

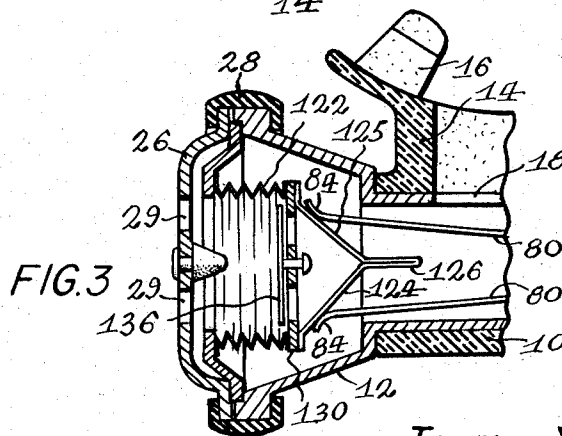
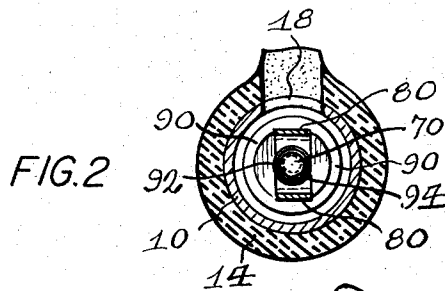
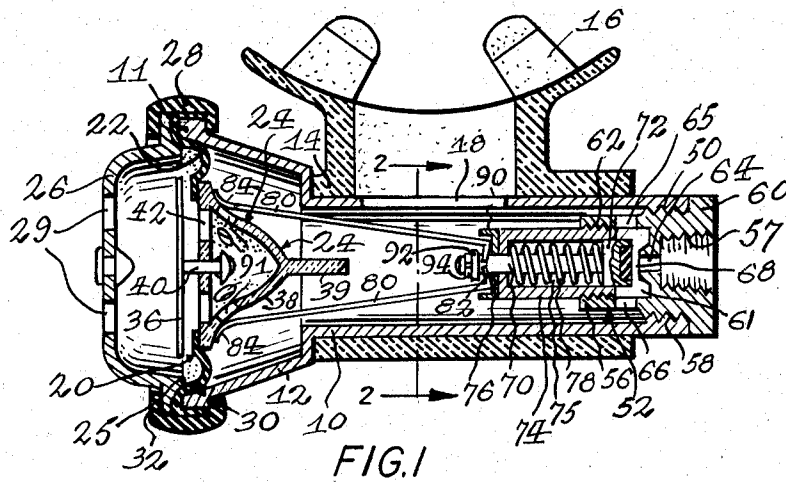
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BREATHING APPARATUS WITH CAM CONTROLLED VALVE

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BREATHING APPARATUS WITH CAM CONTROLLED VALVE

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5 Claims. (Cl. 128—142)

The present invention relates to breathing apparatus in general and more especially respiratory apparatus for deep sea diving in which a breathable gas, compressed under a high pressure inside a cylinder, is expanded to a pressure close to that of the ambient medium before being admitted into the respiratory tracts of the user through a mouth-piece placed at the junction of two distinct channels reserved, one for breathing in, the other one for breathing out.

In most known apparatus of this general type, the mouthpiece is in communication with a pressure regulator placed on the breathing in channel and provided with a deformable wall or diaphragm, the outer face of which is subjected to the pressure of the ambient medium. A valve, coupled with this diaphragm, controls the admission in the chamber of the regulator, of the gas from the cylinder and this valve is closed when the diaphragm is in its equilibrium position, i.e. when the pressure on its two faces are substantially equal. When the user breathes in, the diaphragm is depressed and opens the valve which closes again when the breathing in ceases. Expiration takes place in the ambient medium, through a valve, without going through the expansion chamber of the regulator. Expiration takes place through a different channel from breathing in.

Precautions have to be taken to avoid a spontaneous delivery of air in the ambient medium (particularly in water) when the respective positions of the diaphragm and exhaust point of air give rise to a pressure difference higher than that which operates the regulator. In some apparatus, the remedy consists in bringing back expiration to a point close to the diaphragm, through a special duct. In other apparatus, a loading of the expiration valve allows it to open only above a predetermined pressure difference. In the first case, the apparatus is bulky and the complication of the return pipe and the mounting arrangement for the expiration valve increase its price. In the second case, the counter-pressure, during expiration, is very important in certain positions and tires the diver.

To overcome these drawbacks apparatus has been designed wherein the stream of expired gas alone goes through the chamber adjacent the diaphragm, while the stream of breathed in gas goes directly from the gas supply to the mouth-piece without going through the chamber.

The United States Patent 2,747,572, Emile Gagnan, May 29, 1956, shows an improved form of this type of apparatus in detail. In the construction disclosed in the U.S. Patent 2,727,572, the controlling diaphragm is connected to the gas supply valve by a single lever whereby movement of the diaphragm, caused by the inhalation of the diver is transmitted to the gas supply valve.

The present invention aims to provide an improved construction of this type of apparatus wherein means are provided to give a symmetrical cam action through the movements of the controlling diaphragm directly to the gas supply valve. In accordance with the present invention, this is accomplished by providing a casing having

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the gas inlet valve at one end and the controlling flexible diaphragm at the other end in axial alignment. The mouthpiece is positioned on the side of the casing between the inlet valve and the diaphragm. The controlling diaphragm which has a relatively reduced diameter and increased displacement consists of a first flexible skirt of generally annular formation with the outer periphery secured to the periphery of the one end of the casing and the inner periphery secured to the periphery of an exhaust valve supporting body of light material, for example, plastic or the like. The flexible skirt portion of the diaphragm is folded on itself between the central exhaust valve supporting body and casing to provide the desired displacement capacity. In a preferred construction the exhaust valve supporting portion of the diaphragm is hollow and formed to provide a tapering cam body with an annular rim adapted to support the inner peripheral rim of the flexible skirt of the diaphragm. The cam body includes a central extension from the apex which is directed inwardly of the casing towards the gas inlet valve and between the upper ends of a plurality of valve actuating levers extending through the casing to a connection with the gas inlet valve.

The gas inlet valve includes a main stem protruding from the valve box and having an outstanding head or collar. One end of each of the valve actuating levers engages with the tapered sides of the rigid central diaphragm portion, while the opposite ends are provided with inwardly extending portions which fit beneath the outstanding valve stem head and are loosely retained in this position.

With this arrangement, displacement of the diaphragm inwardly through the inhalations of the user causes the rigid central portion to bear against and spread the upper ends of the levers apart in a cam action which causes a rocking of the opposite ends into contact with the valve stem head and thus opening the valve against the influence of the usual valve closing spring.

This construction provides a smooth cam action to the valve actuating levers which, as will be appreciated, can be predetermined by the contour of the rigid body of the central diaphragm portion.

Having thus generally described the nature of the invention, particular reference will be made to the accompanying drawings wherein there is shown, by way of illustration a preferred embodiment thereof, and in which:

Figure 1 is a sectional view in side elevation of a breathing apparatus embodying the valve controlling means of the invention.

Figure 2 is a trans-axial section of the construction shown in Figure 1 to illustrate the preferred arrangement of the valve actuating levers in more detail.

Figure 3 is a partial sectional view corresponding to Figure 1 to illustrate an alternate form of flexible diaphragm and cam body.

In the embodiment shown, the apparatus consists of a main tubular casing 10, provided at one end with an axial enlargement 12 and on which is mounted by a sleeve 14, the usual mouthpiece 16. A port 18 is provided in the casing 10 which communicates with the mouth piece 16. Preferably casing 10 and sleeve 14 are moulded from suitable plastic material.

A diaphragm assembly 20 is mounted on and masks the enlargement 12 of the casing and consists of a flexible skirt portion 22 and a central rigid cam body 24, supporting an exhaust valve 36. The flexible skirt portion 22 is secured about the outer periphery to the casing portion 12 by engagement between the peripheral rim 11 of the portion 12 and the correspondingly shaped rim or flange 25 of a cover 26. The cover 26 is firmly retained in position on the casing portion 12 by an annular clamping member 28, which in the construction shown is made of

rubber and resiliently expanded to fit over and press together the annular flanges 30, 32 of the casing and cover respectively. It will be appreciated that other suitable means might be employed to retain the cover 26 in place, for example, a split metal ring secured by suitable nuts and bolts, or the cover could be bolted directly to the casing. The cover 26 as shown is provided with a plurality of holes 29 which provide a communication with ambient medium.

The flexible diaphragm skirt 22 is of annular formation with sufficient material intervening the central opening and outer periphery so that it is folded on itself providing the desired displacement characteristics. The inner periphery surrounding the central opening is secured, for example adhesively, to the outer periphery of the rigid supporting body 24 completing the diaphragm assembly. It is also contemplated that a substantial continuation of the skirt 22 might be provided to serve as a support for the exhaust valve 36 or a separate exhaust valve supporting body of annular formation employed. In these forms the cam body 24 would be connected to the exhaust valve supporting members.

The rigid cam body 24 is preferably shaped, as illustrated, to have a substantially tapered or cone-shaped outer surface 38, with an elongation or stem 39 extending axially from the apex of the body. The exhaust valve 36 consists of a flexible disc, preferably of rubber, mounted axially on the front face of the body 24 by a central stem 40 retained centrally and for restricted axial movement by an extension 42 of the body 24.

The end of the casing 10 opposed to the axial enlargement 12 is provided with internal threads 50 and a regulating valve assembly 52 is threadably engaged so as to be retained axially within the casing 10. The valve assembly 52 includes a main cylindrical body having a first unthreaded portion 56, a threaded portion 58 engageable with the threads 50 of the casing, and an outstanding flange or head 60, the underside of which fits directly against the terminal end of the casing 10. The valve assembly body 54 is bored axially at one end to provide a first tapped recess 57 adapted for connection to the source of breathable gas, and on the other end to provide a recess 61 having the outer portion internally threaded as indicated at 62. A further axial boring 64 of reduced diameter connects the recesses 56, 62, and the body 54 is also bored transaxially into and through the recess 61 to provide gas outlet ports 65, 66. The bottom of the recess 61 surrounding the boring 64 is contoured to provide a valve seat 68. A valve stem 70 having on one end a valve closure head 72 is mounted slidably within a cylindrical valve box 74.

The valve and valve box 74 are constructed as a separate assembly which is threadably engaged in the recess 60 of the body 54 before the entire controlling valve assembly is mounted in the casing 10. The cylindrical valve box 74 is provided with an internal recess 75 accommodating the valve stem 70 and closure head 72 with the stem 70 extending slidably through the end 76 of the valve box 74. A coil spring 78 is mounted over the valve stem 70 so as to resiliently urge the valve closure head 72 towards the valve seat 68.

A main feature of the present invention resides in the valve actuating arrangement between the rigid cam body 24 and the valve stem 70. A plurality of lever members 80 are provided each having one end 82 formed at substantially right angles with the body of the lever with a groove or recess 83 conforming to the diameter of the valve stem 70 provided in the terminal edge of the bent over end. The other end 84 of each lever is formed or curved to suit the outside contour of the body 24. The levers 84, two (2) in the construction illustrated, are mounted within the casing 10 with the ends 82 in contact with the valve stem 70, the recesses 83 fitting about the valve stem. They are retained flexibly in this position by a flanged collar 90 fitting over the valve stem 70 beneath

the lever ends 82 with a spacer 92 mounted on the valve stem over the lever ends 82, the whole being retained by a spring clip or washer 94. The upper ends 84 of the levers are disposed at opposing sides of the rigid cam body 24.

With this arrangement, deflection of the diaphragm assembly, by the inhalations of the user, extends the rigid body 24 axially of the casing and between the ends 84 of the levers 80. By reason of the tapering outer contour of the body 24, the frictional contact with the lever ends 84 has a cam-like action so that the lever ends 84 are spread outwardly relative to the axis of the body. This outward spreading of the lever ends 84 causes a rocking of the lever ends 82 against the collar 90 and raises the valve stem 70 against the influence of the spring 78. On breathing out, the deflection of the diaphragm assembly in the opposite direction retracts the rigid body 24 relative to the lever ends 84 and therefore, by the spring 78, the stem 70 is moved into valve closing position. The gas exhausted passes through the ports 91 in the body 24 and by the resilient action of the exhaust valve 36 is discharged into the surrounding medium.

It should be mentioned that the rigid cam body 24 is preferably made of a material having friction-free characteristics, for example, nylon or the like. Further, while two (2) levers 80 are shown by way of illustration, it will be understood that three (3) or more levers 80 can be utilized and arranged symmetrically about the axis of the valve stem 70. The elongation or stem 39 of the rigid body 24 ensures that the rigid body 24 will be always aligned and maintained between the opposed ends 84 of the levers 80 at the maximum outward or exhaust position of the diaphragm assembly. With this arrangement, it is to be possible by applying a predetermined contour to the rigid body 24 to obtain a smooth even lifting and releasing action to the valve stem 70 and closure head 72 not possible in the known constructions of this nature.

In the alternate construction shown in Figure 3 the flexible skirt portion 22 is replaced by a flexible bellows type portion 122 and the cam body 24 is replaced by an alternate cam body 124 which is again of tapered contour but is made as having opposed flat diagonal sides 125 against which the ends 84 of the levers 80 bear. In the construction shown the body 124 is made of a formed strip of suitable material but it will be understood that it could be moulded in one piece to the desired contour. The body 124 is provided with an extension 126 which acts to align the body 124 between the lever ends 84 as previously described. The exhaust valve 136 is mounted on an annular supporting member 130 secured to the inner end of the flexible diaphragm portion 122 and the body 124 is secured to the supporting member 130. The action of this alternate construction is the same as previously described and it will be appreciated that the diaphragm portion 22 could be combined with the cam body 124 or the cam body 24 with the diaphragm portion 122 without changing the operation.

The tapering contour of the exterior of the rigid bodies 24, 124 acts as a cam and by the appropriate cam surface the degree of motion transmitted by the levers 80 for a proportionate deflecting movement of the diaphragm assembly can be predetermined to suit any desired requirement.

We claim:

1. In a breathing apparatus for divers, in combination, a closed hollow cylindrical body having at one end a valve box adapted to close the said end of said casing and to be connected to a source of a breathable gas under pressure, an inlet valve having a valve stem in said valve box for controlling the breathable gas delivered to said body interior, a diaphragm assembly having a flexible portion and a central rigid body portion mounted on and closing off the other end of said hollow body interior, a flexible expiration valve mounted on said diaphragm as-

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sembly and adapted to discharge outside the gas contained in said hollow body interior when its pressure is greater than the pressure of the medium surrounding said body, a mouthpiece connected to said hollow cylindrical body and a communication port in said body leading to said mouthpiece, said diaphragm assembly central rigid body having a tapering external contour with the apex of said body directed towards and in axial alignment with said inlet valve stem, and at least two lever members extending axially within said cylindrical body with one end of each lever in operative engagement with said valve stem and the other end in frictional engagement with the exterior of said rigid body, whereby deflection of said diaphragm assembly reciprocates said rigid body axially of said cylindrical body and through the tapering conformation of said body a cam action is applied to the ends of said levers in frictional contact therewith, said action being transmitted by the opposite ends of said levers to said valve stem.

2. In a breathing apparatus, as claimed in claim 1, wherein the exterior of said diaphragm assembly central rigid body portion is of conical formation with a stem extending axially from the apex thereof.

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3. In a breathing apparatus, as claimed in claim 1, wherein each of said lever ends remote from said diaphragm is bent at substantially right angles from the main body of said lever with the terminal face of said bent lever end recessed to accommodate said valve stem, and there are means mounted on said valve stem adapted to maintain said lever ends in operative contact with said stem.

4. In a breathing apparatus as claimed in claim 1, wherein said diaphragm assembly rigid body is of substantially Y-shaped conformation having opposed flat exterior bearing surfaces converging in the direction of said inlet valve.

5. In a breathing apparatus as claimed in claim 1, wherein said diaphragm assembly flexible portion is a cylindrical bellows of flexible material.

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