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(54) Breathing regulator having air injector feature

Atemregulator mit Luftinjektion

Régulateur respiratoire à injection d'air

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Description

The present invention relates generally to breathing regulators for use with demand breathing systems employed in diving, such as scuba diving, and more particularly to regulators for such systems in which the quantity of air or other gas or gaseous mixtures supplied to the user is determined by the breathing demands of the user and is adjustable by the user during such use.

Demand breathing systems used for diving, particularly scuba diving, typically employ a tank of breathable air or other breathable gaseous mixture (hereinafter referred to as "air" for the sake of brevity), a valve at the tank reducing the pressure of the mixture to approximately 965 kNm⁻² (140 psi) as a first stage of regulating the pressure, a regulator to further reduce and control the pressure of the air in accordance with the breathing demand of the user as a second stage regulation, and a mouthpiece pneumatically coupled to the regulator through which the user breathes and receives air from the system. Typically the regulator, such as disclosed in US-A-3783891, employs a flexible diaphragm which senses the breathing demand of the user, and upon inhalation, the diaphragm is deflected in a first direction, opening a valve within the regulator to admit air from the tank valve to the mouthpiece and to the user. Upon exhalation, the exhaled air passing through the mouthpiece and into the regulator increases the pressure, deflecting the diaphragm in a second or opposite direction causing the valve within the regulator to close, and due to the increased pressure in the regulator, a portion of the air within the regulator is exhausted, equalizing the pressure on the diaphragm. Air can be exhausted by deflection of the diaphragm or a portion thereof away from its seat and exhausted between the diaphragm and its seat or through a separate exhaust valve.

Improvements on the typical demand breathing systems have been made to reduce or control the extent of the breathing demand required to open or crack the valve within the regulator and exhaust exhaled air, particularly where the conditions, such as depth of diving, changes the demand required as compared to ambient or surface or near surface conditions.

Such improvements have included the provision of a conical platform for the diaphragm to provide a varying effective area and permit the diaphragm to function as an exhaust valve, as in U.S. Patent No. 4,147,176 to Christianson. U.S. Patent No. 4,147,176 also provides an aspirator opening downstream of the valve in the regulator to direct the airflow, and in one embodiment provides for adjustment of the direction of the airflow by the user. However, in the arrangement disclosed in the patent, the user may adjust the direction of the airflow to obtain a favorable breathing demand during one portion of the breathing cycle, but in so doing may cause misadjustment, uncomfortable or even difficult operation during another portion of the breathing cycle.

Another attempted improvement is disclosed in U.S. Patent No. 4,796,618 to Garraffa, in which an

adjustable flow vane is provided in the flow of air toward the mouthpiece to deflect a portion of that flow toward or away from the mouthpiece. In the arrangement disclosed in Patent No. 4,796,618, the vane can be adjusted between extremes by the user to substantially defeat the assisting effect of the directing of the airflow on the breathing demand required of the user. Such defeat of the assisting effect can cause uncomfortable breathing demand or difficulty in breathing by the user. A disadvantage of this arrangement is that the deflecting of a portion of the main air stream away from the mouthpiece may impede the delivery of air to the user.

Therefore, there is a need for adjusting apparatus for demand breathing systems which provides for selectively assisting the breathing demand of the user during substantially all of the breathing cycle, and which provides for selective adjustment by the user of the demand requirement and smooth operation of the system during its use.

An object of the present invention is the provision of adjusting apparatus for a demand breathing system which provides for adjustment over a limited range of the demand requirement of the user, which is readily adjustable by the user during use of the system and which reduces the possibility of extreme adjustment which may cause unbalance or difficulty to the user in using the system.

This and other objectives of the invention are achieved by providing adjusting apparatus in connection with a second stage regulator whereby the amount of force required to open or crack the valve and a portion of flow of air from the valve may be selectively adjusted to assist the user in comfortable breathing required by that user under conditions then present.

Accordingly, the present invention provides a second stage diving regulator having a diaphragm, an air inlet valve, a mouthpiece tube, an air inlet valve stem retaining means positioned within the regulator for retaining a portion of an adjustable spring biasing means:

a. said stem retaining means being configured for retaining a portion of an air inlet valve stem movably therewithin, and for forming a chamber with the portion of the valve stem retained therein for receiving a flow of air from the valve stem for pneumatically biasing the valve stem toward a valve seat, thereby balancing the position of the valve stem between the retaining means and the valve seat and restraining the opening of the air inlet valve when the valve stem is not in contact with the valve seat, and

b. air injector means mounted in the regulator, coupled to the air inlet valve and being rotatable and directionally adjustable between a first position toward the mouthpiece tube and away from the diaphragm and a second position toward the diaphragm and away from the mouthpiece tube for adjusting the pressure of air flowing from the air

inlet valve to the mouthpiece tube to adjust the pressure at the inlet valve side of the diaphragm, thereby selectively adjusting the position of the diaphragm to control the amount of breathing effort required of the user to open the air inlet valve,

characterised in that rotatable adjusting means accessible externally of the regulator are provided for axially adjusting the stem retaining means and for adjusting said air injector means within the regulator, the air injector means being disposed relative to the air inlet valve to supply and direct a flow of air separate from the main flow of air from the air inlet valve.

Further, according to another aspect of the present invention, there is provided an air injector device for a second stage regulator for a user demand breathing system, the regulator including a diaphragm, a mouthpiece tube and an air inlet supply valve, said air injector device comprising:

- a. air injector means mounted in the regulator and including a tube having an inlet pneumatically coupled to the air inlet supply valve to receive a flow of air therefrom and having an outlet intermediate its ends, said injector means being directionally adjustable, characterised by said air injector means being pneumatically coupled to the air inlet supply valve for supplying and directing a flow of air separate from the main flow of air from the air inlet valve; and
- b. rotatable adjusting means accessible externally of the regulator and connected to said air injector means for adjusting said air injector tube within the regulator between a first position whereby the flow of air therefrom is directed toward the mouthpiece tube and away from the diaphragm, and a second position whereby the flow of air therefrom is directed toward the diaphragm and away from the mouthpiece tube, thereby adjusting the pressure of air flowing from the air inlet valve to the mouthpiece tube to adjust the pressure at the inlet valve side of the diaphragm, thereby selectively controlling the amount of breathing effort required of the user to open the air inlet valve.

The preferred embodiment of this invention will now be described by way of example, with reference to the drawings accompanying this specification in which:

FIG. 1 is a side view, partially in cross-section, of the present invention.

FIG. 2 is a view substantially similar to FIG. 1 showing the apparatus of the present invention adjusted into another position.

FIG. 3 is a sectional view of a regulator having the apparatus of the present invention and being taken along line 3-3 of FIG. 1 and in the direction indicated generally.

Referring now to the drawings, and in particular to FIGS. 1-3, there is shown a regulator 10 on which is mounted a mouthpiece tube 12, which may be integral with the regulator 10. A mouthpiece (not shown) is secured to mouthpiece tube 12 and sealed against fluid leakage as is known in the art. In a demand breathing system, regulator 10 is pneumatically coupled with a tank (not shown) of air or other breathable gaseous mixture (hereafter referred to as "air" for brevity) under pressure through a first valve (not shown) usually mounted on the tank. Air from the tank and first valve is conveyed to regulator 10 by means of a conduit 14, which can be a flexible tube or hose, having a swaging or flange 15 and secured to regulator 10 by a retaining cap 16 having a corresponding shoulder 17 (FIG. 3). The tank is usually supported on the back of the user, and regulator 10 positioned with the mouthpiece in the mouth of the user with the conduit 14 extending therebetween.

Regulator 10 includes a diaphragm 18 mounted therein and supported by a housing 20 to retain diaphragm 18 while permitting it to deflect in response to changes in air pressure on the air inlet side of diaphragm 18, i.e., the side facing mouthpiece tube 12. Diaphragm 18 and housing 20 are enclosed by a cover 22, with openings (not shown) to permit exhausted air to escape from regulator 10 and to permit fluid from the surroundings, e.g. water if the breathing system is used for diving, to enter so as to exert pressure on the opposite side of the diaphragm 18. Cover 22 is preferably flexible, in part for a purpose to be hereafter described. Diaphragm 18 can also include an exhaust valve or portion 24 which can be deflected by air pressure on the air inlet side of diaphragm 18 after diaphragm 18 has been deflected away from mouthpiece tube 12 to the fullest extent. Diaphragm 18 can include a port 26 to permit the air on the inlet side of diaphragm 18 to pass there-through to exert pressure on portion 24.

Regulator 10 further includes a lever 28 which has one end position 30 normally abutting a portion of diaphragm 18 so that lever 28 moves in response to the movement of diaphragm 18. The function of lever 28 hereinafter will be described in greater detail.

Regulator 10 includes air inlet valve 32 which desirably is aligned and coupled with conduit 14 within valve housing 34. The end of housing 34 adjacent conduit 14 supports a valve seat 36 against which valve stem 38 is normally held by means of a biasing spring 40, and is movable within housing 34 away from seat 36 against the force of spring 40. Valve seat 36 and a valve seat retainer 37 are formed of metal so that the parts receiving relatively high pressure air from conduit 14 will withstand that pressure without deforming as might occur if those components were of plastic. In this manner, housing 34, being of rigid plastic, is not subjected to the relatively high pressure air from conduit 14. Valve stem 38 is connected to lever 28 so that deflection of diaphragm 18 toward mouthpiece 12 will cause lever 28 to deflect and move valve stem 38 away from seat 36, and subse-

quent deflection of diaphragm 18 in the opposite direction will allow lever 28 to return to its normal position, allowing valve stem 38 to return to its normal position against seat 36. Valve seat 36 is secured to retainer 37 by relatively fine screw threads 37', whereby advancing or retracting seat 36 with respect to retainer 37 will initially position or set the lever 28 and the point within housing 20 at which lever 28 engages diaphragm 18. In addition, by removing cap 16, conduit 14, and retainer 37, valve seat 36 can be replaced by unscrewing the latter from retainer 37.

When valve stem 38 is moved away from seat 36, air from conduit 14 passes between seat 36 and the end portion 42 of stem 38 into the cavity 44 formed by housing 34. End portion 42 is preferably made of non-metallic material to cushion the closing or seating of stem 38 against seat 36, and includes a central bore 39 through which a portion of the stream of air from conduit 14 may pass. The remainder of stem 38 also includes a central bore 39' through which the stream of air flowing through the bore 39 in end portion 42 may pass. The opposite end portion of stem 38 is retained in a retainer 46, for axial movement within retainer 46. Retainer 46 also retains and exerts pressure on biasing spring 40, and forms a chamber 48 which receives the stream of air flowing through the bore 39' of stem 38 for a purpose to be hereafter described.

The adjusting apparatus of the present invention includes an adjusting mechanism for axially moving retainer 46 toward and away from seat 36 to provide for adjustment of the tension of biasing spring 40 by the user during use of the breathing system. As shown, the adjusting mechanism includes a non-metallic shaft 50 rotatably supported within housing 34 and extending therefrom, and a non-metallic knob 52 mounted to the portion of shaft 50 extending externally from housing 34 and secured to shaft 50 for rotation therewith by means of splines 54 on shaft 50 engaging mating splines on knob 52. The opposite end portion of shaft 50 is threaded and mates with internal threads 56 formed on the end portion of retainer 46. Knob 52 is mounted so that it is not freeably rotatable nor extends from a thin shaft, and thereby cannot be readily accidentally rotated or caught on structures which may otherwise occur.

Upon purposeful adjustment of knob 52 by the user, the shaft 50 rotates within the housing 34, but does not move axially. Instead, the retainer 46, through its threaded engagement with the shaft 50, moves axially within the cavity 44 to adjust tension on the spring 40. In the preferred embodiment, the retainer 46 is provided with splines 57 which are engaged in a track 58 formed in the housing 34. If rotation of knob 52 is attempted to advance retainer 46 toward valve seat 36 beyond the limits of threads 56, the threads will eventually disengage, and retainer 46 will not advance further, as spring 40 will hold retainer 46 against the end of shaft 50. Upon subsequent adjustment in the opposite direction, the threads will reengage due to the action on the retainer of spring 40. Overadjustment by the user which would

fully retract retainer 46 away from spring 40 and stem 38 is prevented, since full retraction of the retainer 46 would open the valve 32 permitting the free flow of air from conduit 14 to mouthpiece 12 and thus alerting the user to this condition. Thus, by rotation of the knob 52, the tension on biasing spring 40 can be selectively increased or decreased, thereby adjusting the balancing of valve stem 38 between retainer 46 and seat 36, and through the adjustment of the tension on biasing spring 40 restraining the opening of air inlet valve 32 when stem 38 is not in contact with seat 36. The adjusting mechanism provides for limiting the adjustment, while preventing its being damaged by attempted over-adjustment.

The adjusting apparatus of the present invention further includes an adjustable air injector device, which as best shown in FIGS. 1 and 2, is generally designated by numeral 60. Air injector device 60 is shown as including an air injector tube 62 with its open end or inlet 64 pneumatically coupled with cavity 44 of air inlet valve housing 34. It should be noted that the inlet 64 is pneumatically coupled to the cavity 44 separately from the main flow of air. Tube 62 has an outlet 66 intermediate its ends, and is closed at its upper end opposite inlet 64. The outlet 66 is preferably a small circular opening of approximately 3.2 mm (1/8 inch) diameter to increase the flu velocity therethrough relative to the velocity of air directed at the mouthpiece tube 12 from the cavity 44. Tube 62 is integral with a knob 68 external to regulator 10 so as to be adjustably rotatable with the knob, and the tube and knob are retained by a clip or snap ring 70.

FIG. 1 shows air injector tube 62 in a first position with outlet 66 directed toward mouthpiece tube 12 and away from diaphragm 18. FIG. 2 shows air injector tube 62 in a second position with outlet 66 directed toward diaphragm 18 and away from mouthpiece tube 12. It is contemplated that knob 68 may be adjusted to a third position intermediate the first and second positions, wherein air injector tube 62 is positioned with outlet 66 directed toward the side, i.e. directed toward neither diaphragm 18 nor mouthpiece tube 12. It should be noted here that although three basic positions have been described for the injector tube 62, the tube is infinitely adjustable between the positions shown in FIGS. 1 and 2.

Additionally, air inlet valve housing 34 includes an outlet port 72 leading and directed to mouthpiece tube 12 through which the main stream of air from air inlet valve cavity 44 flows directed toward mouthpiece tube 12. The port 72 is preferably constructed as an elongate rectangle, and upper edge of port 72 is defined by a wedge shaped member 74 which directs the main stream of air from cavity 44 toward mouthpiece tube 12. The narrow port 72 as compared to the volume of cavity 44 tends to create a venturi effect upon the main stream of air as it flows through port 72 and into mouthpiece tube 12, assisting the inhalation of the stream of air by the user.

In operation, the air inlet valve 32 is initially closed by the bias of spring 40 and assisted by the portion of air flow from conduit 14 passing through the central bore of stem 38, entering chamber 48 and impinging upon the end of stem 38 opposite seat 36. Upon inhalation by the user, air is withdrawn from the cavity formed within regulator 10 between diaphragm 18 and mouthpiece tube 12, causing diaphragm 18 to deflect toward mouthpiece tube 12, and forcing lever 28 to deflect, moving valve stem 38 away from seat 36. The main stream of air from conduit 14 flows between seat 36 and stem 38, through cavity 44 and outlet 72 into mouthpiece tube 12 and through the mouthpiece to the user.

The effort or the amount of demand of the inhalation of the user needed to open or crack the valve 32 can be adjusted by the user by adjusting knob 52, causing the retainer 46 to increase or decrease the tension on spring 40. An increase in the tension of spring 40 causes a greater inhalation demand on the user to open valve 32, while a decrease in the tension on spring 40 will cause the opposite result. Advantageously, the splined shaft 50 and knob 52 arrangement and positive threaded connection between shaft 50 and retainer 46 prevents accidental adjustment from being made without purposeful adjustment of knob 52, and the valve stem 38 is cushioned against casual or accidental misadjustments. Additionally, having the knob 52, shaft 50 and retainer 46 of non-metallic material reduces unintended changes to the latter which may result if those components were metallic, due in large part to changes in temperature, for example when the system is used for diving into cold water or water having lowered temperatures at the greatest depth of the dive.

The presence of the adjustable air injector device 60, in the preferred embodiment including injector tube 62 and the knob 68, permits adjustment by the user to assist or resist the effort or demand required to effect operation of the regulator. When the tube 62 is in the first position with outlet 66 directed toward mouthpiece tube 12, the stream of air passing through inlet 64 and out the outlet 66 is added at relatively higher velocity to the main stream of air passing through port 72, thus injecting the air into the user's mouth. In addition, the action of the tube 62 creates a suction on the air inlet side of diaphragm 18 and a consequent early deflection of the diaphragm and relatively effortless opening of air inlet valve 32 upon inhalation.

With the tube 62 in the second position, the stream of air from inlet 64 is directed to diaphragm 18, increasing the pressure on the air inlet side of the diaphragm, or counteracting the suction due to inhalation, and thereby requiring a greater inhalation effort or demand by the user to open air inlet valve 32. The most desirable position of the injector tube 62 for most users, is the third position, in which the air stream is directed toward neither mouthpiece tube 12 nor diaphragm 18, and a normal demand or inhalation effort is required to open air inlet valve 32. As a user encounters increased ambient pressure, for example, when a relatively high current

is encountered, adjustment of the injector tube can be made by turning knob 68 to rotate the injector tube 62 with outlet 66 increasingly directed toward the diaphragm 18 to increase the pressure in the regulator to offset the increased ambient pressure on the opposite or outwardly facing side of the diaphragm. However, where greater air pressure to the mouthpiece 12 is desired, as when a diver descends to a greater depth, the knob can be rotated in the opposite direction to approach or reach the position illustrated in FIG. 1. As only a constant portion of the air from cavity 44 is tapped by the air injector tube 62, gradual changes in user breathing effort can be effected, unlike the attempts at improvement disclosed in the prior art.

Occasionally, the user may find it necessary to clear the regulator of water and/or to obtain a quantity of air rapidly, as when the user has not used the breathing system for some period during a dive. To fulfill such requirements, a purge mechanism is included in regulator 10. In particular, a purge button 76 is provided supported by diaphragm 18, which button may also be used as the abutting surface in diaphragm 18 to abut portion 30 of lever 28. Cover 22 is made flexible, in part to permit the user to easily depress cover 22 above purge button 76 to depress the button. When purge button 76 is depressed, lever 28 is directly deflected, opening air inlet valve 32 and causing a surge of air from conduit 14 to enter cavity 44 and exit through port 72 to mouthpiece tube 12 and hence to the user. At the same time, the depression of diaphragm 18 by depressing purge button 76 decreases the volume of the space between diaphragm and mouthpiece tube 12, forcing air and water within that space to be exhausted through port 26 and the edge of portion 24 of the diaphragm as portion 24 is deflected from its seat by the fluid pressure within the described space.

While a particular embodiment of the breathing regulator having air injector feature of the invention has been shown and described, it will be appreciated by those skilled in the art that changes and modifications may be made thereto without departing from the invention in its broader aspects and as set forth in the following claims.

Claims

1. A second stage diving regulator (10) having a diaphragm (18), an air inlet valve (32), a mouthpiece tube (12), an air inlet valve stem retaining means (46) positioned within the regulator (10) for retaining a portion of an adjustable spring biasing means (40):

- a. said stem retaining means (46) being configured for retaining a portion of an air inlet valve stem (38) movably therewithin, and for forming a chamber (48) with the portion of the valve stem (38) retained therein for receiving a flow of air from the valve stem (38) for pneumatically

biasing the valve stem toward a valve seat (36), thereby balancing the position of the valve stem (38) between the retaining means (46) and the valve seat (36) and restraining the opening of the air inlet valve (32) when the valve stem (38) is not in contact with the valve seat (36), and

b. air injector means (60) mounted in the regulator, coupled to the air inlet valve (32) and being rotatable and directionally adjustable between a first position toward the mouthpiece tube (12) and away from the diaphragm (18) and a second position toward the diaphragm (18) and away from the mouthpiece tube (12) for adjusting the pressure of air flowing from the air inlet valve (32) to the mouthpiece tube (12) to adjust the pressure at the inlet valve side of the diaphragm (18), thereby selectively adjusting the position of the diaphragm (18) to control the amount of breathing effort required of the user to open the air inlet valve (32),

characterised in that rotatable adjusting means (52,68) accessible externally of the regulator are provided for axially adjusting the stem retaining means (46) and for adjusting said air injector means (60) within the regulator (10), the air injector means (60) being disposed relative to the air inlet valve (32) to supply and direct a flow of air separate from the main flow of air from the air inlet valve (32).

2. A regulator according to claim 1, wherein retainer adjusting means (50,52) move the air inlet valve stem retaining means (46) toward and away from the air inlet valve seat (36), whereby the tension on the adjustable spring biasing means (40) can be selectively increased or decreased by the user during use of the system.
3. A regulator according to claim 1 or claim 2, wherein said air injector means (60) is further characterized by a tube (62) having an inlet (64) pneumatically coupled to the air inlet supply valve housing (34) to receive a flow of air therefrom and having an outlet (66) intermediate its ends, and said tube (62) being directionally adjustable.
4. A regulator according to claim 3, wherein the axis of said tube (62) is normal to the axis of the air inlet supply valve housing (34).
5. A regulator according to claim 3 or claim 4, further characterized by said outlet (66) of said tube (62) being dimensioned to inject air at a high velocity relative to the main flow.
6. A regulator according to claim 3, claim 4 or claim 5, wherein the rotatable adjusting means (68) is further characterized by a knob selectively rotatably

mounted on the regulator device (10) and connected with said tube (62) so as to be rotatable therewith.

7. A regulator according to claim 2 or any one of claims 3 to 6 when dependent on claim 2, wherein the retainer adjusting means (50,52) is further characterized by a non-metallic shaft (50) rotatably journaled in the air inlet valve housing (34) and extending externally from said housing, said shaft (50) having threads engaging mating threads (56) on retainer means (46), and a non-metallic knob (52) mounted on said shaft (50) externally of said housing (34) and rotatable only with said shaft (50), whereby rotation of said knob (52) causes the threads on said shaft to rotate and axially move the retainer means (46) toward and away from the air inlet valve seat (36).
8. A regulator according to claim 2 or any one of claims 3 to 6 when dependent on claim 2, wherein the retainer adjusting means (50,52) is further characterized by a shaft (50) having screw threads, and said retaining means (46) having screw threads (56) mating with the screw threads of said shaft (50), said shaft being rotatable with respect to said retaining means (46), whereby adjustment of the retainer adjusting means (52) toward the valve seat (36) causes unthreading of said retaining means (46) with respect to said shaft, and upon disengagement of said threads of said shaft (50) from said threads (56) of said retaining means (46), no further adjustment of the retaining means (46) toward said valve seat (36) can be made, and the retaining means (46) is held against the end of said shaft (50) by the spring biasing means (40).
9. An air injector device for a second stage regulator (10) for a user demand breathing system, the regulator including a diaphragm (18), a mouthpiece tube (12) and an air inlet supply valve (32), said air injector device comprising:
 - a. air injector means (60) mounted in the regulator (10) and including a tube (62) having an inlet (64) pneumatically coupled to the air inlet supply valve (32) to receive a flow of air therefrom and having an outlet (66) intermediate its ends, said injector means (60) being directionally adjustable, characterised by said air injector means (60) being pneumatically coupled to the air inlet supply valve (32) for supplying and directing a flow of air separate from the main flow of air from the air inlet valve (32); and
 - b. rotatable adjusting means (68) accessible externally of the regulator and connected to said air injector means (60) for adjusting said

air injector tube (62) within the regulator between a first position whereby the flow of air therefrom is directed toward the mouthpiece tube (12) and away from the diaphragm (18), and a second position whereby the flow of air therefrom is directed toward the diaphragm (18) and away from the mouthpiece tube (12), thereby adjusting the pressure of air flowing from the air inlet valve (32) to the mouthpiece tube (12) to adjust the pressure at the inlet valve side of the diaphragm (18), thereby selectively controlling the amount of breathing effort required of the user to open the air inlet valve (32).

10. An air injector device according to claim 9, wherein said tube (62) has an outlet (66) dimensioned to inject air at a high velocity relative to the main flow.

Patentansprüche

1. Sekundärer Tauchregulator (10) mit einer Membran (18), einem Lufteinlaßventil (32), einem Mundstückrohr (12), einer Haltevorrichtung (46) für den Lufteinlaßventilschaft, die innerhalb des Regulators (10) positioniert ist um ein Teilstück einer einstellbaren Federvorbelastungsvorrichtung (40) zu halten:

a) wobei die genannte Schaffthaltevorrichtung (46) ausgelegt ist um ein Teilstück eines Lufteinlaßventilschafts (38) darin beweglich zu halten und mit dem darin gehaltenen Teilstück des Ventilschafts (38) eine Kammer (48) zu bilden um einen Luftstrom aus dem Ventilschaft (38) aufzunehmen zur pneumatischen Vorbelastung des Ventilschafts auf einen Ventilsitz (36) hin, wodurch die Position des Ventilschafts (38) zwischen der Haltevorrichtung (46) und dem Ventilsitz (36) ausgeglichen wird und das Öffnen des Lufteinlaßventils (32) unterdrückt wird, wenn sich der Ventilschaft (38) nicht in Kontakt mit dem Ventilsitz (36) befindet und

b) mit einer Luftinjektionsvorrichtung (60), die im Regulator montiert ist, die an das Lufteinlaßventil (32) angeschlossen ist und die drehbar und richtungsmäßig einstellbar ist zwischen einer ersten Position in Richtung auf das Mundstückrohr (12) und weg von der Membran (18) und einer zweiten Position hin zu der Membran (18) und weg vom Mundstückrohr (12) zum Einstellen des Drucks der Luft, die aus dem Lufteinlaßventil (32) zum Mundstückrohr (12) strömt, um den Druck an der Einlaßventilseite der Membran (18) einzustellen, wodurch selektiv die Position der Membran (18) eingestellt wird, um die Menge an Atemanstrengung zu kontrollieren, die vom Benutzer verlangt wird, um das Lufteinlaßventil (32) zu öffnen,

dadurch gekennzeichnet, daß drehbare Einstellvorrichtungen (52, 68), die von außerhalb des Regulators zugänglich sind, vorgesehen sind zur axialen Einstellung der Schaffthaltevorrichtung (46) und für die Einstellung der genannten Luftinjektionsvorrichtung (60) innerhalb des Regulators (10), wobei die Luftinjektionsvorrichtungen (60) relativ zu dem Lufteinlaßventil (32) so angeordnet ist, daß ein Luftstrom separat vom Hauptstrom der Luft aus dem Lufteinlaßventil (32) geliefert und gelenkt werden kann.

2. Regulator gemäß Anspruch 1, bei dem die Halte-einstellvorrichtungen (50, 52) die Haltevorrichtung (46) für den Lufteinlaßventilschaft zum Lufteinlaßventilsitz (36) hin- und von dem Lufteinlaßventilsitz (36) wegbewegen, wobei die Spannung der einstellbaren Federvorbelastungsvorrichtung (40) durch den Benutzer während der Verwendung des Geräts selektiv erhöht oder verringert werden kann.

3. Regulator gemäß Anspruch 1 oder Anspruch 2, bei dem die genannte Luftinjektionsvorrichtung (60) weiterhin gekennzeichnet ist durch ein Rohr (62) mit einem Einlaß (64), der pneumatisch an das Lufteinlaßzuführungsventilgehäuse (34) angeschlossen ist, um einen Luftstrom daraus aufzunehmen, und einem Auslaß (66) zwischen seinen Enden und wobei das genannte Rohr (62) richtungsmäßig einstellbar ist.

4. Ein Regulator gemäß Anspruch 3, bei dem die Achse des genannten Rohrs (62) senkrecht zur Achse des Lufteinlaßzuführungsventilgehäuses (34) ist.

5. Regulator gemäß Anspruch 3 oder Anspruch 4, der weiterhin dadurch gekennzeichnet ist, daß der genannte Auslaß (66) des genannten Rohrs (62) so ausgelegt ist, daß Luft mit einer hohen Geschwindigkeit in bezug auf den Hauptstrom injiziert wird.

6. Regulator gemäß Anspruch 3, Anspruch 4 oder Anspruch 5, bei dem die drehbare Einstellvorrichtung (68) weiterhin gekennzeichnet ist durch einen Knopf, der selektiv drehbar auf der Regulatorvorrichtung (10) montiert ist und der an das genannte Rohr (62) so angeschlossen ist, daß es mit diesem drehbar ist.

7. Regulator gemäß Anspruch 2 oder einem der Ansprüche 3 bis 6, wenn Abhängigkeit von Anspruch 2 besteht, wobei die Haltereinstellvorrichtung (50, 52) weiterhin gekennzeichnet ist durch eine nichtmetallische Welle (50), die im Lufteinlaßventilgehäuse (34) drehbar gelagert ist und die sich von dem genannten Gehäuse nach außen erstreckt, wobei die genannte Welle (50) Gewinde

aufweist, die in passende Gewinde (56) auf der Haltevorrichtung (46) eingreifen, und durch einen nichtmetallischen Knopf (52), der auf der genannten Welle (50) außerhalb des genannten Gehäuses (34) montiert ist und der ausschließlich mit der genannten Welle (50) drehbar ist, wobei eine Drehung des genannten Knopfes (52) die Gewinde auf der genannten Welle dazu veranlaßt, sich zu drehen und die Haltevorrichtung (46) axial hin zu und weg von dem Lufteinlaßventilsitz (36) zu bewegen.

8. Regulator gemäß Anspruch 2 oder einem der anderen Ansprüche 3 bis 6, wenn Abhängigkeit von Anspruch 2 besteht, bei dem die Haltereinstellungsvorrichtung (50, 52) weiterhin gekennzeichnet ist durch eine Welle (50) mit Schraubengewinden und dadurch, daß die genannte Haltevorrichtung (46) Schraubengewinde (56) hat, die mit den Schraubengewinden der genannten Welle (50) zusammenpassen, wobei die genannte Welle drehbar ist in bezug auf die genannte Haltevorrichtung (46), wobei die Einstellung der Haltereinstellungsvorrichtung (52) hin zum Ventilsitz (36) ein Herauswinden der genannten Haltevorrichtung (46) in bezug auf die genannte Welle verursacht, und wobei bei einem Ausrücken der genannten Gewinde der genannten Welle (50) aus den genannten Gewinden (56) der genannten Haltevorrichtung (46) keine weitere Einstellung der Haltevorrichtung (46) hin zu dem genannten Ventilsitz (36) gemacht werden kann und die Haltevorrichtung (46) durch die Federvorbelastungsvorrichtung (40) gegen das Ende der genannten Welle (50) gehalten wird.

9. Luftinjektionsvorrichtung für einen sekundären Regulator (10) für ein Atemgerät mit Benutzeranforderung, bei der der Regulator eine Membran (18), ein Mundstückrohr (12) und ein Lufteinlaßzuführungsventil (32) umfaßt, wobei die genannte Luftinjektionsvorrichtung enthält:

- a) eine Luftinjektionsvorrichtung (60), die im Regulator (10) montiert ist und ein Rohr (62) aufweist mit einem Einlaß (64), der pneumatisch an ein Lufteinlaßzuführungsventil (32) angeschlossen ist, um einen Luftstrom daraus aufzunehmen, und einem Auslaß (66) zwischen dessen Enden, wobei die Injektionsvorrichtung (60) richtungsmäßig einstellbar ist, gekennzeichnet dadurch, daß die genannte Luftinjektionsvorrichtung (60) pneumatisch an das Lufteinlaßzuführungsventil (32) angeschlossen ist zur Lieferung und Lenkung eines Luftstroms separat von dem Hauptluftstrom aus dem Lufteinlaßventil (32); und
- b) durch eine drehbare Einstellvorrichtung (68) die von außerhalb des Regulators zugänglich

ist und die an die genannte Luftinjektionsvorrichtung (60) angeschlossen ist zur Einstellung des genannten Luftinjektionsrohrs (62) innerhalb des Regulators zwischen einer ersten Position, bei der der Luftstrom daraus in Richtung auf das Mundstückrohr (12) und weg von der Membran (18) gerichtet ist, und einer zweiten Position, bei der der Luftstrom daraus auf die Membran (18) und weg von dem Mundstückrohr (12) gerichtet ist, wodurch der Druck der Luft eingestellt wird, die aus dem Lufteinlaßventil (32) zu dem Mundstückrohr (12) strömt, um den Druck an der Einlaßventilseite der Membran (18) einzustellen, wodurch selektiv die Menge an Atemanstrengung kontrolliert wird, die vom Benutzer zum Öffnen des Lufteinlaßventils (32) verlangt wird.

10. Eine Luftinjektionsvorrichtung gemäß Anspruch 9, bei der das genannte Rohr (62) einen Auslaß (66) hat, der zur Injizierung von Luft mit einer hohen Geschwindigkeit in bezug auf den Hauptstrom ausgelegt ist.

Revendications

1. Régulateur secondaire de plongée (10) comportant une membrane (18), une valve d'entrée d'air (32), un tube d'embout buccal (12), un moyen formant cage (46) pour une tige de la valve d'entrée d'air (46), positionné dans le régulateur (10) pour retenir une partie d'un moyen de rappel à ressort réglable (40) :

a) le moyen formant cage (46) pour la tige étant configuré pour retenir de manière mobile dans celui-ci une partie d'une tige (38) de la valve d'entrée d'air, et pour former une chambre (48) avec la partie de la tige (38) de la valve qui y est retenue, pour recevoir un écoulement d'air provenant de la tige (38) de la valve, pour rappeler pneumatiquement la tige de la valve vers un siège (36) de la valve, de façon à équilibrer la position de la tige (38) de la valve entre le moyen formant cage (46) et le siège (36) de la valve et à restreindre l'ouverture de la valve d'entrée d'air (32) lorsque la tige (38) de la valve n'est pas en contact avec le siège (36) de la valve, et

b) des moyens injecteurs d'air (60) montés dans le régulateur, couplés à la valve d'entrée d'air (32), lesquels moyens injecteurs sont rotatifs et réglables en direction entre une première position orientée vers le tube d'embout buccal (12) et à l'écart de la membrane (18) et une seconde position orientée vers la membrane (18) et à l'écart du tube d'embout buccal (12) pour régler la pression d'air s'écoulant de la valve d'entrée d'air (32) vers le tube d'embout

buccal (12) pour régler la pression du côté valve d'entrée de la membrane (18), de façon à régler sélectivement la position de la membrane (18) pour commander l'intensité de l'effort respiratoire requis de l'utilisateur pour ouvrir la valve d'entrée d'air (32),

caractérisé en ce que des moyens de réglage rotatifs (52, 68) accessibles de l'extérieur du régulateur sont prévus pour régler axialement le moyen (46) formant cage pour la tige et pour régler les moyens injecteurs d'air (60) à l'intérieur du régulateur (10), les moyens injecteurs d'air (60) étant disposés par rapport à la valve d'entrée d'air (32) pour fournir et envoyer un écoulement d'air séparé de l'écoulement d'air principal à partir de la valve d'entrée (32).

2. Régulateur selon la revendication 1, dans lequel des moyens de réglage (50, 52) de la cage déplacent le moyen (46) formant cage pour la tige de la valve d'entrée d'air vers le siège (36) de la valve d'entrée d'air et à l'écart de celui-ci, de sorte que l'utilisateur peut sélectivement augmenter ou réduire la tension sur le moyen de rappel à ressort réglable (40) pendant l'utilisation du système.
3. Régulateur selon la revendication 1 ou 2, dans lequel le moyen injecteur d'air (60) est caractérisé en outre par un tube (62) ayant une entrée (64) couplée pneumatiquement au boîtier (34) de la valve d'alimentation d'entrée d'air pour en recevoir un écoulement d'air et ayant une sortie (66) en position intermédiaire entre ses extrémités, et ledit tube (62) étant réglable en direction.
4. Régulateur selon la revendication 3, dans lequel l'axe dudit tube (62) est normal à l'axe du boîtier (34) de la valve d'alimentation d'entrée d'air.
5. Régulateur selon la revendication 3 ou 4, caractérisé en outre en ce que ladite sortie (66) du tube (62) est dimensionnée pour injecter de l'air à vitesse élevée relativement à l'écoulement principal.
6. Régulateur selon la revendication 3, 4 ou 5, dans lequel les moyens de réglage rotatifs (68) sont caractérisés en outre par un bouton monté sélectivement rotatif sur le dispositif régulateur (10) et relié avec ledit tube (62) de façon à tourner avec lui.
7. Régulateur selon la revendication 2 ou l'une quelconque des revendications 3 à 6 lorsqu'elles dépendent de la revendication 2, dans lequel les moyens de réglage de la cage (50, 52) sont en outre caractérisés par une tige non métallique (50) supportée en rotation dans le boîtier (34) de la valve d'entrée d'air et s'étendant à l'extérieur à par-

tir dudit boîtier, ladite tige (50) ayant des filets en prise avec des filets correspondants (56) sur les moyens formant cage (46), et un bouton non métallique (52) monté sur ladite tige (50) à l'extérieur du boîtier (34) et ne pouvant tourner qu'avec ladite tige (50), de sorte que la rotation du bouton (52) fait tourner les filets sur ladite tige et leur fait déplacer axialement les moyens formant cage (46) vers le siège (36) de la valve d'entrée d'air et à l'écart de celui-ci.

8. Régulateur selon la revendication 2 ou l'une quelconque des revendications 3 à 6 lorsqu'elles dépendent de la revendication 2, dans lequel les moyens (50, 52) de réglage de la cage sont caractérisés en outre par une tige (50) ayant des filets de vis, et le moyen formant cage (46) ayant des filets de vis (56) correspondant aux filets de vis de ladite tige (50), ladite tige étant rotative par rapport au moyen formant cage (46), de sorte que le réglage des moyens de réglage de la cage (52) vers le siège (36) de la valve provoque un dévissage du moyen formant cage (46) par rapport à ladite tige, et une fois les filets de ladite tige (50) dégagés de ceux (56) du moyen formant cage (46) il n'est plus possible de régler davantage les moyens formant cage (46) vers le siège (36) de la valve, et le moyen formant cage (46) est tenu contre l'extrémité de ladite tige (50) par les moyens de rappel à ressort (40).
9. Dispositif injecteur d'air pour régulateur secondaire (10) pour système de respiration fonctionnant d'après la demande de l'utilisateur, le régulateur possédant une membrane (18), un tube d'embout buccal (12) et une valve d'alimentation d'entrée d'air (32), le dispositif injecteur d'air comprenant :
 - a) des moyens injecteurs d'air (60) montés dans le régulateur (10) et incluant un tube (62) ayant une entrée (64) couplée pneumatiquement à la valve d'alimentation d'entrée d'air (32) pour en recevoir un écoulement d'air et ayant une sortie (66) en position intermédiaire entre ses extrémités, les moyens injecteurs d'air (60) étant réglables en direction, caractérisé en ce que les moyens injecteurs d'air (60) sont couplés pneumatiquement à la valve d'alimentation d'entrée d'air (32) pour fournir et envoyer un écoulement d'air séparé de l'écoulement d'air principal provenant de la valve d'entrée d'air (32); et
 - b) des moyens de réglage rotatif (68) accessibles de l'extérieur du régulateur et reliés aux moyens injecteurs d'air (60) pour régler ledit tube injecteur d'air (62) dans le régulateur entre une première position telle que l'écoulement d'air qui en provient est dirigé vers le tube d'embout buccal (12) et à l'écart de la mem-

brane (18), et une seconde position telle que l'écoulement qui en provient est dirigé vers la membrane (18) et à l'écart du tube d'embout buccal (12), de façon à régler la pression de l'air s'écoulant de la valve d'entrée d'air (32) 5 vers le tube d'embout buccal (12) pour régler la pression du côté valve d'entrée de la membrane (18), de façon à commander sélectivement l'intensité de l'effort respiratoire requis de l'utilisateur pour ouvrir la valve d'entrée d'air 10 (32).

10. Dispositif injecteur d'air selon la revendication 9, dans lequel ledit tube (62) a une sortie (66) dimensionnée pour injecter de l'air à vitesse élevée relativement à l'écoulement principal. 15

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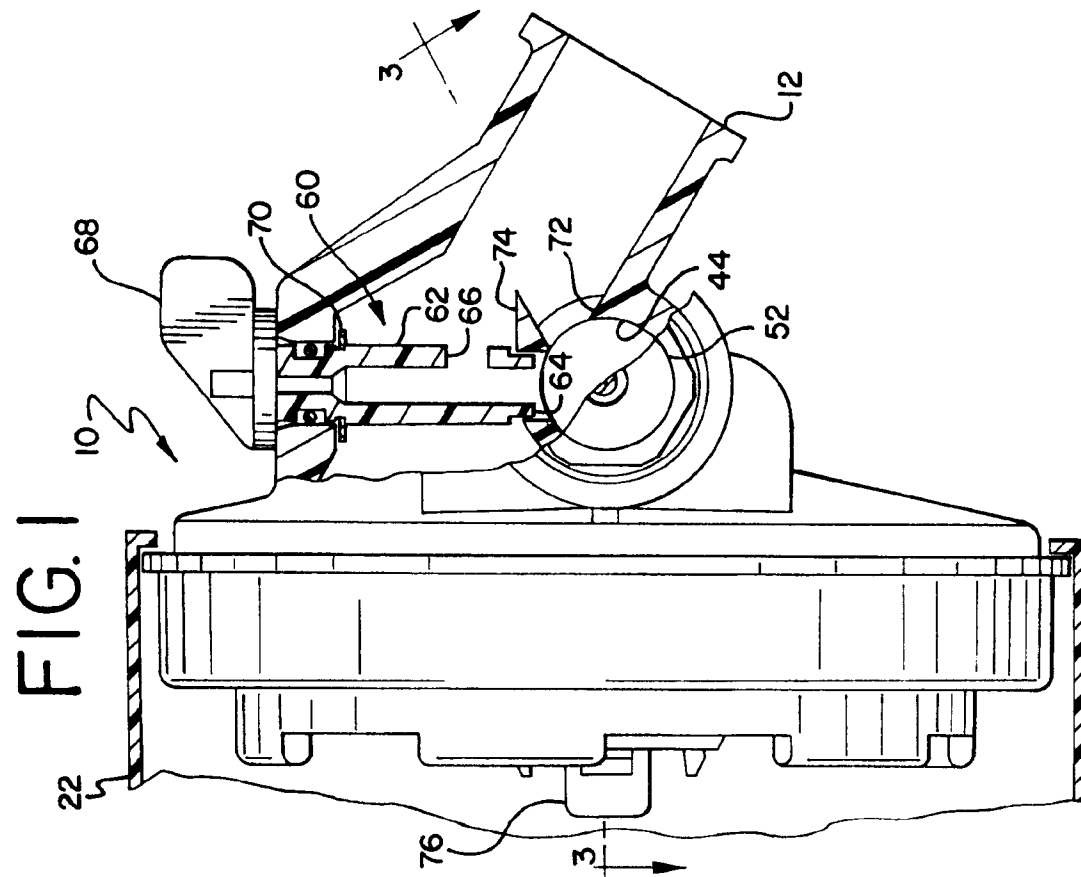
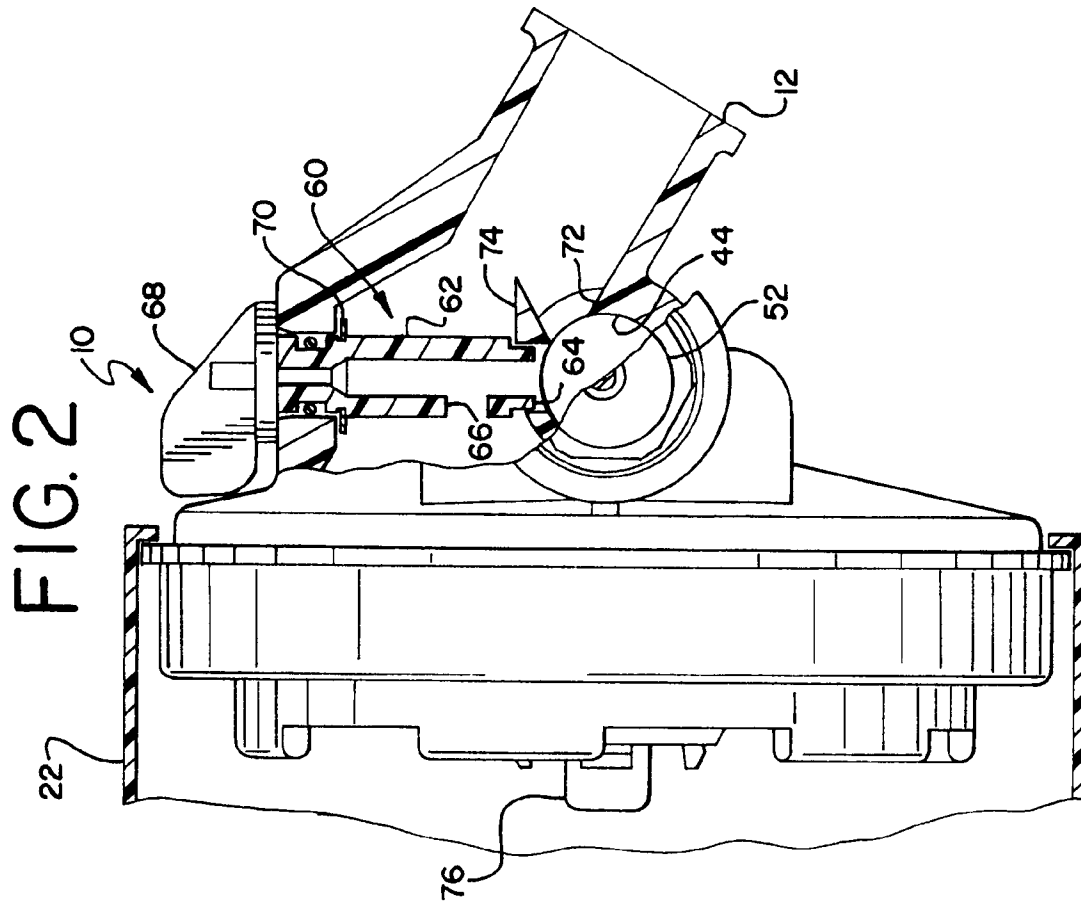


FIG. 3

