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[73] Assignee **La Spirotechnique**
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[54] **DEVICE FOR DISCHARGING A GAS TOWARDS A SPACE HAVING A LOWER PRESSURE**
6 Claims, 1 Drawing Fig.

[52] **U.S. Cl.** **137/81,** 137/490
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[50] **Field of Search** ..... 137/63 R, 489, 490, 81

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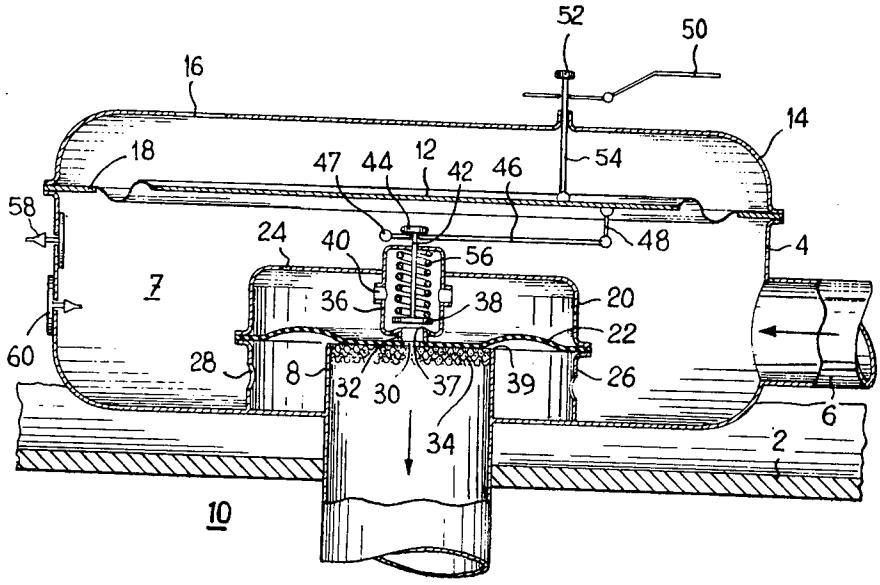
ABSTRACT: Device for discharging breathed-out gas towards a space having a lower pressure. The breathing-out moves a diaphragm which then opens a pilot valve. This opening of the pilot plane creates inside a casing the wall of which comprises another diaphragm an underpressure which lifts said another diaphragm and connects the space where is breathed-out the gas to the space with a lower pressure.



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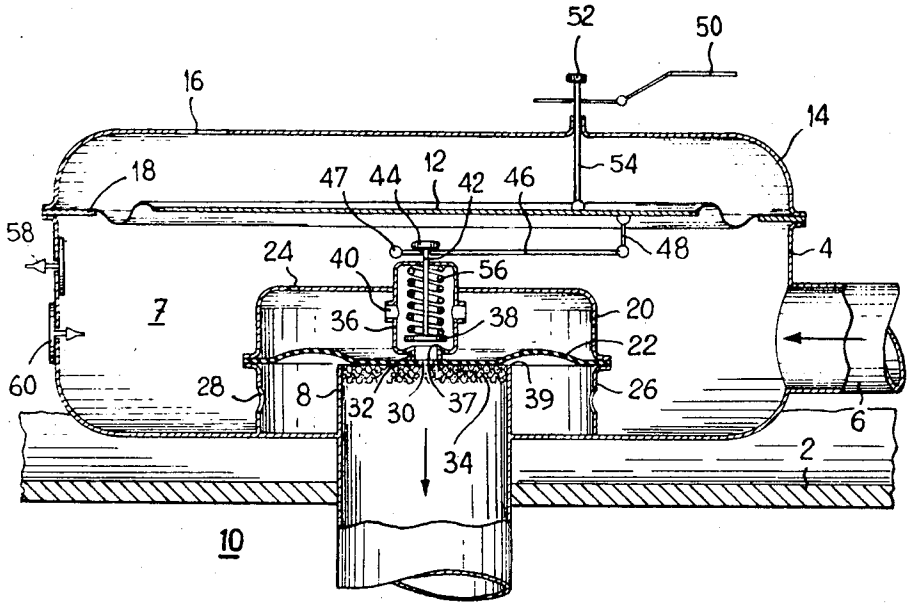

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ATTYS

DEVICE FOR DISCHARGING A GAS TOWARDS A SPACE HAVING A LOWER PRESSURE

The present invention relates to means for discharging fluids, and more particularly, but not exclusively, is concerned with means for discharging fluids from a source at one pressure to a system at a lower pressure; for example, for discharging gases exhaled by a user inhaling and exhaling a gas at a pressure which is considerably greater than atmospheric pressure.

Apparatus has been used for discharging to the exterior the gases exhaled by a patient in a hyperbaric chamber, so that the composition of the atmosphere in this chamber is not modified by the exhaled breath. Such apparatus has consisted of a bag, connected by a valve to the exhalation end of a mask worn by the patient; and a cock which enables the bag to be emptied at intervals into the room in which the hyperbaric chamber is situated. This apparatus has the disadvantage of requiring constant supervision; the bag must not be allowed to become completely inflated and it must only be partially deflated.

According to the present invention there is provided a device for discharging fluids from a system at one pressure to a system at a lower pressure, comprising:

i. A first casing, the interior of which can be connected to the source of fluid to be discharged, and comprising a first movable means which is subjected, on its inner face, to the pressure of fluid to be discharged;

ii. a second casing, within said first casing, which communicates with the space within said first casing by way of one or more holes, and which comprises a second movable means which is subjected, on its outer face, to the pressure of the fluid in the first casing;

iii. a first passage, connecting the interior of the second casing with the atmosphere into which the fluid is to be discharged;

iv. means attached to said first movable means, for controlling the flow of fluid through said first passage; and

v. a second passage, connecting the interior of the first casing with the atmosphere into which a fluid is to be discharged, the flow of fluid through the second passage being controlled by said second movable means.

The two movable means can be pistons, bellows or preferably membranes, for example a fluid-impermeable rubberised fabric sheet. The hole or holes allowing communication between said first and second casing is, or are, small, for example less than 1 mm. diameter. The fluid will generally be air, and the source of air to be discharged can be, for example, the air exhaled by a patient in a hyperbaric chamber or caisson. The source of air to be discharged can also be the air exhaled by a diver; the device is then connected to a tube which discharges above the surface of the water. In this way, the production of bubbles is avoided, this being a very important advantage in those cases where the diver has to remove acoustic mines, as the noise of bubbles could cause such a mine to explode.

For a better understanding of the invention, and to show how the same can be carried into effect, reference will now be made, by way of example, to the accompanying drawing, which shows one embodiment of the present invention which can be disposed in a hyperbaric chamber in which a patient is breathing an atmosphere rich in oxygen, at a pressure which is higher, for example by 2 bars, than the atmospheric pressure which surrounds the hyperbaric chamber.

Externally, the gas-discharging device comprises a first casing **4** equipped with a first tube **6** connecting the interior **7** of the first casing **4** to the exhalation union of a mask worn by a patient, and a second tube **8** by which the discharge device is connected to the space **10** surrounding the chamber, to which space the exhaled gases have to be evacuated.

The casing **4** is closed by a membrane **12**, which is composed of a rigid central portion and a flexible annular portion.

A cover **14** protects the membrane; it has holes such as 16 formed therein, so that the membrane is subjected, on its face opposite to the interior of the casing **4**, to the ambient pressure, that is to say, to the pressure obtaining in the hyperbaric

chamber and to which the patient is subjected and at which he is breathing. The periphery of the flexible annular portion of the membrane is extended by a ring **18** clamped between the casing and its cover.

Situated in the space **7** is a second casing **20**, closed by a membrane **22**. Its internal space communicates by way of a small hole **24** with the space **7**. A sleeve **26** supports this second casing; it is formed with holes, such as **28**, so that the face of the membrane **22** opposite to the interior of the second casing is exposed to the pressure in the first casing, except at certain moments for the central portion of this membrane, as will herein after be seen.

The membrane **22** has a central hole **30**, and is clamped around this hole between a short neck **32** and a filter **34**. It rests on the end of the tube **8** when it is exposed to the same pressure on both its faces. When the pressure inside the second casing is lower than that underneath, the peripheral portion is raised and the membrane assumes a shape similar to that illustrated.

The neck **32** forms part of a third casing **36**; by means of its upper end **37**, it forms a valve seat cooperating with a valve member **38** which can be displaced and which is disposed in casing **36**. This seat and this valve member form a closure device which controls the flow of the gas through holes, such as **40**, and the tubes **32** and **8**, between the internal space of the second casing and the space **10**.

The valve member or head **38** is fixed to a rod **42** which terminates outside the casing **36** in a button **44**. A member (not shown), for example, a toroidal joint, ensures tight movement of the rod through the casing. Through the button **44**, a lever **46**, pivoted at **47** and connected by a rod **48** to the rigid portion of the membrane **12**, lifts the valve when the pressure inside the casing **4** is slightly above the ambient pressure; this is the case illustrated in the drawing.

By operating a handle **50**, it is possible, through a button **52** forming the end of a rod **54** pivoted on the rigid portion of the membrane **12**, to lift the membrane and thus open the valve **37, 38**. Conversely, by applying pressure to the button **52**, it is possible to lower the membrane and close the valve; a spring **56**, supported on the casing **36**, permanently bears on the valve head. The button **52** and the handle **50** can be disposed outside the chamber or be operated from the exterior.

Mounted in the wall of the first casing are two calibrated valves. A first valve **58** opens towards the interior of the first casing **4** when the reduced pressure in this casing is greater than that under which, because of small inevitable pressure drops, the patient normally breathes. This avoids the patient becoming fatigued when these pressure drops are too great; he is able, at such times, to inhale the atmosphere of the hyperbaric chamber through this valve, the space **7** and the tube **6**.

A second calibrated valve **60** opens towards the exterior of the first casing **4** when the excess pressure in the space **7** is greater than normal, this permitting the patient to exhale even if the mechanism of the discharge device is not functioning satisfactorily.

The functioning of the device is as follows:

When the patient inhales, the pressure in the space **7** is lower than the ambient pressure, which is that in the hyperbaric chamber; the membrane **12** is lowered and allows the spring **56** to close the valve **37, 38**. The membrane **22** is also lowered and comes into contact with the upper rim **39** of the tube **8**, because of its elasticity and because the central portion of its lower face is exposed to a smaller pressure than that which affects the remainder of this membrane.

When the patient exhales, the pressure in the space **7** becomes greater than the ambient pressure. The membrane **12** is lifted, thus lifting the valve member **38** through the levers **46, 48** and the button **44**. When the valve member leaves the seat **37**, the gas inside the second casing **20** passes through the holes **40** into the casing **36** and through the tubes **32** and **8**, into the air surrounding the hyperbaric chamber. The flow of this gas is regulated by the narrowness of the hole **24**, which brings the second chamber under vacuum relative to a pres-

sure lower than that in the first. When this underpressure is sufficient, the membrane **22** is lifted, except at its center, as indicated above, and frees a passage between it and the rim **39**; through this passage and through the holes, such as **28**, the gas which is in the first casing is able to escape towards the space **10** by passing through the tube **8**. The exhalation of the patient is then effected through this path with very little pressure drop.

In one embodiment, there was a single hole **24** with a diameter of 0.6 mm., 12 holes **28**, each with a diameter of 3 mm., and 2 holes **40**, each of 2 mm. The internal diameter of the tube **8** was 23 mm.; the internal and external diameters of the tube **32** were 1.4 and 10 mm. The membrane was formed by an impermeable sheet of rubberised fabric.

As the valve **37, 38** has a passage area which is very small in relation to the active surface of the membrane **12** (of the order of 1:3,000), the excess pressure which opposes the exhalation of the patient is very low. It serves as a pilot valve for the valve **22, 39**, the force actuating this latter being the difference of the pressures between the spaces **7** and **10**.

The apparatus as described can be modified without departing from the scope of the present invention. For example, it is possible to use membranes of different constitution; one or both membranes can be replaced by one or two bellows. The second membrane can operate a valve instead of forming the valve member. The filter **34** can be replaced by a perforated or strainer plate.

Apparatus in accordance with the invention can be used for controlling the flow of a gas in other circumstances; it can also be used for controlling the flow of a liquid.

What I claim is:

1. A discharge device for gas exhaled by a user inhaling and exhaling a gas substantially at a first ambient pressure which is higher than a second pressure to which the exhaled gas is evacuated, comprising a first casing, means for connecting the interior of the first casing to the respiratory passages of the user, a first movable gastight wall closing said first casing and being exposed to said first pressure on its face opposite the interior of said first casing and the wall defining with said first casing a first expansible chamber communicating with said connecting means, a second casing in said first casing, said second casing communicating with said first chamber through at least one hole, a second movable gastight wall closing said second casing and being exposed to said first chamber on its face opposite the interior of said second casing and defining with said second casing a second expansible chamber, means controlled by said second wall to control the venting of said first chamber to the space to which the exhaled gases are evacuated, and means controlled by said first wall to control the venting of said second chamber to the space to which the exhaled gases are evacuated.

2. A discharge device as claimed in claim **1**, and means for manually opening or closing the last-named means.

3. A discharge device as claimed in claim **1**, said second wall cooperating with a fixed member to open or close the interior of said first casing to the space to which the exhaled gases are evacuated.

4. A discharge device as claimed in claim **1**, and filter means through which the exhaled gases are evacuated.

5. A discharge device as claimed in claim **1**, and calibrated valve means permitting the passage of said gas at said first pressure into the interior of said first casing.

6. A discharge device as claimed in claim **1**, and calibrated valve means permitting the passage of gas out of the interior of said first casing into a region at said first pressure.

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