June 7, 1960 J. P. FAY 2,939,456

BREATHING DEVICE

Filed Aug. 6, 1956 2 Sheets-Sheet 1

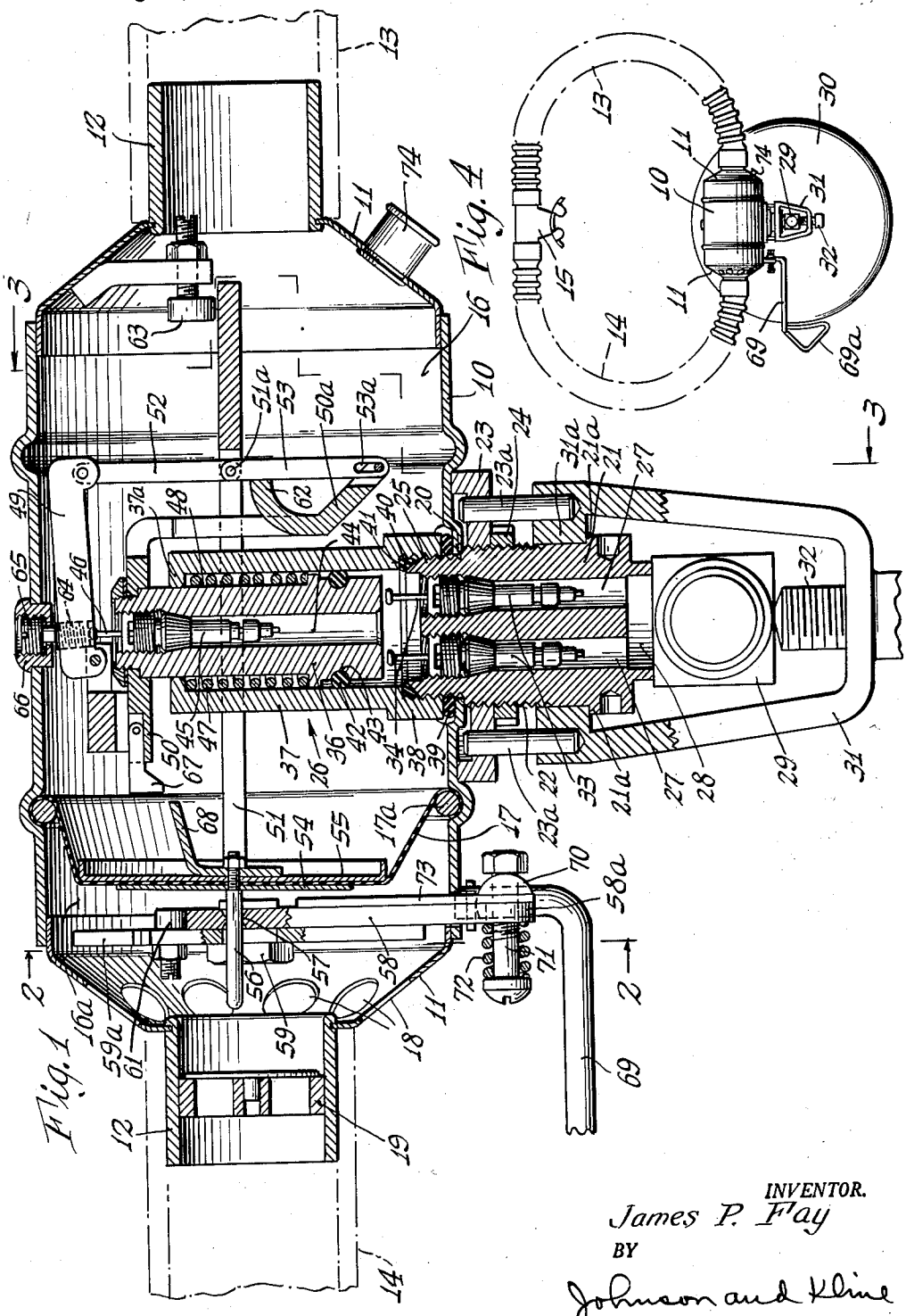


Fig. 1

Fig. 4

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Fig. 3

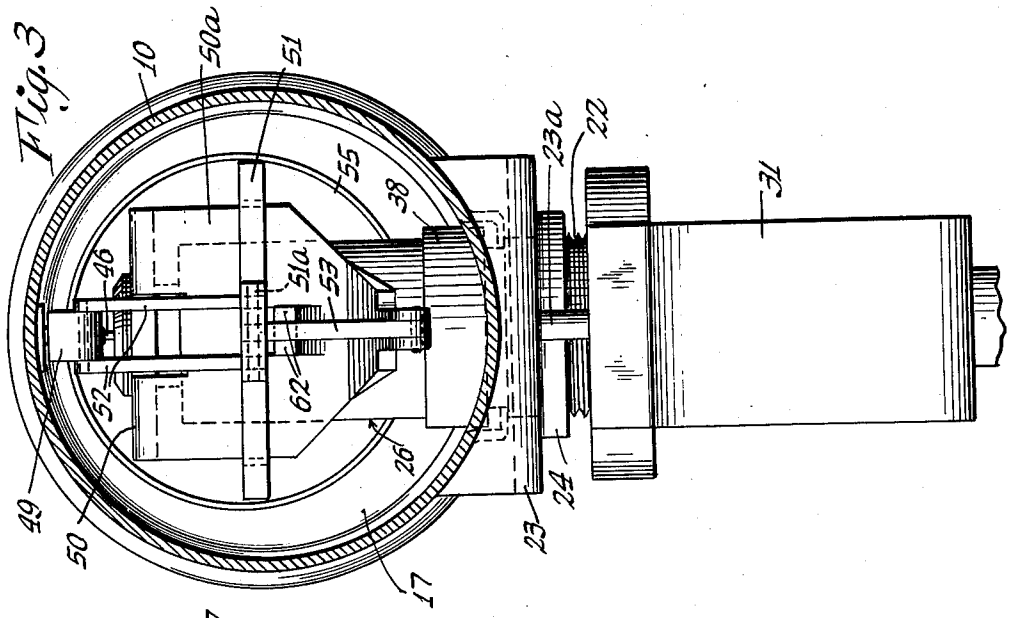
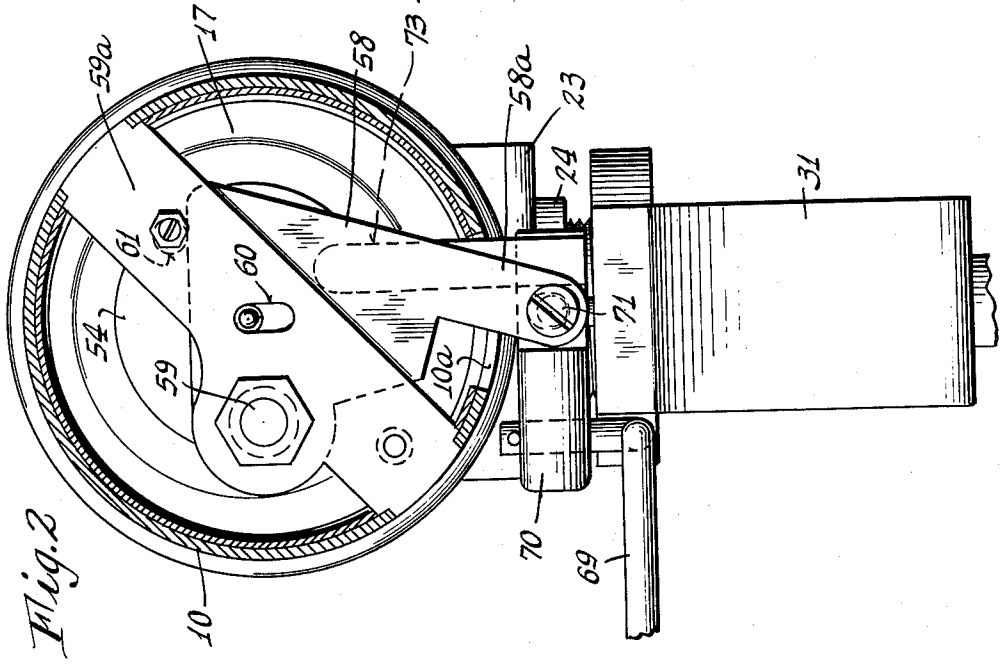


Fig. 2



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BREATHING DEVICE

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Filed Aug. 6, 1956, Ser. No. 602,214

11 Claims. (Cl. 128—142)

The present invention relates to a regulator for breathable gases and is an improvement on the regulator shown in my copending application Serial No. 485,020, filed January 31, 1955, now Patent No. 2,757,680, dated August 7, 1956.

It is an object of the present invention to provide a regulator which is less expensive to manufacture and one which is smoother and more safe to operate.

This is accomplished by providing the regulator with a piston and cylinder type of expansible chamber which is easy to manufacture and assemble; also, the actuator for controlling the operation of the regulator operates with a substantially straight line motion and utilizes toggle links to produce a smooth, even operation of the valves controlling the flow of gas.

Further, the present invention provides a novel reserve and flush mechanism which is less expensive to manufacture, easier and more sure in its operation. Also, there is provided means for automatically bleeding and/or venting the expansible chamber of the regulator should the pressure in the chamber become excessive, said means being readily adjusted as required.

Other features and advantages of the invention will be apparent from the specification and claims when considered in connection with the drawings in which:

Figure 1 is a longitudinal sectional view of the regulator.

Fig. 2 is a sectional view taken along line 2—2 of Fig. 1.

Fig. 3 is a sectional view taken along line 3—3 of Fig. 1.

Fig. 4 is a top view of the regulator assembled on a tank and connected to the breathing hose.

While the regulator of the present invention is adaptable to a single stage operation, it is herein illustrated as applied to a two-stage operation and comprises a housing 10 having a generally tubular shape and provided at its ends with the belts 11 which are secured thereto and have hose connectors 12 at the ends thereof to be connected to the inhalation or breather hose 13 and the exhalation or exhaust hose 14 which extend to the usual mouthpiece 15, as shown in Fig. 4. The housing is divided into an inhalation chamber 16 and an exhalation chamber 16*a* by means of a flexible diaphragm 17 of neoprene or the like elastomeric material suitably secured by a ring 17*a* therein to extend across the housing. The exhalation chamber 16*a* is provided with apertures 18 opening to the water or surrounding medium so that the diaphragm has impressed thereon the pressure of the water. A usual flap type valve 19 having a skeleton frame 19*a* is mounted in the hose connector connected to exhaust hose 14 and has a flexible flap 19*b* connected by a portion 19*c* to the skeleton frame so that the flap extends across the connector 12 to permit exhaled air to pass ino the chamber to be exhausted through the apertures 18 while at the same time preventing the flow of the water from the chamber into the hose 14.

On one side of the housing intermediate the ends thereof and in the inhalation chamber there is provided an aperture or opening 20 into which is mounted a fitting 21.

The fitting is secured by any suitable means to the housing. As herein illustrated, the fitting has a threaded outer surface 22 on which is threaded a saddle 23 for engaging the outer surface of the housing. A lock nut 24 threaded on the surface 22 securely holds the saddle to the fitting. The fitting has a threaded neck 25 of reduced diameter extending through the opening 20 and to which an expansible chamber means 26 located in the inhalation chamber is connected, as will be described. The fitting has a pair of parallel bores 27 therein opening into a chamber 28 at the end of which is adapted to overlie a valve port (not shown) in the neck 29 projecting from the cylinder 30 providing the supply of air under pressure. Disposed in the parallel bores 27 is a pair of Dill or Schrader-type valves 33 having the operators 34 therefor projecting beyond the end of the fitting.

The regulator is connected to the neck by means of a U-shaped yoke 31 having its ends 31*a* interlocked with shoulders 21*a* on the fitting and is clamped to the neck by a clamping screw 32 located in the bow of the U and pressing the neck into fluid-tight engagement with the end of the fitting. Pins 23*a* connect the yoke to the saddle to prevent rotation of the housing with respect to the yoke. The fitting is sealingly secured to the housing and the expansible chamber by means of the neck 25 of reduced diameter projecting through the opening in the housing and secured to the expansible chamber means 26.

According to the present invention the expansible chamber means 26 is formed by a piston 36 disposed in cylinder 37. While either the piston or cylinder may be connected to the fitting, in the herein illustrated form of the invention, the cylinder 37 is connected to the fitting by means of an enlarged mouth 38 which is adapted to be threaded onto the neck 25 at the end of the fitting so as to clamp the housing between the end of the cylinder and the fitting adjacent the reduced neck portion. If desired, an O-ring 39 may be disposed between the end of the cylinder and housing to seal the housing around the opening 20, and also an O-ring 40 is positioned between the end of the neck 25 and a shoulder 41 in the cylinder to seal the cylinder to the fitting.

The piston 36 is mounted in the cylinder and has an O-ring 42 positioned in a groove 43 around the sides of the piston and engaging the walls of the cylinder to form a seal therewith. With this construction the expansible chamber is formed in the cylinder between the end of the fitting and the end of the piston, which chamber is adapted to receive air from the source and maintain it at a predetermined reduced pressure. The piston 36 has a bore 44 extending therethrough to connect the expansible chamber to the inhalation chamber and in which is mounted a Dill or Schrader-type valve 45 with its operator 46 projecting beyond the end of the piston to control the flow of gas therethrough and into the inhalation chamber.

In accordance with the present invention the piston is urged from its normal position, i.e., the position in which there is full pressure in the expansible chamber so as to collapse or contract the chamber when the pressure is reduced due to the passage of air to the inhalation chamber. While this may be carried out in many ways, it is herein illustrated as being accomplished by means of a spring 47 surrounding a reduced portion 48 of the piston and having its outer end engaging an end wall 37*a* of the cylinder so as to urge the piston downwardly toward the fitting as the pressure in the expansible chamber falls below said predetermined amount.

As shown in Fig. 1, the operators 34 for the valves 33 which control the flow of gas from the source under pressure in the tank extend beyond the end of the fitting and into the expansible chamber under the end of the

piston so that when the pressure in the expansible chamber falls below a predetermined value and the spring moves the piston downwardly, it will engage with the operators **34** for the two valves to cause the valves to admit air from the source and quickly restore the predetermined pressure in the expansible chamber and move the piston upwardly to its normal position. It will be apparent that by adjusting the extent of projection of the valve operators they can be made to actuate the valves **33** in sequence or simultaneously as required to restore the pressure.

The pressures in the supply and expansible chamber can be selected as required. For example, the pressure in the tank can be 2500 p.s.i. while the predetermined normal pressure in the expansible chamber can be 300 p.s.i.

In order to control the valve **45** so as to replenish the air in the inhalation chamber and maintain the required pressure therein, the present invention provides an actuating lever **49** which is pivotally mounted on a bracket **50** carried by and secured to the threaded end of the piston projecting beyond end **37***a* of the cylinder.

As shown in Fig. 1 the lever extends over and engages the operator **46** for the valve and is actuated in accordance with variations in the pressure in the inhalation chamber to open the valve to restore the pressure in the inhalation chamber. This is accomplished, according to the present invention, by having a yoke **51** extending around the expansible chamber and having the lever **49** connected to it by a double pivoted toggle link **52** which is also pivotally connected by a pin **51***a* to the yoke adjacent one end thereof. A second toggle link **53** has one end pivotally connected to the pin **51***a* in the yoke and the other end pivotally connected to a dependent portion **50***a* of the bracket **50**. The other end of the yoke is connected to the diaphragm **17** to be operated thereby in accordance with the unbalance of pressures in the inhalation and exhalation chambers. Preferably, the diaphragm is provided with central plates **54**, **55** to reenforce and stiffen the center section thereof and to which the yoke is connected and has a guide pin **56** projecting from the face opposite said yoke in alignment with the yoke as shown in Fig. 1. The guide pin passes through the guide eye **57** in a plate **58** pivotally mounted on stud **59** on a bracket **59***a* secured to extend across the housing and having an elongate opening **60** to permit free passage of the guide pin in normal and reserve position as will be explained. The bracket carries an adjustable stop **61** for limiting movement of the plate in its upward or normal position as shown in Fig. 2. With this arrangement when the pressure in the inhalation chamber is reduced due to the breathing of air therefrom, the diaphragm collapses and moves to the right, as viewed in Fig. 1, causing the yoke to move to the right and breaking the toggle and causing the toggle link **52** to draw the actuating lever **49** down into engagement with the operator **46** for the valve. This causes the air in the expansible chamber to pass into the inhalation chamber to restore pressure therein and return the diaphragm to balanced position.

A stop member **62** carried by the dependent portion of the bracket **50***a* engages the toggle links adjacent the pivotal connection thereof to the yoke and limits the movement of the yoke to the left as viewed in Fig. 1 and the toggle links in aligned position.

Should the pressure in the expansible chamber exceed the normal maximum pressure the bracket will be moved upwardly carrying the yoke into engagement with the adjustable abutment **63** carried by the housing which will prevent the yoke from rising and will cause the lever to automatically bleed the expansible chamber and indicate the improper operation of the device. If the pressure is more than can be bled therefrom, the end of the piston will move upwardly until the lever **49** engages the top of the housing whereupon continued movement of the

piston will cause the lever to be depressed and open valve **45** and vent the expansible chamber to prevent damage thereto. It will be noted that the toggle link **53** is connected to the bracket **50***a* by an elongate slot **53***a* which provides for the downward movement of the toggle with respect to the bracket to permit said downward movement of the lever **49** while the links are aligned.

The actuating arm, it will be noted, is provided with an adjustable contact portion in the form of a threaded plug **64** overlying the operator **46** of the valve **45** so that the operation of the valve thereby can be controlled by the position of the plug. Access to the plug for adjusting purposes is afforded through a removable closure **65** carried in a bushing **66** in the housing.

The present invention provides an indication when the air supply in the tank reaches a safe minimum and provides for a reserve supply of air. As has been noted above, when the pressure in the expansible chamber is reduced a predetermined amount the piston will move downwardly and open the valves **33** to increase the pressure and return the piston to normal position. If, however, the pressure in the tank is reduced to a point where it cannot overcome the spring and return the piston, a stop **67** on the bracket will be located in the path of a reserve finger **68** carried by the diaphragm and prevent operation of the diaphragm and yoke and the replenishment of the air in the inhalation chamber. This lack of air in the inhalation chamber will indicate that the reserve pressure has been reached.

In order to utilize the low pressure air in the tank the plate **58** is moved downwardly as viewed in Fig. 2, and the guide eye will move the pin and yoke downwardly to a position wherein the finger **68** is below the stop **67** and the diaphragm can control the yoke and the lever **49** to restore pressure directly from the tank through valves **33** and **45** to permit the reserve air in the tank to be used. The stop **67** is pivotally mounted on the bracket **50** to move upwardly and permit the finger **58** to pass thereby as it returns to the position of Fig. 1 should the finger be located to the right of the stop when the reserve pressure is reached.

In order to move the plate downwardly, a rod **69** is connected to an actuator **70** which is yieldably connected to the plate by a long bolt **71** passing through an aperture in an arm **58***a* on the plate extending through a slot **10***a* in the housing. The bolt has a spring **72** which normally presses the arm and actuator together. The rod extends along the tank as shown in Fig. 4 and has a handle **69***a* thereon by which it can be manipulated to move the plate between normal and reserve positions.

Fixed on the actuator and extending through the slot **10***a* in the housing is a finger **73** which extends up and is positioned to engage the plate **54** on the diaphragm to manually move the diaphragm and yoke inwardly when it is desired to introduce air at a higher than normal pressure into the inhalation chamber to flush the hose as may be required. The finger is moved into engagement with the plate by rotating the rod on its axis and causing the actuator to rotate with respect to the plate and rotate the finger to the right as shown in Fig. 1. The yieldable connection between the actuator and plate permits the flushing operation in either normal or reserve position of the plate.

If desired, the inhalation chamber can have a fitting **74** by which it can be connected to pressurize a camera or the like.

Variations and modifications may be made within the scope of the claims and portions of the improvements may be used without others.

I claim:

1. A breathable gas regulator apparatus comprising a housing; a pressure-responsive diaphragm dividing the housing into an inhalation chamber and an exhalation chamber, said exhalation chamber being exposed to the

pressure of a surrounding fluid medium; a pressure-responsive, expansible chamber comprising piston and cylinder means connected to the housing and normally urged to contracted position; a source of breathable gas under pressure; means securing the housing to said source of breathable gas; valve means having operating means connecting the source of breathable gas to the expansible chamber; second valve means connecting the expansible chamber to the inhalation chamber; means actuated by the diaphragm for controlling the second valve means to cause gas to pass from the expansible chamber into the inhalation chamber and cause the expansible chamber to contract; and actuating means controlled by the piston and cylinder means and directly engaging operating means for said first valve means to open said valve means in response to decrease in pressure in the expansible chamber and movement of the piston and cylinder means to contracted position, thereby to cause gas from said source to restore the pressure in the expansible chamber and move the piston and cylinder to expanded position to withdraw the actuating means from valve operating position.

2. A breathable gas regulator apparatus comprising a housing; a pressure-responsive diaphragm dividing the housing into an inhalation chamber and an exhalation chamber, said exhalation chamber being exposed to the pressure of a surrounding fluid medium; a cylinder connected to the housing; a piston mounted in the cylinder to form an expansible chamber; means normally urging the piston to contract the expansible chamber; a source of breathable gas under pressure; means securing the housing to said source of breathable gas; means mounted in the end of the cylinder connecting the source of breathable gas to the expansible chamber, said means including a pair of parallel valve means having operating means therefor, said operating means extending into the cylinder to be engaged by the piston in contracted position; a bore in said piston and a second valve means mounted in said bore and connecting the expansible chamber to the inhalation chamber; means actuated by the diaphragm for controlling the second valve means to cause gas to pass from the expansible chamber, and to decrease the pressure in the expansible chamber, into the inhalation chamber whereby the piston moves to contracted position and directly engages the operating means for said first valve means to open said first valve means to cause gas from said source to restore the pressure in the expansible chamber and move the piston to withdraw out of engagement with the first valve operating means.

3. A breathable gas regulator apparatus comprising a housing; a pressure-responsive diaphragm dividing the housing into an inhalation chamber and an exhalation chamber; a pressure-responsive, expansible chamber including piston and cylinder means disposed in the inhalation chamber; means normally urging the piston and cylinder means to contract the expansible chamber; a source of breathable gas under pressure; means securing the housing to said source; valve means connecting the source of breathable gas to the expansible chamber; second valve means connecting the expansible chamber to the inhalation chamber, said exhalation chamber being exposed to the pressure of a surrounding fluid medium and the inhalation chamber having a balancing pressure therein to normally maintain the diaphragm in a predetermined balanced position; a pivoted lever mounted on the expansible chamber for controlling the second valve means; means, including a toggle link, connected to the diaphragm for actuating the pivoted lever in accordance with the variation of pressure in the inhalation chamber due to the inhaling of gas therefrom to cause the second valve to be operated and gas to pass from the expansible chamber into the inhalation chamber to return the pressure therein to balanced relation; and means carried by the piston and cylinder means and engaging and controlling operating means for said first valve means in response to decrease in pressure in the expansible chamber and movement of the piston and cylinder means to contract the expansible chamber to directly open the first valve and cause gas from said source to restore the pressure in the expansible chamber and expand the chamber and move the means carried thereby out of engagement with said first valve.

4. A breathable gas regulator apparatus adapted to be connected by a breathing hose to a mouthpiece comprising a housing; a pressure-responsive diaphragm dividing the housing into an inhalation chamber and an exhalation chamber, said exhalation chamber being exposed to the pressure of a surrounding fluid medium; a source of breathable gas under pressure; means securing the housing to said source of breathable gas; valve means connecting the source of breathable gas to the inhalation chamber to normally balance the pressure in the exhalation chamber; means actuated by the diaphragm upon decrease of pressure in the inhalation chamber for controlling the valve means to cause gas to pass into the inhalation chamber to restore the balanced pressure therein; and a finger mounted for pivotal movement on the housing and extending into the exhalation chamber and manually movable into engagement with the diaphragm to actuate the diaphragm independently of the pressure in the housing to operate the diaphragm and the means actuated thereby cause gas under pressure in excess of the normal balancing pressure to flow into the inhalation chamber and to flush the hose connected thereto.

5. A breathable gas regulator apparatus comprising a housing; a pressure-responsive diaphragm dividing the housing into an inhalation chamber and an exhalation chamber; a source of breathable gas under pressure; means securing the housing to said source; means, including an expansible pressure-reducing chamber and valve means, connecting the source of breathable gas to the inhalation chamber, said exhalation chamber being exposed to the pressure of a surrounding fluid medium and the inhalation chamber adapted to have a balancing pressure therein to normally maintain the diaphragm in a predetermined balanced position; an actuating pivoted lever means overlying the valve means; and means, including toggle means connected to the lever means and means connecting the toggle means to the diaphragm for movement thereby in accordance with the variation of pressure in the inhalation chamber due to the inhaling of gas therefrom to actuate the valve means and cause gas to pass into the inhalation chamber to return the pressure therein to balanced relation.

6. A breathable gas regulator apparatus comprising a housing; a pressure-responsive diaphragm dividing the housing into an inhalation chamber and an exhalation chamber; a source of breathable gas under pressure; means securing the housing to said source; means, including an expansible pressure-reducing chamber and valve means, connecting the source of breathable gas to the inhalation chamber, said exhalation chamber being exposed to the pressure of a surrounding fluid medium and the inhalation chamber adapted to have a balancing pressure therein to normally maintain the diaphragm in a predetermined balanced position; an actuating pivoted lever means overlying the valve means; and means, including a pair of normally aligned pivoted toggle links connected to the lever means and means connecting the pivot between the toggle links to the diaphragm for movement thereby in accordance with the variation of pressure in the inhalation chamber due to the inhaling of gas therefrom to cause the links to move from aligned relation and draw the lever means into position to operate the valve means to pass the gas into the inhalation chamber to return the pressure therein to balanced relation.

7. A breathable gas regulator apparatus comprising a housing; a pressure-responsive diaphragm dividing the housing into an inhalation chamber and an exhalation

chamber; a pressure-responsive, expansible chamber means disposed in the inhalation chamber; a source of breathable gas under pressure; means securing the housing to said source; first valve means connecting the source of breathable gas to the expansible chamber means; second valve means connecting the expansible chamber means to the inhalation chamber, said exhalation chamber being exposed to the pressure of a surrounding fluid medium and the inhalation chamber adapted to have a balancing pressure therein to normally maintain the diaphragm in a predetermined balanced position; an actuating pivoted lever mounted on the expansible chamber means and overlying the second valve means; means, including a pair of normally aligned pivoted toggle links connected to the lever and means connecting the pivot between the toggle links to the diaphragm for movement thereby in accordance with the variation of pressure in the inhalation chamber due to the inhaling of gas therefrom to cause the links to move from aligned relation and draw the lever into position to operate the second valve means to pass the gas into the inhalation chamber to return the pressure therein to balanced relation; and means carried by the expansible chamber means and engaging and controlling operating means for said first valve means in response to decrease in pressure in the expansible chamber means and contraction thereof to directly open the first valve means and cause gas from said source to restore the pressure in the expansible chamber and expand the chamber and move the means carried thereby out of engagement with said first valve.

8. A breathable gas regulator apparatus comprising a housing; a pressure-responsive diaphragm dividing the housing into an inhalation chamber and an exhalation chamber; a pressure-responsive, expansible chamber means disposed in the inhalation chamber; a source of breathable gas under pressure; means securing the housing to said source; first valve means connecting the source of breathable gas to the expansible chamber means; second valve means connecting the expansible chamber means to the inhalation chamber, said exhalation chamber being exposed to the pressure of a surrounding fluid medium and the inhalation chamber adapted to have a balancing pressure therein to normally maintain the diaphragm in a predetermined balanced position; an actuating pivoted lever mounted on the expansible chamber means to move therewith and overlying the second valve means; means, including a pair of normally aligned pivoted toggle links connected to the lever and a yoke connecting the pivot between the toggle links to the diaphragm for movement thereby in accordance with the variation of pressure in the inhalation chamber due to the inhaling of gas therefrom to cause the links to move from aligned relation and draw the lever into position to operate the second valve means to pass the gas into the inhalation chamber to return the pressure therein to balanced relation; means carried by the expansible chamber means and engaging and controlling operating means for said first valve means in response to decrease in pressure in the expansible chamber means and contraction thereof to directly open the first valve means and cause gas from said source to restore the pressure in the expansible chamber and expand the chamber and move the means carried thereby out of engagement with said first valve; and means on the housing engaging the yoke to operate the lever and first valve means to vent the expansible chamber means in response to abnormal expansion of the expansible chamber means under abnormally high pressure therein.

9. A breathable gas regulator apparatus comprising a housing; a pressure-responsive diaphragm dividing the housing into an inhalation chamber and an exhalation chamber; a pressure-responsive, expansible chamber means disposed in the inhalation chamber and having a position for normal operating pressure therein and a second position for reserve pressure; a source of breathable gas under pressure; means securing the housing to said source; first valve means connecting the source of breathable gas to the expansible chamber means; second valve means connecting the expansible chamber means to the inhalation chamber, said exhalation chamber being exposed to the pressure of a surrounding fluid medium and the inhalation chamber adapted to have a balancing pressure therein to normally maintain the diaphragm in a predetermined balanced position; an actuating pivoted lever mounted on the expansible chamber means and overlying the second valve means; means including a pair of normally aligned pivoted toggle links connected to the lever and connector means connecting the pivot between the toggle links to the diaphragm for movement thereby in accordance with the variation of pressure in the inhalation chamber due to the inhaling of gas therefrom, said last means including a guide pin passing through a guide aperture in a pivotally mounted plate and guiding the connector means in a substantially straight line movement to cause the links to move from aligned relation and draw the lever into position to operate the valve means to pass the gas into the inhalation chamber to return the pressure therein to balanced relation; stop means preventing actuating movement of the diaphragm when the pressure in the expansible chamber means is below normal and the chamber is in reserve position; and manually operable means for moving the pivotally mounted plate to shift the guide pin, diaphragm and connector to reserve operating position and out of engagement by the stop means whereby control of the flow of gas at a low reserve pressure can be obtained.

10. A breathable gas regulator apparatus comprising a housing; a pressure responsive diaphragm dividing the housing into an inhalation chamber and an exhalation chamber, said diaphragm having reenforcing plates secured to the center thereof; a pressure-responsive, expansible chamber means disposed in the inhalation chamber and comprising a cylinder connected to the housing and a piston movable therein and having a position for normal operating pressure and a second position for reserve pressure in the expansible chamber means; a source of breathable gas under pressure; means including first valve means connecting the source of breathable gas to the expansible chamber means; means on the piston including a second valve means connecting the expansible chamber means to the inhalation chamber, said exhalation chamber being exposed to the pressure of a surrounding fluid medium and the inhalation chamber adapted to have a balancing pressure therein to normally maintain the diaphragm in a predetermined balanced position; an actuating lever pivotally mounted on a bracket secured to a projecting portion of the piston and overlying the second valve means; means, including a pair of normally aligned pivoted toggle links connected to the lever and bracket; connector means connecting the pivot between the toggle links to the reenforced diaphragm for movement thereby in accordance with the variation of pressure in the inhalation chamber due to the inhaling of gas therefrom, said last means including a guide pin secured to the reenforced center of the diaphragm and passing through a guide aperture in a plate pivotally mounted on the housing and guiding the connector means in a substantially straight line movement to cause the links to move from aligned relation and draw the lever into position to operate the valve means to pass the gas into the inhalation chamber to return the pressure therein to balanced relation; stop means on the bracket adapted to engage a finger on the diaphragm to prevent actuating movement of the diaphragm when the pressure in the expansible chamber means is below normal; rotatable and longitudinally movable, manually operable means for moving the pivotally mounted plate in response to a longitudinal pull to shift the guide pin and diaphragm to reserve position and out of engage-

ment by the stop means to control the flow of gas at a low reserve pressure, and separate means including a flushing finger actuated by rotation of the manually operable means for engaging the reenforcing plate and moving the diaphragm to cause the lever to open the second valve means and introduce gas under excess pressure into the inhalation chamber to flush an inhalator hose connected thereto.

11. A breathable gas regulator apparatus comprising a housing; a pressure-responsive diaphragm dividing the housing into an inhalation chamber and an exhalation chamber, said exhalation chamber being exposed to the pressure of a surrounding fluid medium; a cylinder connected to the housing; a piston mounted in the cylinder to form an expansible chamber; spring means normally urging the piston to contract the expansible chamber; a first source of breathable gas under pressure; means securing the housing to said source of breathable gas; means mounted in the cylinder connecting the source of breathable gas to the expansible chamber, said means including a first valve means having operating means therefor, said operating means extending into the cylinder to be engaged by the piston in contracted position to cause gas from the source to enter the cylinder and move the piston against said spring means to form a second source of gas of lower pressure than said first source; a bore in said piston and a second valve means mounted in said bore and connecting the expansible chamber to the inhalation chamber; means including a lever actuated by the diaphragm for engaging and controlling the second valve means to cause gas to pass from the second source in the expansible chamber, and to decrease the pressure in the expansible chamber, into the inhalation chamber whereby the piston moves to contracted position and directly engages the operating means for said first valve means to open said first valve means to cause gas from said source to restore the pressure in the expansible chamber and move the piston out of engagement with the first valve operating means, decrease of pressure in the first source below the pressure necessary to move the piston against said spring enough to close the first valve means causing said piston to remain in contracted position and preventing operation of the second valve by said lever in response to movement of the diaphragm; and manually operated means restoring the lever to operating relation with the second valve means to actuate said second valve means in response to movement of the diaphragm whereby the gas in the first source is supplied directly through the continually open first valve means and lever actuated second valve means to the inhalation chamber.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,939,456 June 7, 1960

James P. Fay

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 50, for "the belts" read -- end bells --; line 67, for "ino" read -- into --; column 6, line 26, after "thereby" insert -- to --; column 8, line 12, after "means", second occurrence, insert a comma.

Signed and sealed this 8th day of November 1960.

(SEAL)
Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents