Feb. 11, 1969 L. S. DEY 3,426,790

SOURCE OF REGULATED PRESSURE AND PRESSURE REGULATOR FOR USE THEREIN

Filed Jan. 5, 1965

FIG. 1

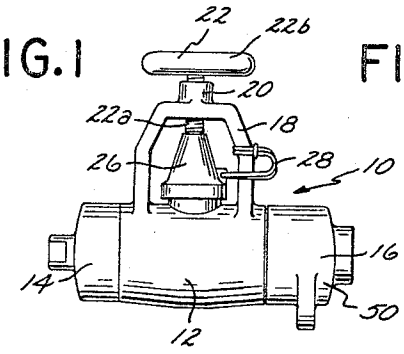
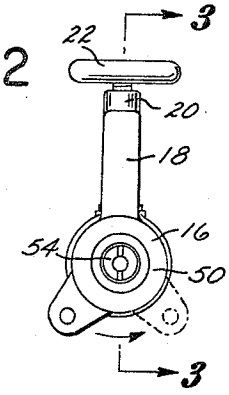


FIG. 2



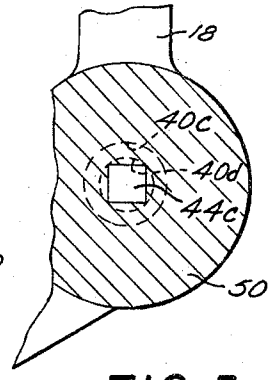


FIG. 5

FIG. 3

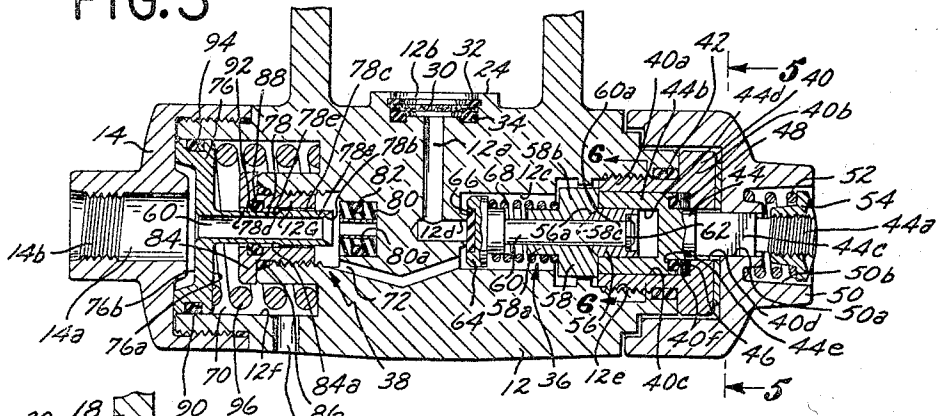


FIG. 4

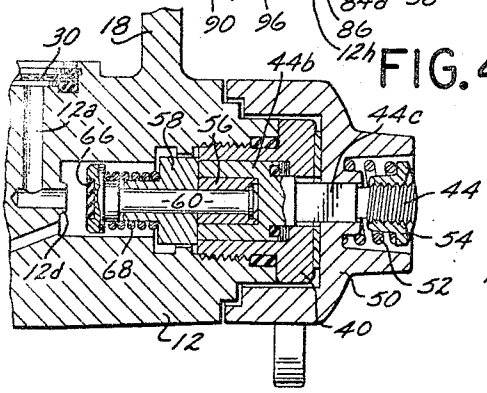
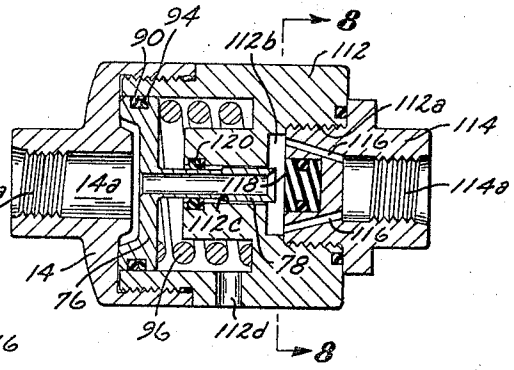


FIG. 7



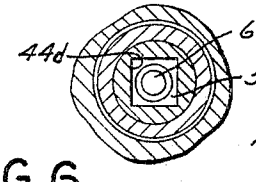


FIG. 6

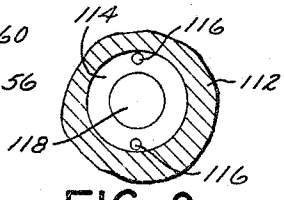


FIG. 8

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SOURCE OF REGULATED PRESSURE AND PRESSURE REGULATOR FOR USE THEREIN

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U.S. Cl. 137—505.18 2 Claims
Int. Cl. G05d 16/16; F16k 31/38; A61m 16/02

ABSTRACT OF THE DISCLOSURE

This invention teaches a highly sensitive pressure regulator having a balanced piston which carries a hollow stem integrally formed therewith. Said stem cooperates with a relatively stationary valve seat for controlling the flow of fluid pressure, and said piston is formed with a relatively thick or heavy marginal portion for cooperation with a cylinder chamber while the intermediate portion of such piston is relatively thin for increasing the response of such piston to variations in pressure.

This invention relates generally to sources of regulated pressure and to pressure regulators for use therein, and more particularly to such means for use in underwater breathing apparatus.

Within the past decade or two, the sport of skin diving has enjoyed increased popularity, so that today there exists an entire industry for supplying equipment for this sport. This industry manufactures and sells a wide variety of instruments, devices and equipment to enable a person to properly breathe underwater so as to enable him to remain beneath the surface for extended periods of time.

One of the most vital concerns in the manufacture of underwater breathing apparatus, is the need for a source of air at substantially constant pressure. That is, in order to enable a person to breathe properly and hence function as desired, it is necessary to have a source of air the pressure of which does not fluctuate haphazardly or at random. However, the pressure of such air must be variable in accordance with variations in ambient pressure, that is, the pressure surrounding the body of the person using the air. In this regard, as the skin diver descends to greater depths within the water, greater pressures are exerted on the outside of his body. To enable such person to continue to breathe without undue exertion and difficulty, it is necessary that the pressure of the air supply be increased accordingly.

Devices and systems heretofore available for providing a relatively constant pressure in the air being supplied have suffered from certain shortcomings. The structures employed in such prior equipment have caused many malfunctions and dangerous conditions for the user.

It is an object of the present invention to provide a source of regulated air pressure which is substantially foolproof and immune to frequent malfunctions.

Another object of the present invention is to provide a source of regulated air pressure having a regulator wherein a piston is slidable within a cylinder chamber for controlling accordingly the flow of air from a source thereof.

Another object of the present invention is to provide a source of regulated air pressure as characterized above which comprises an air regulator and a reserve indicator whereby a supply of regulated air pressure is afforded, but only when said reserve indicator is in open position.

Another object of the present invention is to provide an air regulator as characterized above wherein sealing means is provided between the piston and cylinder chamber for preventing fluid flow therebetween.

A further object of the present invention is to provide a source of regulated air pressure and air regulator as characterized above which are simple and inexpensive to manufacture and which are rugged and dependable in operation.

The novel features which I consider characteristic of my invention are set forth with particularity in the appended claims. The device itself, however, both as to its organization and mode of operation, together with additional objects and advantages thereof, will best be understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIGURE 1 is a side elevational view of a first embodiment of the present invention;

FIGURE 2 is an end elevational view of the first embodiment;

FIGURE 3 is a fragmentary longitudinal sectional view through said first embodiment, taken substantially along line 3—3 of FIGURE 2;

FIGURE 4 is a fragmentary sectional view of the reserve indicator of the first embodiment;

FIGURE 5 is a fragmentary sectional view taken substantially along line 5—5 of FIGURE 3;

FIGURE 6 is a fragmentary sectional view taken substantially along line 6—6 of FIGURE 3;

FIGURE 7 is a longitudinal sectional view through a second embodiment of the present invention; and

FIGURE 8 is a fragmentary sectional view taken substantially along line 8—8 of FIGURE 7.

Like reference characters indicate corresponding parts throughout the several views of the drawings.

Referring to FIGURE 1 of the drawings, there is shown therein one preferred embodiment for illustration of the present invention. Such embodiment comprises a housing **10** having a main body portion or valve body **12** and opposite end members **14** and **16** therefor.

Formed integrally with valve body **12** is a generally U-shaped yoke **18** having an internally threaded boss **20**. A fastening member **22** comprising an internally threaded stem **22***a* and a handle **22***b* is provided in boss **20** for operation within yoke **18** as will hereinafter appear.

Valve body **12** intermediate yoke **18** is provided with an annular raised portion or mounting boss **24** which is formed to receive an outlet fitting **26** of a source (not shown) of air under pressure. Such fitting, for reasons of safety, may be tied to the yoke **18** by a lanyard **28**.

Fitting **26**, as shown most clearly in FIGURE 1 of the drawings, fits over boss **24** of valve body **12**. Fastening member **22** is then operable to force such fitting firmly onto boss **24** to provide a hermetic seal therewith. This arrangement affords a supply of air under pressure to the valve body **12** as will hereinafter be explained.

Valve body **12** is further provided with a fluid passageway **12***a* as shown most clearly in FIGURE 3 of the drawings. The inlet **12***b* to such passageway **12***a* is provided with a filter **30** which is held in place by a resilient washer **32** and an O-ring **34**.

Positioned within valve body **12** along passageway **12***a* therein, is a reserve indicator **36** and a pressure regulator **38**.

Reserve indicator **36** is provided within an opening or cavity **12***c* in valve body **12**. One end of such cavity is formed with an annular valve seat **12***d* about the passageway **12***a*.

Opening **12***c* is formed with internal fastening threads **12***e* for receiving a fitting or bonnet **40** having an externally threaded main body **40***a* and a hexagonally-shaped head **40***b*. An O-ring **42** is interposed between the bonnet

40 and valve body 12 to prevent fluid flow therebetween as will hereinafter become more apparent.

Bonnet 40 is formed with a through opening 40*c* having a reduced circular portion 40*d* and an enlarged circular portion 40*e* providing an annular shoulder 40*f* therebetween. Such portions 40*d* and 40*e* are provided with circular cross sections as shown in FIGURE 5 of the drawings.

Mounted within through opening 40*c* of bonnet 40 is a stem 44 having a threaded end portion 44*a*, and enlarged end portion 44*b* and an intermediate portion 44*c*. Enlarged end portion 44*b* is provided with a generally circular external cross section affording a cylindrical external surface for rotation within enlarged portion 40*e* of through opening 40*c* in bonnet 40. Thus, as will hereinafter become more apparent, the stem 44 is permitted to rotate within bonnet 40.

Enlarged end portion 44*b* is further formed with a cutout 44*d* having a generally square or rectangular cross section for operation as will hereinafter be explained. Also, enlarged end portion 44*b* is formed with an annular groove or retainer 44*e* for receiving an O-ring 46. Suitable gasket means 48 is interposed between O-ring 46 and bonnet 40 to provide a firm hermetic seal therebetween against the relatively high pressure of the fluid or air in passageway 12*a*.

Intermediate portion 44*c* of stem 44 is also provided with a relatively square cross sectionas shown most clearly in FIGURE 5 of the drawings. The end member 16 of valve body 12 constitutes a handle or lever 50 which is nonrotatably connected to such intermediate portion 44*c* of stem 44. Such handle 50 is formed with a square opening 50*a* which corresponds in size and shape to the cross section of intermediate portion 44*c* for proper sliding engagement. Handle 50 is further provided with a recess 50*b* wherein a compression spring 52 is positioned, and a nut 54 is threadedly secured to end portion 44*a* of stem 44.

Compression spring 52, as will be readily apparent to those persons skilled in the art, urges nut 54 and stem 44 to the right as viewed in FIGURE 3 of the drawings, and thus assists O-ring 46 and gasket 48 in effectively sealing the space between stem 44 and bonnet 40.

With the arrangement thus far described it is seen that manual rotation of handle 50 causes stem 44 to be rotated therewith.

Positioned within cutout 44*d* of enlarged end portion 44*b* of stem 44 is a block 56 having a substantially square cross section as shown most clearly in FIGURE 6 of the drawings. The cross sectional shape and size of block 56 is complemental to the cross section of cutout 44*d* of stem 44. Thus, block 56 is also caused to rotate with stem 44 whenever the latter is rotated by handle 50.

One end of block 56 is beveled on opposite sides to provide a generally V-shaped configuration as shown at 56*a* which fits within and engages corresponding V-shaped groove formed in one end of a cam member 58. Such cam member is formed with a reduced end portion 58*a* and an enlarged end portion 58*b*, the latter of which is provided with the elongated V-shaped groove 58*c*.

Cam member 58 and block 56 are formed with aligned through openings for receiving a valve stem 60. One end 60*a* of stem 60 is provided with a washer 62 which fits within a recess in one end of block 56 and provides a shoulder for engagement with said block. End 60*a* of stem 60 is upset or spun over to retain washer 62 in its assembled position.

The other end of stem 60 is provided with a valve member 64 which carries a valve disc 66 formed of any appropriate resilient material such as rubber, plastic, fabric or the like. Such valve disc 66 is operable between flow permitting and flow preventing positions with respect to valve seat 12*d* in valve body 12 as will hereinafter be explained in detail.

A compression spring 68 is interposed between cam member 58 and valve member 64 to urge valve disc 66 into engagement with valve seat 12*d* to prevent fluid flow through passageway 12*a*.

Regulator 38 is positioned in passageway 12*a*, downstream of reserve indicator 36. Valve body 12 is formed with an opening 12*f* affording a cylinder chamber 70 having an inlet 72 which is part of passageway 12*a* and an outlet 14*a*. Outlet 14*a*, as will be readily apparent from FIGURE 3 of the drawings, is formed in end portion 14 of housing 12. Such end portion is threadedly secured to valve body 12, as shown most clearly in FIGURE 3 of the drawings, and is formed with internal fastening threads 14*b* whereby the housing 10 can be attached to tubing or other conduit means (not shown) for conducting air to a given device or apparatus such as a face mask to be worn by a skin diver.

A piston 76 is slidably mounted within cylinder chamber 70, and has one side 76*a* which faces inlet 72 of regulator 38 and another side 76*b* which faces outlet 14*a*. Attached to piston 76 or formed integrally therewith is a hollow stem 78 which extends toward inlet 72. One end 78*a* of stem 78 is formed with a valve member 78*b* which cooperates, as will hereinafter appear, with a valve seat 80 positioned within an appropriate recess in valve body 12. Such valve seat 80 is generally tubular in construction, having a centrally located through opening 80*a* for receiving a tool by which such valve seat is inserted within the valve body 12. An appropriate O-ring 82 is interposed between valve seat 80 and valve body 12 to prevent fluid flow therebetween.

Valve body 12 is formed with an annular extension 12*g* having internal fastening threads for receiving a bushing 84. A suitable O-ring 86 is interposed between bushing 84 and said annular extension 12*g*.

Bushing 84 is formed with a through opening 84*a* which slidably receives the stem 78 on piston 76.

Suitable sealing means in the form of O-rings 88 and 90 are provided in bushing 84 and piston 76, respectively, to prevent exposure to side 76*a* of piston 76 to either the inlet fluid pressure or the outlet fluid pressure of the regulator 38, as will become more apparent. O-ring 88 is positioned within an appropriate annular cutout in bushing 84 and a backup ring 92 is provided therein to further insure hermetic sealing between bushing 84 and stem 78. O-ring 90 is positioned within an annular cutout in piston 76, and a backup ring 94 is provided therein for insuring the desired seal.

Compression spring 96, one end of which abuts against valve body 12 while the other end engages piston 76, is provided to urge piston 76 in a direction such as to place valve member 78*b* in flow permitting position relative to valve seat 80.

A through opening 12*h* is provided in the side of valve body 12 to vent a portion of cylinder chamber 70 to ambient pressure conditions as will hereinafter become more apparent.

To insure better pressure regulation by regulator 38, valve member 78*b* of stem 78 is beveled so as to provide a relatively narrow edge for engagement with valve seat 80. Also, it should be noted that stem 78 is provided with a larger diameter 78*c* near valve member 78*b* and a smaller diameter 78*d* spaced from said valve member to provide an annular shoulder 78*e* therebetween. Such shoulder 78*e*, it will be noted, is on the inlet side of O-ring 88 so as to be exposed to the inlet pressure to the regulator 38. Such shoulder thus causes the inlet pressure to urge stem 78 and piston 76 to the right as viewed in FIGURE 3, thus counteracting and cancelling the force thereon to the left created by the inlet pressure acting on the valve member 78*b* of stem 78. By this arrangement, the extraneous forces on piston 76 and stem 78 are cancelled so as to permit the pressure in outlet 14*a* to be determined by the force of compression spring 96 and the ambient pressure which enters cylinder chamber 70 through opening 12*h* in valve body 12.

The embodiment shown in detail in FIGURE 3 of the drawings operates generally as follows.

With the handle **50** of reserve indicator **36** positioned as shown in said figure, the V-shaped end portion **56***a* of block **56** rests within the V-shaped recess or groove **58***c* of cam member **58**. As such, compression spring **68** is operable to urge valve disc **66** to flow preventing engagement with annular valve seat **12***d* in valve body **12**. However, if the pressure from the source of air exceeds a predetermined minimum, such as 300 lbs. per square inch, sufficient force is thereby applied to disc **66** to move it to flow permitting position against the force of compression spring **68**. That is, the air pressure within passageway **12***a*, when in excess of 300 lbs. per square inch, is sufficient to push said valve to open position against the force of spring **68**.

Thus air under pressure is permitted to flow to the inlet **72** of regulator **38**.

With the pressure at outlet **14***a* less than a predetermined maximum, compression spring **96** and the ambient pressure conditions on side **76***a* of piston **76** cooperate to move piston **76** to flow permitting position of valve member **78***b* with respect to valve seat **80**. The air under pressure thus is permitted to flow from inlet **72** through the hollow interior of stem **78** and the opening in piston **76** to the outlet **14***a* where it is conducted to appropriate means such as a face mask or the like by a suitable conduit. The pressure at outlet **14***a* acts against the side **76***b* of valve member **76** to urge valve member **78***b* toward flow preventing position. When such pressure reaches the predetermined maximum, the flow through stem **78** and piston **76** is terminated. This, of course, is effected by engagement of valve member **78***b* with valve seat **80**.

As long as such maximum pressure remains in outlet **14***a*, valve member **78***b* remains closed. However, when the pressure decreases from such maximum the compression spring **96** and ambient pressure conditions take over to move such valve to open position. Thus air is permitted to flow to outlet **14***a* and regulator **38** is operable to maintain the pressure at outlet **14***a* within predetermined relatively narrow limits.

When the pressure at the source decreases below a predetermined minimum, for example 300 lbs. per square inch, spring **68** of reserve indicator **36** operates to move valve disc **66** to flow preventing engagement with annular valve seat **12***d*. This terminates the supply of air to the face mask thus putting the wearer thereof on notice that the source of air is almost depleted.

Thereafter, the handle **50** of reverse indicator **36** is manually rotated to lift valve disc **66** from its closed position. This is accomplished by virtue of the fact that rotation of handle **50** causes stem **44** and block **56** to be rotated therewith due to the square or rectangular interconnection thereof. Cam member **58**, on the other hand, does not rotate therewith so that the V-shaped end portion **56***a* of block **56** is caused to rotate with respect to the V-shaped recess **58***c* in cam member **58**. Since cam member **58** is relatively stationary, this action causes block **56** to be cammed away from member **58** or to the right as viewed in FIGURE 3 of the drawings, to the position shown in FIGURE 4 of the drawings. Such camming action moves stem **60** and with it valve disc **66** to the right against the force of compression spring **68**. Thus the reserve indicator **36** is manually adjusted to permit fluid flow to regulator **38**, but it has put the wearer of the apparatus on notice that only a reserve amount of air remains at the source.

The aforedescribed regulation afforded by regulator **38** continues to take place so that the pressure in outlet **14***a* remains substantially constant.

The embodiment of FIGURE 7 is substantially identical with the aforedescribed embodiment of regulator **38**, but differs therefrom by being separated from the reserve indicator **36**. Under these conditions, a valve body **112** is provided having a threaded opening **112***a* for receiving a fitting **114**. Fitting **114** is formed with a threaded opening **114***a* for receiving a suitable conduit leading from a source of fluid under pressure. A pair of conduits **116** are formed in fitting **114** and lead from opening **114***a* to an inlet chamber **112***b* in valve body **112**. Piston **76** and stem **78** thereon are identical with the piston and stem of the embodiment of FIGURE 3. However, although the valve seat **80** of the embodiment of FIGURE 3 is generally tubular in construction, the corresponding seat member **118** in the embodiment shown in FIGURE 7 may be cylindrical in construction. This is because the valve seat member **118** does not have to be positioned in the valve body through the cylinder chamber but rather can be positioned within the fitting **114** before the latter is threaded into the valve body **112**.

The second embodiment shown in FIGURE 7 also utilizes valve body **112** as guide means for stem **78**. That is, rather than employing bushing **84** as in the above described first embodiment, the second embodiment utilizes an opening **112***c* in said valve body to slidably receive stem **78**. Suitable sealing means such as O-ring **120** is provided within an appropriate annular groove for effectively sealing stem **78** in such valve body. Other than as mentioned above, the embodiment shown in FIGURES 7 and 8 is substantially identical with the regulator **38** shown in FIGURE 3. Also, such second embodiment works in substantially the same manner as the aforedescribed first embodiment, the pressure in outlet **14***a* being balanced against the combined force of compression spring **96** and ambient pressure conditions afforded through opening **112***d* in body **112**.

It is thus seen that the present invention provides a source of regulated fluid pressure whereby due to the use of a piston within a cylinder chamber, a reliable and effective regulator is provided.

Although I have shown and described certain specific embodiments of my invention, I am fully aware that many modifications thereof are possible. My invention, therefore, is not to be restricted except insofar as is necessitated by the prior art and by the spirit of the appended claims.

I claim:

1. A highly sensitive pressure regulator for maintaining constant output pressure notwithstanding variations in pressure at the source thereof comprising in combination, a valve body formed with an opening affording a cylinder chamber having an inlet end portion and an outlet end portion, said body being further formed with an inlet opening having connection with a source of fluid pressure, said inlet opening extending transversely of said chamber and communicating with said inlet end portion at one side thereto to provide fluid pressure to said inlet portion transversely of said chamber to thereby cause said inlet end portion to be a pressure chamber, a nondeformable piston slidably mounted in said chamber with said inlet and outlet end portions on opposite sides thereof and operable to afford substantially constant resistance to pressure throughout its range of travel in said chamber, a stem on said piston for movement therewith, flow control means comprising a relatively stationary valve seat at the inlet portion of said chamber and a valve member formed as an annular internal bevel on said stem for flow permitting and flow preventing cooperation with said seat, means biasing said piston toward said flow permitting position of said valve member, passage means in said stem and piston permitting fluid flow from said inlet portion to said outlet portion through said piston when said valve member is in flow permitting position, means insuring a predetermined minimum space between said piston and said chamber when said valve is in maximum flow permitting position, the fluid pressure in said outlet portion urging said piston toward flow preventing position of said valve member, an annular shoulder formed on said stem,

and sealing means on said stem intermediate said shoulder and said outlet end portion of said cylinder chamber to provide a pressure chamber with said shoulder affording exposure of the latter to pressure in said inlet end portion of said cylinder chamber to urge said valve member toward flow preventing position to thereby cancel the force of said inlet pressure on said valve member urging the same toward flow permitting position, whereby the fluid pressure in said outlet portion is caused to remain substantially constant.

2. A highly sensitive pressure regulator according to claim 1, wherein said sealing means comprises an O-ring between said stem and said valve body cooperating with said valve body and stem to form said pressure chamber for said shoulder.

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U.S. Cl. X.R.

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