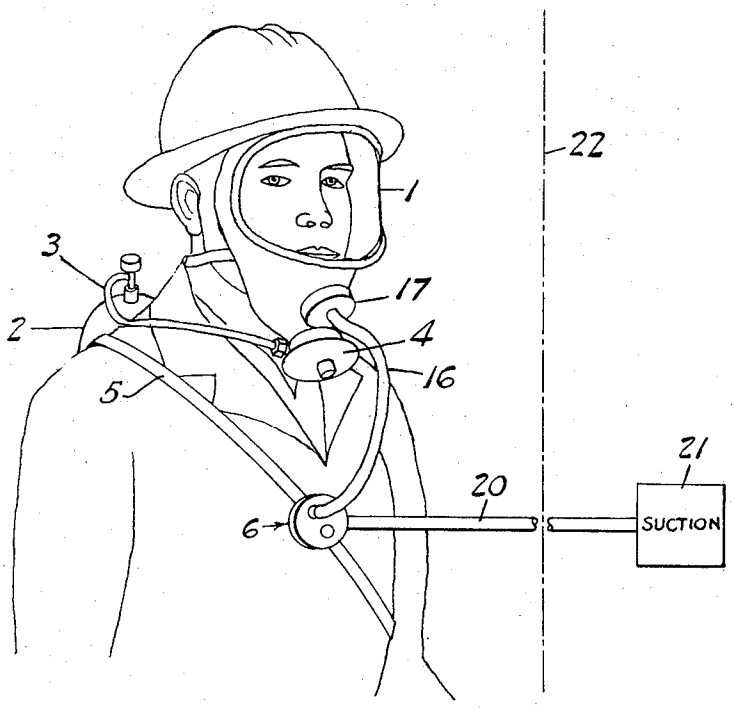
Oct. 24, 1967 H. A. BENZEL 3,348,538

BREATHING APPARATUS EXHALATION VALVE WITH SUCTION CONTROL

Filed Nov. 5, 1964 2 Sheets-Sheet 1

FIG. 1.



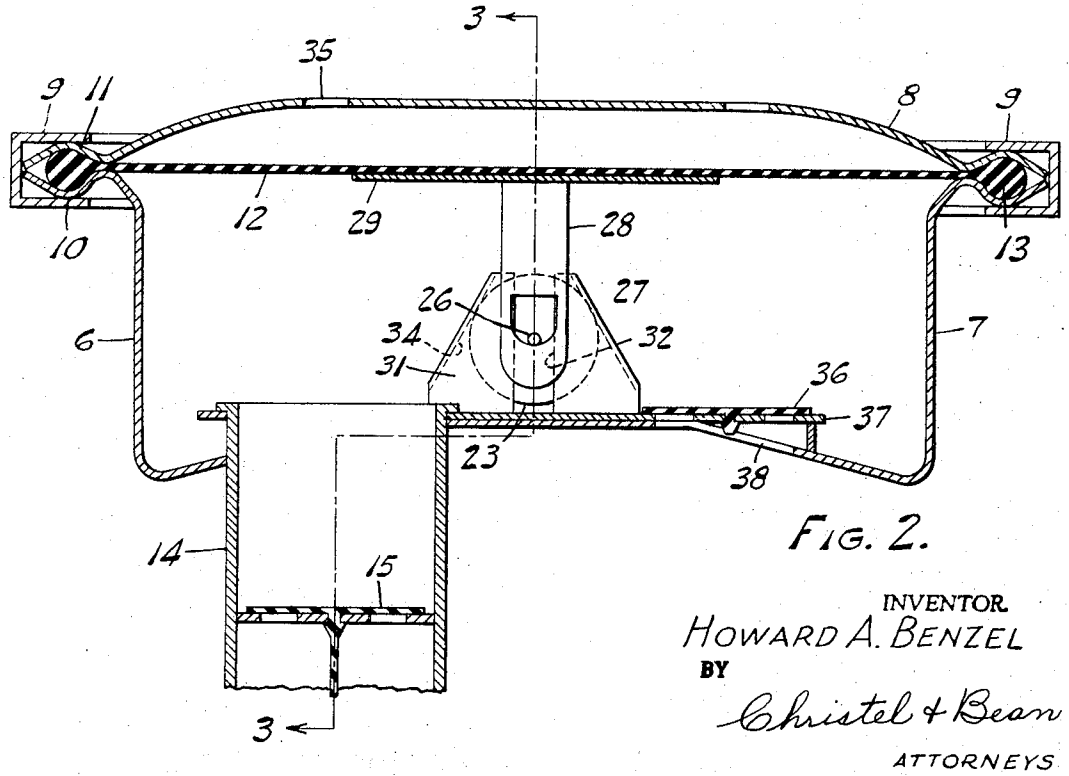


FIG. 2.

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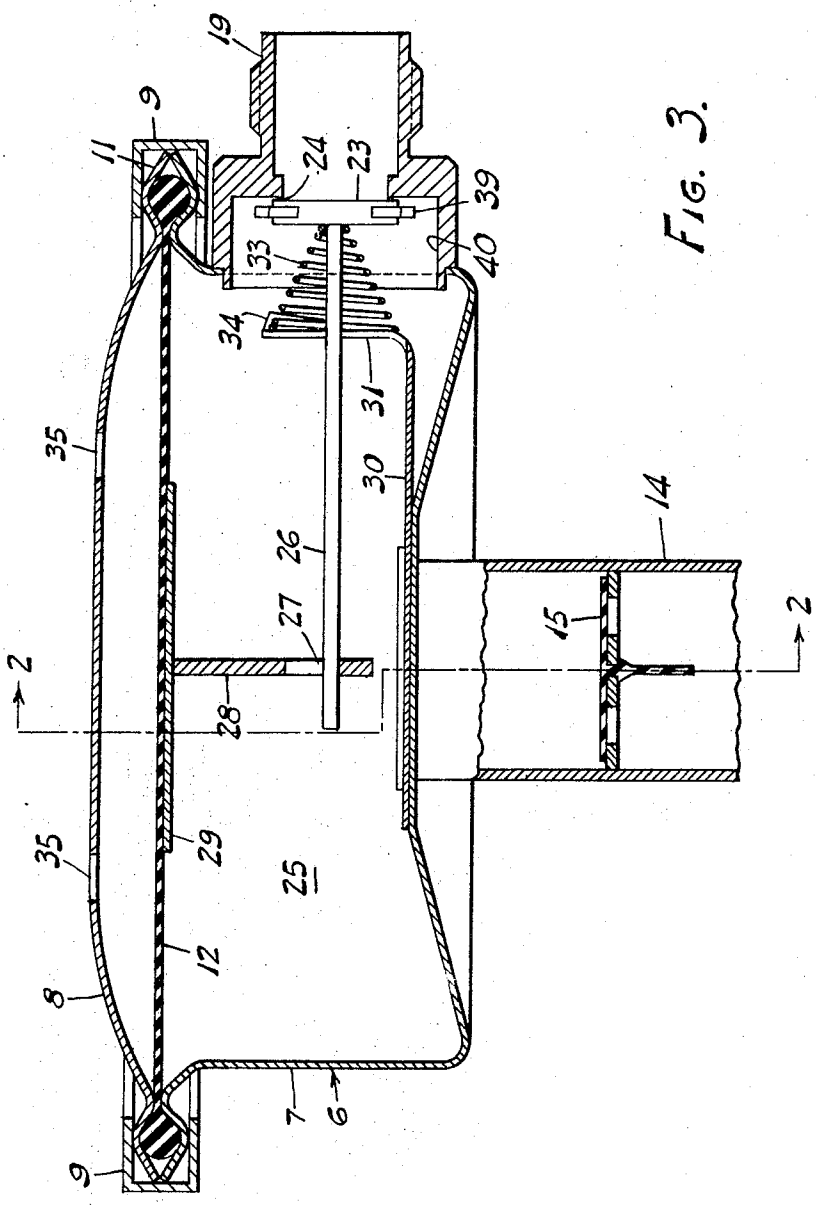

FIG. 3.

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BREATHING APPARATUS EXHALATION VALVE WITH SUCTION CONTROL

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15 Claims. (Cl. 128—142)

ABSTRACT OF THE DISCLOSURE

A control chamber with a movable wall has a fluid inlet communicating with a fluid outlet from a breathing mask or other life support system for movement of the wall upon fluid flow into the chamber from the system. The chamber also has a fluid outlet communicating with a source of suction. A normally closed valve controls fluid flow through the chamber outlet and is opened by such wall movement to place the chamber in communication with the suction source.

This invention relates generally to the control art, and more specifically to a new and useful suction control for life support systems.

When a person must subsist in an atmosphere which is toxic, oxygen deficient or for some other reason cannot support human life, he is equipped with a life support system comprising, for example, a breathing mask supplied with oxygen from a regulated source. His exhalation usually is exhausted to the ambient atmosphere.

However, there are situations wherein the surrounding atmosphere must not be contaminated with such exhalation. While a closed circuit breathing system might be used, under certain circumstances at least, frequently it is neither a practical nor a desirable solution to the problem.

Accordingly, a primary object of my invention is to provide a suction control arrangement for receiving the exhalation from a breathing mask, pressure suit or the like, and removing it under pressure in a manner avoiding contamination of the surrounding atmosphere.

Another object of my invention is to accomplish the foregoing in an arrangement which is simple and practical in construction, while being durable and dependable in operation.

In one aspect thereof, my invention is characterized by the provision, in combination with a life support system having a fluid outlet, of a source of suction, and a suction control including a chamber having a movable wall, a fluid inlet to the chamber communicating with the life support system outlet for movement of the chamber wall upon fluid flow into the chamber from the life support system, a fluid outlet from the chamber communicating with the source of suction, valve means controlling fluid flow through the chamber outlet, and means connecting the valve means to the movable wall for placing the chamber in communication with the source of suction upon movement of the chamber wall in response to fluid flow from the system outlet into the chamber.

In another aspect thereof, a suction control for life support systems constructed in accordance with my invention is characterized by the provision of means defining a chamber having a movable wall, a fluid inlet to the chamber adapted for connection to a breathing mask exhalation conduit or the like, a fluid outlet from the chamber adapted for connection to a source of suction, a valve normally closing the outlet, and means connecting the valve to the chamber wall for movement thereby to open the outlet only upon movement of the wall in a direction enlarging the chamber.

The foregoing and other objects, advantages and characterizing features of my invention will become clearly apparent from the ensuing detailed description of an illustrative embodiment thereof, reference being made to the accompanying drawings depicting the same wherein like reference numerals denote like parts throughout the various views and wherein:

FIG. 1 is a schematic view illustrating a life support system suction control of my invention, as it appears in use;

FIG. 2 is a transverse sectional view of the suction control on an enlarged scale, being taken about on line 2—2 of FIG. 3; and

FIG. 3 is another transverse sectional view thereof, being taken about on line 3—3 of FIG. 2.

Referring now in detail to the embodiment depicted in the accompanying drawing for illustrative purposes, there is shown a man equipped with a life support system, comprising a full face breathing mask **1** supplied with breathing fluid from a cylinder **2** via a breathing hose **3** and a demand regulator **4**, which latter is attached to the mask **1**. Cylinder **2** is carried on the back by a harness indicated at **5**.

Usually, mask **1** would be provided with an exhalation valve opening directly to the ambient atmosphere. However, where the ambient atmosphere must not be contaminated by exhaled air from the mask, I provide a suction control generally designated **6**.

Control **6** comprises a housing including a generally cup-shaped body **7** and a cover **8**, the two being held together by a generally U-shaped clamping ring **9** having a radially inwardly facing channel receiving the reversely curved, laterally outwardly projecting peripheral flanges **10**, **11** of body **7** and cover **8**. A movable wall, herein shown as a resiliently flexible diaphragm **12**, is suspended across the upper end of body **7**, having an enlarged, peripheral bead **13** engaged between the peripheral flanges **10** and **11** for securing diaphragm **12** in position.

Control **6** is provided with a tubular fluid inlet conduit **14** containing an inwardly opening flapper valve **15** and connected via a flexible hose **16** (FIG. 1) to the exhalation conduit **17** from mask **1**. Control **6** also is provided with a tubular fluid outlet conduit **19** formed to receive a coupling, not shown, for connection to a flexible hose **20** leading to a source of suction indicated at **21**. As indicated by the separation line **22** in FIG. 1, the source of suction **21** can be located in another room, or elsewhere remote from the user.

Fluid outlet conduit **20** from control **6** is controlled by a tilt valve having a body **23** of any suitable construction. Valve body **23** engages a valve seat **24** around conduit **19** at its inner end which opens laterally into a chamber **25** formed by control housing body **7** and flexible diaphragm **12**. A valve stem **26** is connected at one end to valve body **23**, and extends therefrom generally parallel to diaphragm **12** through an elongated opening or slot **27** in a connecting link member **28** carried by a back-up plate **29** secured to diaphragm **12** for movement therewith. Valve stem **26** normally engages the outer, lower end of slot **27**, whereby movement of diaphragm **12** toward control body cover **8**, in a direction enlarging chamber **25** will tilt stem **26** upwardly, pivoting valve body **23** on valve seat **24**, at the upper portion thereof as shown in FIG. 3, thereby opening fluid outlet conduit **19** and placing the suction source **21** in communication with chamber **25**. However, movement of diaphragm **12** inwardly of chamber **25**, in a direction reducing its volume, will not tilt stem **26** because of the elongation of slot **27**. The outer, lower end of member **28** will engage a mounting plate portion **30** of a spring bracket, which base is mounted on the bottom wall of control housing body **7**. This limits inward movement of

diaphragm 12, during which inward movement stem 26 will remain in its horizontal, inoperative position of rest.

A bifurcated arm 31 at the valve body end of the spring bracket has a vertical slot 32 through which stem 26 extends and in which it can tilt vertically, in the plane of the paper as viewed in FIG. 3, without interference. At the same time, undue lateral movement of stem 26 is prevented by the arm 31. A helical spring 33 encircles stem 26 between arm 31 and valve body 23, bearing at one end against the latter. At its opposite end, spring 33 bears against arm 31, being held against lateral shifting by flanges 34 extending from the opposite sides of the bifurcated arm 31 at generally a right angle thereto. Multiple protrusions 39 project radially from valve body 23 for engagement with wall 40 to center valve 23 on its seat.

The chamber between cover 8 and diaphragm 12 is at ambient atmospheric pressure, being open to the surrounding atmosphere through multiple openings 35.

In operation, the suction source 21 normally is cut off from the control chamber 25 by valve body 23. However, when the user exhales, the exhalation passes through conduit 17, hose 16 and fluid inlet 14, past the one-way check valve 15 and into chamber 25. The pressure of exhalation increases the pressure in chamber 25 above atmospheric, and the resulting pressure differential on diaphragm 12 moves it toward cover 8, enlarging chamber 25. Such movement of diaphragm 12 carries with it valve stem 26, titling valve body 23 to open the fluid outlet 19 from control chamber 25. As soon as this occurs, the negative pressure from suction source 21 pulls the exhalation from chamber 25, thereby immediately removing it from the chamber, whereupon the pressure on opposite sides of diaphragm 12 is equalized and diaphragm 12 returns to its position of rest, with spring 33 closing valve body 23 on seat 24. Thus, valve 23, 26 is actuated to place chamber 25 in communication with the suction source 21 upon exhalation from mask 1 into chamber 25, and only then. If for some reason chamber 25 should be at less than atmospheric pressure, diaphragm 12 moves inwardly but does not tilt valve stem 26 and body 23 because of the lost motion connection provided by the elongated slot 27.

A one-way check valve 36 can be arranged on a lateral extension 37 of bracket base 30, to permit entrance of ambient atmospheric air into chamber 25 through openings 38, if for any reason the suction source 21 should remain in communication with chamber 25 and thereby produce less than atmospheric pressure in the chamber. Valve 15 thereby remains closed and conditions in the mask will not change.

Accordingly, it is seen that my invention fully accomplishes its intended objects. The user exhales from mask 1 into the control chamber, and such exhalation actuates valve 23, 26 to open chamber 25 to suction whereupon the exhalation is removed, all without contaminating the ambient atmosphere. While I have disclosed and described in detail only one embodiment of my invention, that has been done by way of illustration only, without thought of limitation. The control of my invention is not limited to use with breathing masks, but can be used with pressure suits and other life support systems, and various modifications and variations therein will naturally occur to those skilled in the art.

Having fully disclosed and completely described my invention, and its mode of operation, what I claim as new is:

1. In combination with a life support system having a fluid outlet, a source of suction, and a control including a chamber having a movable wall, a fluid inlet to said chamber communicating with said system outlet for movement of said wall upon fluid flow into said chamber from said system, a fluid outlet from said chamber communicating with said source of suction, valve means controlling fluid flow through said chamber outlet, and means

connecting said valve means to said movable wall for placing said chamber in communication with said source of suction upon such movement of said wall.

2. In combination with a life support system having a fluid outlet, a source of suction, and a control including a chamber having a movable wall, a fluid inlet to said chamber communicating with said system outlet for movement of said wall upon fluid flow into said chamber from said system, a fluid outlet from said chamber communicating with said source of suction, said outlet having a valve seat, valve means engageable with said seat for controlling fluid flow through said chamber outlet, means urging said valve means into chamber outlet closing position, and means connecting said valve means to said movable wall for placing said chamber in communication with said source of suction upon such movement of said wall.

3. In combination with a breathing mask having inlet means and an exhalation conduit, a source of suction, and a control including a chamber having a movable wall, a fluid inlet to said chamber, a fluid outlet from said chamber, means placing said outlet in communication with said source of suction, means placing said inlet in communication with said exhalation conduit for movement of said wall in response to exhalation from said mask, normally closed valve means controlling the flow of fluid from said chamber through said outlet, and means opening said valve means upon exhalation induced movement of said wall, whereby exhalation from said mask is withdrawn from said chamber by said suction source.

4. In combination with a breathing mask having inlet means and an exhalation conduit, a source of suction, and a control including a chamber having a movable wall, a fluid inlet to said chamber, a fluid outlet from said chamber, means placing said outlet in communication with said source of suction, means placing said inlet in communication with said exhalation conduit for movement of said wall in response to exhalation from said mask, normally closed valve means controlling the flow of fluid from said chamber through said outlet, an actuating stem carried by said valve means, and connecting link means connected to said wall and to said stem for opening said valve means upon exhalation induced movement of said wall, whereby exhalation from said mask is withdrawn from said chamber by said suction source.

5. A control for life support systems comprising, in combination with a source of suction, means defining a chamber having a movable wall, a fluid inlet to said chamber adapted for connection to a life support system exhalation conduit or the like, a fluid outlet from said chamber communicating with said source of suction, a valve normally closing said outlet, and means connecting said valve to said wall for movement thereby to open said outlet for removal of fluid from said chamber upon movement of said wall in a direction enlarging said chamber.

6. A control for life support systems comprising means defining a chamber having a movable wall, a fluid inlet to said chamber adapted for connection to a life support system exhalation conduit or the like, a fluid outlet from said chamber adapted for connection to a source of suction, said outlet having a valve seat, valve means normally closing said outlet including a valve body engaging said seat, a stem connected adjacent one end thereof to said body, and means linking said stem adjacent the other end thereof to said movable wall for tilting said valve stem and body to open said outlet immediately upon movement of said wall in a direction enlarging said chamber, thereby to remove from said chamber substantially all fluid admitted to said chamber through said inlet.

7. A control as set forth in claim 6, together with spring means urging said valve body into outlet closing position.

8. A control for life support systems comprising, in combination with a source of suction, means defining a chamber having a movable wall, a fluid inlet to said chamber adapted for connection to a life support system exhalation conduit or the like, a fluid outlet from said chamber

communicating with said source of suction, a valve normally closing said outlet, and connecting link means connected to said wall for movement thereby and having a lost motion connection with said valve for moving the same to open said outlet only upon movement of said wall in a direction enlarging said chamber.

9. A control for life support systems comprising means defining a chamber having a movable wall, a fluid inlet to said chamber adapted for connection to a life support system exhalation conduit or the like, a fluid outlet from said chamber adapted for connection to a source of suction, a valve normally closing said outlet, and connecting link means connected to said wall for movement thereby and having a lost motion connection with said valve for moving the same to open said outlet only upon movement of said wall in a direction enlarging said chamber, said link means being engageable with the chamber wall opposite said movable wall to limit movement of the latter in a direction reducing said chamber.

10. In combination with breathing equipment having an exhalation conduit, a source of suction, and a control including a chamber defined in part by a flexible diaphragm, a fluid inlet to said chamber, a fluid outlet from said chamber, means placing said outlet in communication with said source of suction, means placing said inlet in communication with said exhalation conduit for movement of said diaphragm in response to exhalation from said equipment, a valve controlling the flow of fluid from said chamber through said outlet, an actuating stem extending from said valve, a spring encircling said stem and urging said valve into closed position, and a connecting link carried by said diaphragm, said link having lost motion engagement with said stem for tilting the latter to open said valve only upon exhalation induced movement of said diaphragm, whereupon exhalation from said equipment is withdrawn from said chamber by said suction source.

11. The combination set forth in claim **1**, said system having means including a regulator for supplying fluid thereto.

12. The combination set forth in claim **3**, together with means including a demand regulator for supplying breathing fluid to said mask.

13. The combination set forth in claim **1**, wherein said movable wall comprises a resiliently flexible diaphragm

14. The combination set forth in claim **13**, wherein said control comprises a housing having a body and a cover, said diaphragm being suspended across said body between said body and said cover, said diphragm and said body defining said chamber, and said diaphragm and said cover defining another chamber.

15. The combination set forth in claim **14**, said other chamber being at ambient atmospheric pressure.

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