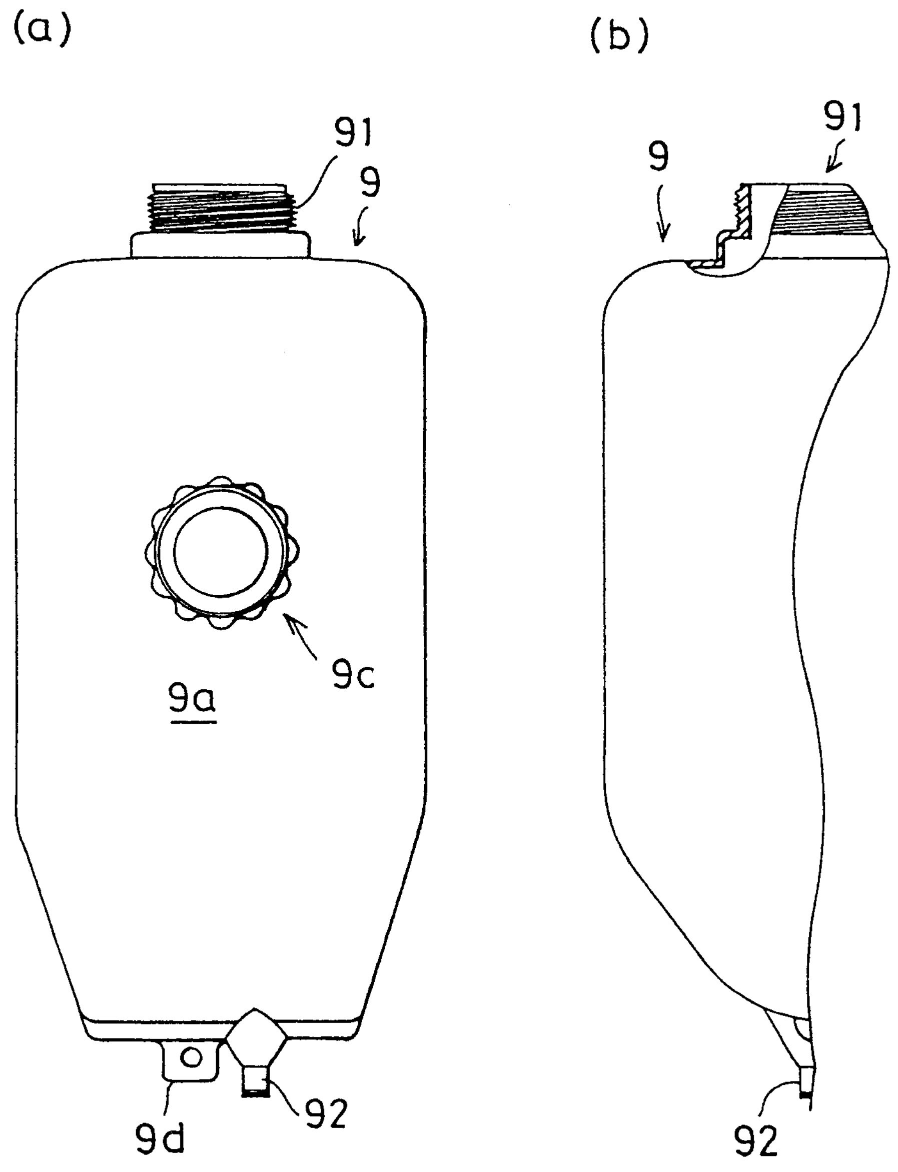


Fig. 4

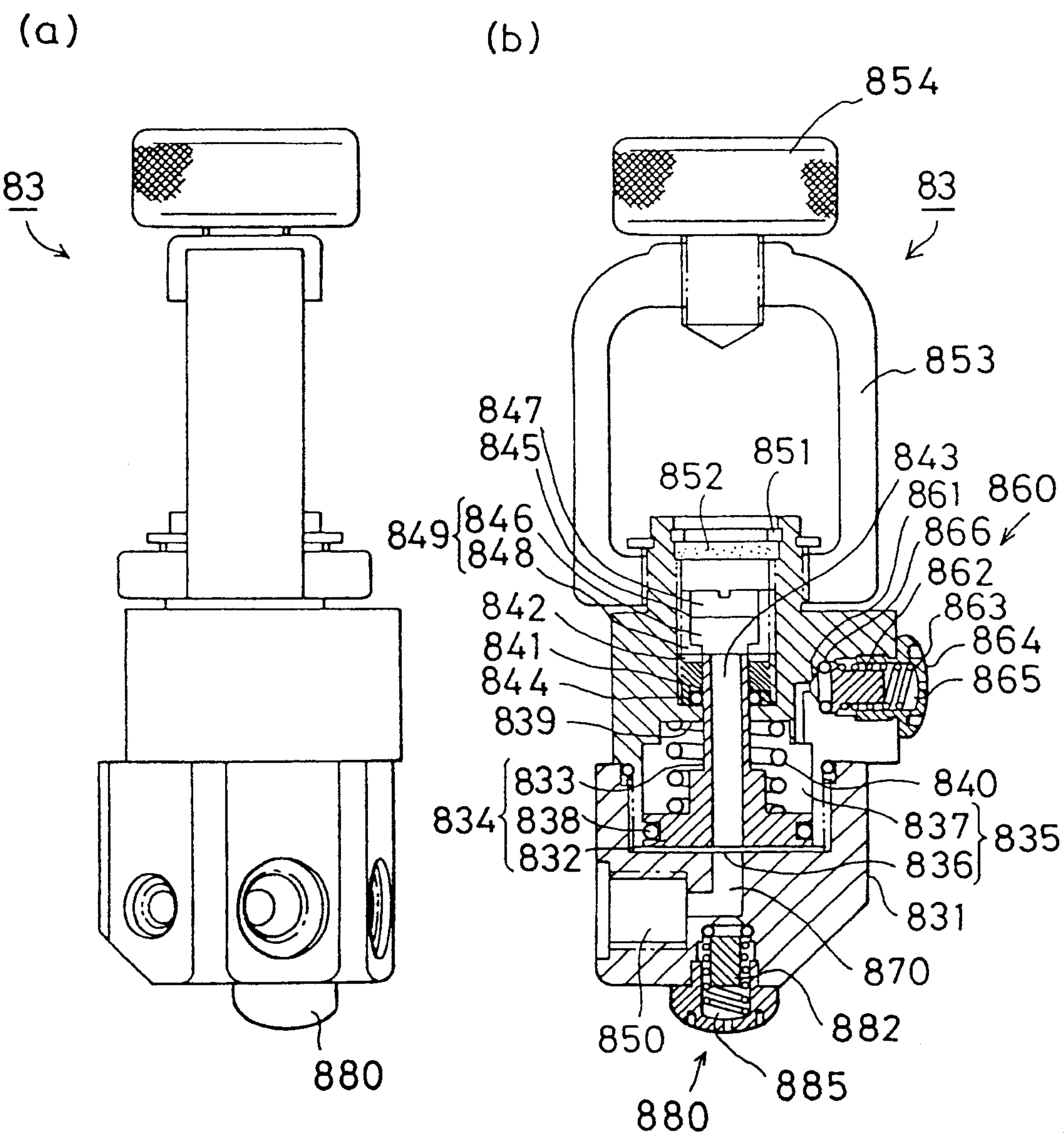
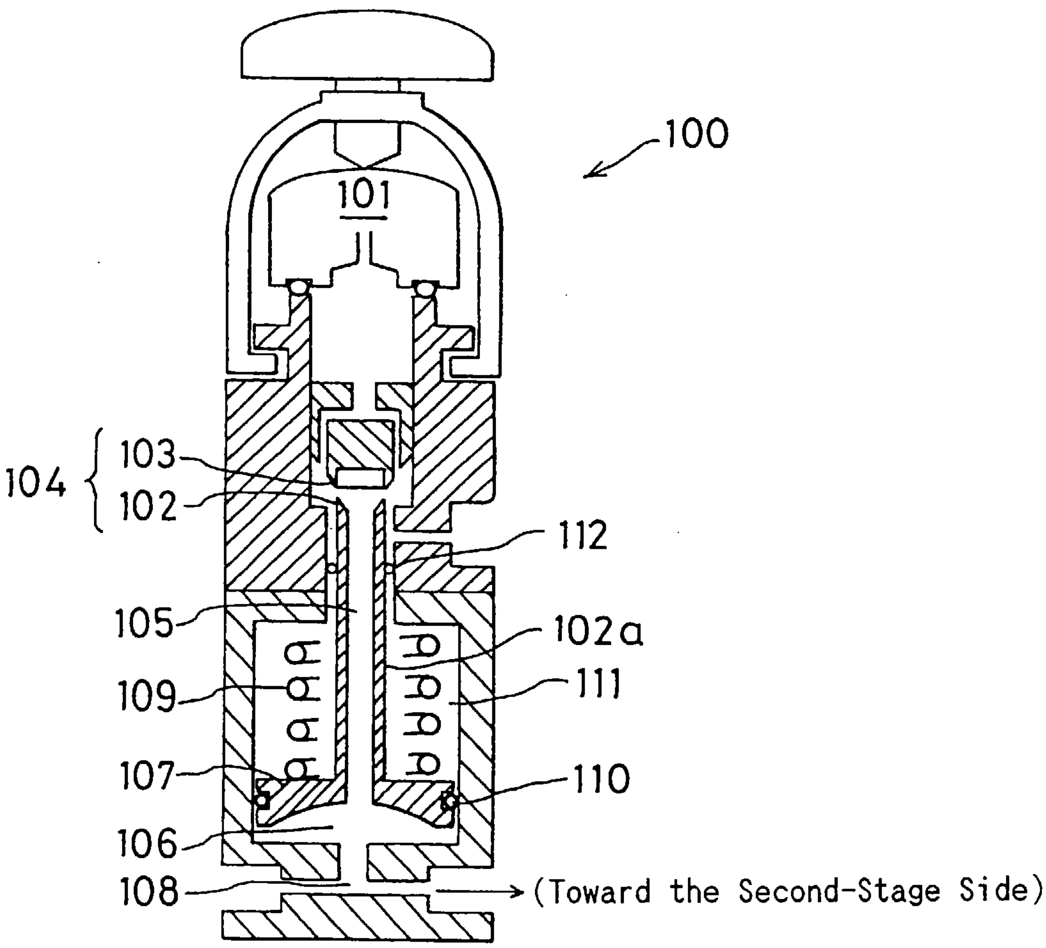

(a)
(b)
83
880
854
83
853
847
845
852
851
843
861
860
849
846
848
866
862
842
863
841
864
844
865
839
833
840
834
838
837
835
832
836
831
870
882
850
885
880

Fig. 5


100
101
104
103
102
112
105
102a
109
111
107
110
106
108
(Toward the Second-Stage Side)

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP95/01559

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl^6 B63C11/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl^6 B63C11/18-11/24

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1926 - 1995
Kokai Jitsuyo Shinan Koho 1971 - 1995

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP, 7-101388, A (Grand Bleu Inc.), April 18, 1995 (18. 04. 95), Line 17, left column to line 2, right column, page 9 & WO, 9509762, A1 & AU, 9458235, A	1, 2, 3, 4
Y	JP, 6-171589, A (Grand Bleu Inc.), June 21, 1994 (21. 06. 94), Lines 8 to 27, right column, page 2 (Family: none)	1
A	JP, 6-171588, A (Grand Bleu Inc.), June 21, 1994 (21. 06. 94)(Family: none)	1
A	JP, 6-171591, A (Grand Bleu Inc.), June 21, 1994 (21. 06. 94)(Family: none)	1

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
October 4, 1995 (04. 10. 95)	October 31, 1995 (31. 10. 95)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)