July 9, 1963 M. M. ARBORELIUS ET AL 3,096,778

VALVE ARRANGEMENT FOR BREATHING DEVICES

Filed Jan. 3, 1958

FIG. 1

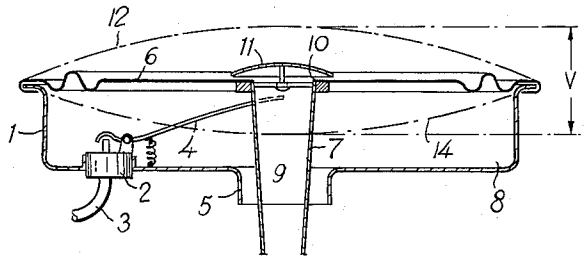


FIG. 2

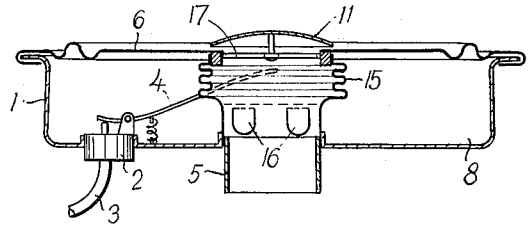
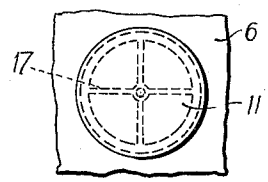


FIG. 3



INVENTOR.

BY

United States Patent Office

3,096,778

Patented July 9, 1963

3,096,778
VALVE ARRANGEMENT FOR BREATHING DEVICES

Måns Månsson Arborelius and Claes Erik Gunnar Lundgren, both of Stora Tvargatan 36, Lund, Sweden

Filed Jan. 3, 1958, Ser. No. 706,993
Claims priority, application Sweden Jan. 5, 1957
2 Claims. (Cl. 137—63)

The invention refers to breathing devices, particularly for operation under water or in smoke, of the type having a membrane chamber with an inlet valve adapted to admit air from a source of pressurized air in response to the membrane of the membrane chamber and having an outlet valve and a breathing aperture for connection to a mouthpiece. The object of the invention is to provide a valve arrangement in devices of this type which makes possible substantial saving of air, whereby the device can be used for a longer time than has hitherto been possible without renewal of the stored pressurized air.

It is known to arrange the outlet valve in a valve chamber separate from the membrane chamber and also to arrange this valve on one of the walls of the membrane chamber. Particularly for under water work it is of advantage to place the outlet valve in the same plane as the membrane of the membrane chamber, since the outlet valve and the membrane are then responsive to the same hydrostatic pressure. The disadvantage of the constructions in which the outlet valve is located in one of the membrane chamber walls is that the chamber is filled during the exhalation with exhaled air. In the succeeding inhalation air, which is bad from a physiological viewpoint is returned to the wearer's lungs before he receives fresh air from the membrane chamber. In addition, the fresh air remaining in the chamber after an inhalation is spilled during the exhalation.

The present invention removes these disadvantages, enabling the fresh air remaining in the air passages of the wearer and of the device after an inhalation to be retained in the system during the exhalation.

A few examples of the application of the invention is illustrated on the drawing, FIGS. 1 and 2 of which show schematically each one embodiment in axial section and FIG. 3 of which shows a detail of the FIG. 2 device.

In FIG. 1, a membrane chamber **1** is provided with an inlet valve **2** having an inlet tube **3** for connection to a source of pressurized air. An actuating member in the form of a two-armed lever **4** is actuated by a corrugated membrane **6** forming the upper wall of the chamber, in such a way that the valve **2** is opened upon deflection of the membrane inwardly, such as during an inhalation. The chamber is provided with a breathing aperture in a socket **5** on the fixed wall thereof, this socket being adapted for connection to the breathing passages of the wearer via a mouthpiece. Attached to the membrane is a tubular partition **7** screening off a fresh-air space **8** in the chamber from a used-air space **9**. The junction of the partition to the membrane forms the seat **10** of an exhalation valve **11** comprising, for instance, a rubber disc attached centrally in the aperture of the tube **7** and the rims of which are free to be pressed against the seat **10** in the closed position of the valve. The tube **7** extends freely into the socket **5** and its external diameter is smaller at this point than the inner diameter of the socket.

The membrane **6** is shaped, for instance by means of corrugations or in any other manner, so as to define between an outer, extended position and an inner, extended position (shown by dash lines **12, 14**) a volume V equal to the volume of the breathing passages leading from the chamber to the wearer and in the connection between the

latter and the chamber. The length of the tube **7** is chosen so as to let the tube extend into the socket **5** even in the extended position of the membrane. The tubular partition forms a passage through the membrane chamber for used-up exhaled air and leading from the breathing aperture of the socket **5** to the exhalation valve.

In principle, the operation of the device shown in FIG. 1 is as follows:

In inhalation, as the membrane **6** has reached its inner extended position **14**, the inlet valve **2** is opened owing to the influence of the membrane, which then actuates the lever **4** in the opening direction of the valve **2**, thereby admitting fresh air to the membrane chamber. In the dead space in the breathing passages of the wearer and in the connections between these and the chamber there is likewise fresh air of volume V. This air forms the first portion of the exhalation and flows through the slot between the tubes **5** and **7** into the chamber **1** as the membrane passes from its inner to its outer position. The valve **11** then opens and during the rest of the exhalation the bad air from the lungs flows through the tubes **5** and **7** and through the said valve into the surrounding medium. At the subsequent inhalation, the wearer first inhales the volume V of fresh air from the space **8** as the membrane **6** passes from its outer to its inner position. The wearer then obtains the remaining quantity of fresh air for the inhalation from the valve **2**. For each inhalation, there is thus a saving amounting to an air quantity of volume V.

In the embodiment shown in FIG. 2, the screening partition is formed by a flexible tube **15** which is extendable, being provided with corrugations, and is connected at one end to the membrane surrounding the outlet valve **11** and at its other end to the breathing aperture, i.e. the socket **5**. The valve **11** is mounted on a spider **17** located in the membrane aperture. Owing to the corrugations or elasticity of the tube or to both these factors, the tube permits the membrane to flex to an inner and to an outer extended position, just as was described in connection with the foregoing embodiment. The tube is provided with apertures in the form of sickle-shaped slits forming movable flaps **16** allowing passage of gas in both directions.

The volume V of fresh air from the dead space of the wearer and of the device flows during the exhalation into the space **8** of the chamber via the apertures at the flaps **16**, since the pressure in the tube **15** during the exhalation is higher than in the space **8**.

When the membrane **6** reaches its outermost position, the pressure in the chamber **1** and in the tube **15** is the same and the flaps return to their neutral positions, whereupon the tube **15** forms a closed-off space leading the rest of the exhalation to the valve **11** to the surrounding medium. In inhalation, a lower pressure is created in the tube **15** than in the chamber **1** and the flaps open towards the tube interior allowing fresh air from the chamber to pass through. The invention is not limited to the embodiments shown, these serving only as examples illustrating the principle of the invention. It is however possible to place the exhalation valve on some other wall of the chamber than the membrane. This removes the need for a movable tube but the increased difference in depth between the exhalation valve and the membrane necessitates a higher opening pressure on the exhalation valve.

Inhalation may be considered as divided into three stages. During the first stage, while both valves are closed, the diaphragm moves from the outer extended position to the inner position so that the area corresponding to the volume V is sucked into the lungs of the wearer. Next, the inlet valve is opened when the diaphragm

reaches its innermost extended position, and additional fresh air is applied as the wearer inhales. The last stage of inhalation is that when fresh air from the inlet valve fills the passages leading from the chamber to the lungs. Since this air does not ever reach the lungs its oxygen cannot be used, and this air has a high oxygen content.

Exhalation may be considered divided into two stages. During the first stage the air in the breathing passages from the chamber to the lungs of the wearer flows into the chamber and causes the diaphragm to move from its inner extended position to its outer extended position. During this stage of exhalation the outlet valve is closed. Accordingly, the air from the breathing passages flows into the space 8 of the chamber. When the diaphragm has reached its outermost extended position, the second stage begins. At this point the outlet valve 11 opens and the air from the lungs of the wearer, which is of low oxygen content, escapes through the outlet valve. When exhalation is finished, the outlet valve closes, and the first inhalation stage begins.

The purpose of the device is to conserve the supply of air by preventing mixing between the "used" air and the "unused" air, that is, between air with low oxygen content and that with high oxygen content. The arrangement is such that the air from the lungs of the wearer escapes through the tube 7 and the outlet valve, while the chamber 8 contains only air having a high oxygen content. Accordingly, the tube 7 or some equivalent partition serves the purpose of preventing the fresh air in chamber 8 from escaping through the outlet valve during the second stage of exhalation.

What is claimed is:

1. A breathable gas regulating device comprising a housing having a valve chamber therein, an extensible diaphragm forming one wall of said chamber, an outlet valve mounted on said diaphragm, an inlet valve located in a wall of said housing opposite said extensible diaphragm, actuating means operatively connecting said diaphragm and said inlet valve, a source of breathable gas connected to said inlet valve, a single aperture in said wall of said housing opposite said diaphragm for directly conducting said gas to and from a point of use, a conducting tube extending through said chamber, one end of said tube being connected to said diaphragm and disposed around said outlet valve and the other end of said tube extending through said aperture at all times and said tube having a smaller diameter than said aperture to allow free flow of gas between said chamber, said tube and said outlet.

2. A breathable gas regulating device comprising a housing having a valve chamber therein, an extensible diaphragm forming one wall of said chamber, an outlet valve mounted on said diaphragm, an inlet valve located in a wall of said housing opposite said extensible diaphragm, actuating means operatively connecting said diaphragm and said inlet valve, a source of breathable gas connected to said inlet valve, a single aperture in said wall of said housing opposite said diaphragm for directly conducting said gas to and from a point of use, an extensible conducting tube in said chamber, one end of said tube being connected to said diaphragm and disposed around said outlet valve and the other end of said tube being connected to said wall of said housing opposite said diaphragm and around said single aperture to place said tube in direct communication with said aperture, said tube having means communicating flow between said chamber and said tube.

References Cited in the file of this patent

UNITED STATES PATENTS

2,383,649	Heidbrink	Aug. 28, 1945
2,695,609	Nourse et al.	Nov. 30, 1954
2,788,001	Brown	Apr. 9, 1957
2,823,739	Kimes	Apr. 1, 1958
2,871,854	Lambertson	Feb. 3, 1959

FOREIGN PATENTS

1,038,345	France	May 6, 1953