Dec. 31, 1968 R. E. ROBERTS 3,419,042

RESERVE VALVE MECHANISM

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FIG. 1.

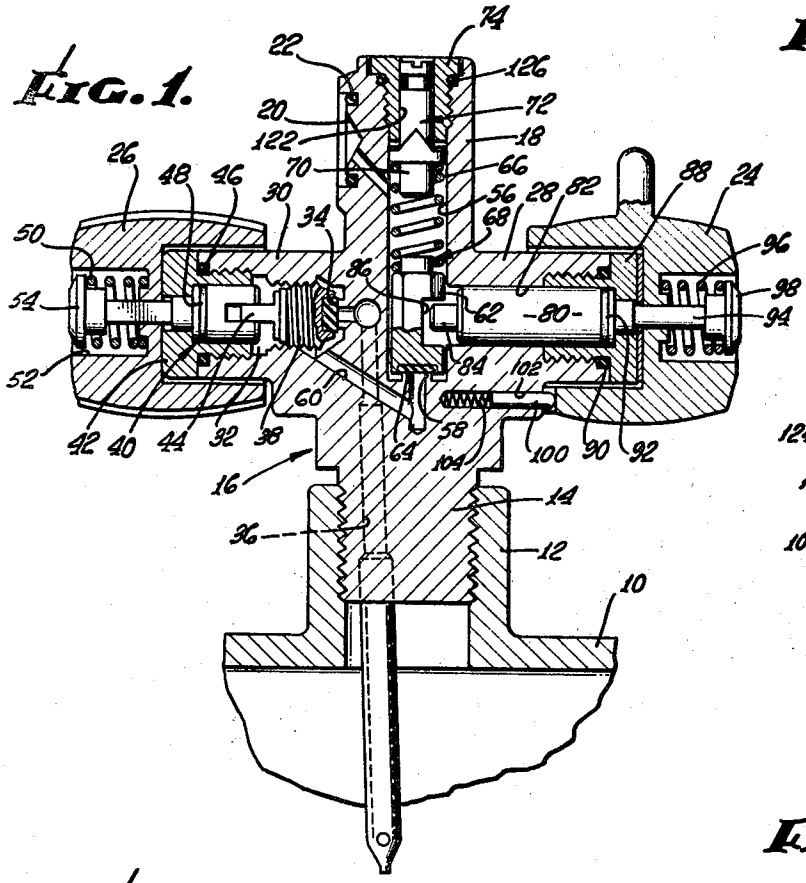


FIG. 4.

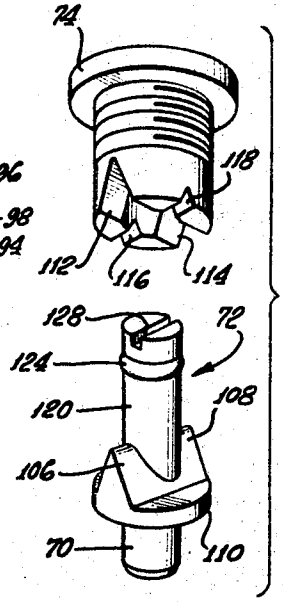


FIG. 2.

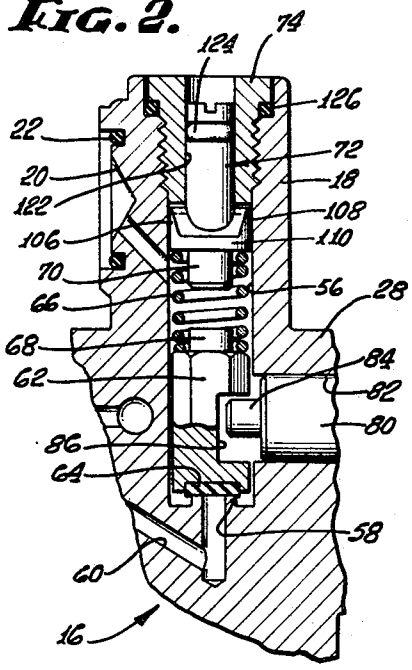
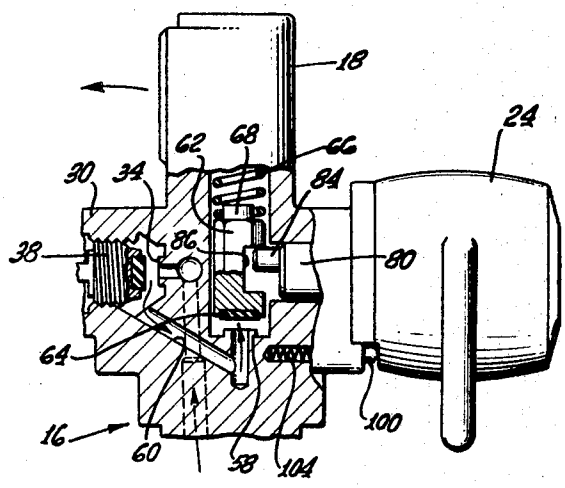


FIG. 3.



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RESERVE VALVE MECHANISM

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6 Claims. (Cl. 137—613)

This invention relates to self-contained breathing apparatus for use under water, in mephitic or rarefied atmospheres.

In order to allow safe return to a base where breathable gases are ambient, the user of self-contained breathing apparatus must start back when there is yet a supply of breathable gases in his tank adequate for the return trip. Known scuba equipment utilizes a spring pressed closure that actually shuts off the flow of breathable gases when the tank pressure drops to a value corresponding to the spring pressure. Thereupon, the diver operates a manual override to retract the closure, and the flow of breathable gases is re-established. However the diver now knows that the tank supply is about exhausted, and he begins his ascent.

The spring force is ordinarily set so as to allow a safe ascent from a certain substantial depth. However, more time may be required in the case of cave explorations. More time may be required if the diver is required to decompress at successive levels. The obvious solution is to use a sufficiently strong closure spring whereby the diver is compelled to open the reserve when there is a very substantial supply remaining. But this may be quite uneconomical for ordinary shallow dives. Reserve requirements may also be variable where breathing apparatus is used in mephitic or rarefied atmospheres.

Accordingly, the primary object of this invention is to provide a reserve valve that can be preset to determine one of a number of pressures at which the reserve valve will close.

Another object of this invention is to provide a device of this character that is essentially simple in construction, and easily operated as by any coin, screwdriver or other tool.

Another object of this invention is to provide an adapter unit that can be installed in existing reserve devices whereby the reserve device is converted for selective reserve values.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of one embodiment of the invention. For this purpose, there is shown a form in the drawings accompanying and forming a part of the present specification, and which drawings are true scale. This form will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of this invention is best defined by the appended claims.

Referring to the drawings:

FIGURE 1 is a sectional view of a reserve valve incorporating the present invention, a fragmentary portion of the supply tank also being shown;

FIG. 2 is an enlarged sectional view showing a portion of the apparatus of FIG. 1 but with the parts in reserve closed position;

FIG. 3 is elevational view, a portion of the apparatus being broken away and shown in section, the apparatus being in manual override position; and

FIG. 4 is a pictorial view of the parts providing adjustment of the spring force.

In FIG. 1 there is shown a tank **10** containing a supply of breathable gases. The tank has an internally screw-

threaded neck **12** adapted to receive an externally threaded fitting **14** of a valve body **16**. A mask, mouthpiece or other structure is connected to the valve body **16** by the aid of a conventional yoke structure (not shown). This yoke structure cooperates with a projection **18** located on that side of the body **16** opposite the fitting **14**. This projection **18** provides a lateral outlet opening **20** surrounded by an O-ring **22**.

Handles **24** and **26** are mounted upon oppositely extending lateral projections or stems **28** and **30** of the valve body **16**. In a manner hereinafter to be described, the handle **24** operates an override for the reserve valve mechanism. The handle **26**, in a manner hereinafter to be described, operates the shutoff valve for the tank **10**.

The stem **30** has a stepped recess **32** in the bottom of which a valve seat **34** is formed. Gas from the tank **10** is conducted to the valve seat **34** via a passage **36**. A threaded closure **38** is movable to open and close the port **34** and thus allow or prevent communication between the valve chamber **32** and the tank **10**.

A valve actuator **40** is journaled in a hollow closure screw **42** attached to the end of the stem **30**. The actuator **40** has a cross slot at its inner end cooperable with a key or flat **44** formed at the outer end of the valve closure **38**. The actuator **40** has a non-circular stem extending rearwardly and outwardly of the screw **42** which is connected to the handle **26**. The screw **42** is sealed to the end of the stem **30**, as by an O-ring **46**. The actuator **40** carries an O-ring **48** that seals the internal bore of the screw **42**. A spring **50** urges the handle **26** against the end of the screw **42** to impose some functional restraint against angular movement of the actuator **40**. The spring is accommodated in a recess **52** of the handle **26** and its outer end bears against a cap **54** attached to the projecting end of the actuator **40**.

Breathable gases, after passing into the valve chamber **32**, are conducted to the bottom of an elongate valve chamber **56** that extends generally axially of the projection **18**. The chamber **56** extends inwardly beyond the center line of the stems **28** and **30**. In the bottom of the recess **56** a valve seat **58** is formed. A slanting bore **60** establishes communication between the chamber **32** and the chamber **56** via the valve seat **58**. A reserve valve closure **62**, of hexagonal or other suitable non-circular form to provide clearance with the walls of the chamber **56**, is slidably movable in the chamber **56**. The closure **62** carries a washer **64** at its lower end that cooperates with the seat **58**. The closure **62** is urged downwardly to engage the seat **58** by the aid of a coiled compress-spring **66**. The lower end of the spring fits about a cylindrical embossment **68** formed on the upper end of the closure **62**. The upper end of the spring surrounds a cylindrical embossment **70** formed at the inner end of the spring mounting member **72** (see FIG. 4). The spring mounting member **72** is held in the recess **56** by the aid of a hollow screw **74** fastened to the end of the projection **18**.

In a well-understood manner, if the pressure in the chamber **56** is less than the pressure of the supply by an amount exceeding the equivalent pressure exerted by the spring **66**, then the closure **62** will be moved off its seat until pressure in the chamber **56** is increased. The pressure in the chamber **56** drops ordinarily in response to the consumption of breathable gases by the diver or user. If the pressure in the tank **10** drops below the equivalent pressure exerted by the spring **66**, then the closure **62** will seat and remain seated. The interruption of flow of breathable gases is, of course, noticed by the diver and he is aware of the fact that his supply is almost exhausted. In order to restore flow the diver or user manipulates the handle **24**.

The handle **24** operates an actuator **80** that is journaled in a bore **82** of the laterally extending stem **28**. The inner

end of the actuator **80** has an eccentric pin **84** that projects into a lateral slot **86** of the reserve closure **62**. By moving the actuator **80**, the eccentric pin **84** is caused to engage the top of the slot **86** as hown in FIG. 3, and thus to lift the closure **62** from the seat **58**. The diver then begins his ascent.

The recess **82** is sealed by a hollow screw **88** forming an outer continuation of the bore **82**. O-rings **90** and **92** provide seals for preventing escape of gas through the stem **28**. The actuator **80** has an extension **94** of noncircular configuration that is coupled to the handle **24**. A spring **96**, similar to the spring **50**, engages a cap **98** at the end of the extension **94** and frictionally urges the handle **24** against the end of the screw **88**. A detent **100** determines alternate stable positions of the reserve handle **24** corresponding to open and closed. The detent **100** is accommodated in a cylindrical recess **102**. A spring **104** urges the detent **100** outwardly. Opposite the detent **100** is an arcuate surface of the handle **24**. Formed in the arcuate surface are two notches in which the detent **100** may be fitted corresponding to the two handle positions. Thus a positive force is required in order to move the reserve handle **24** from the normal position of FIG. 1 to the override position of FIG. 3 and vice versa for obvious safety purposes.

Force exerted by the reserve valve spring **66** and hence the pressure at which the closure **62** remains seated is determined by the axial position of the spring mounting member **72**. The spring mounting member **72** may be moved inwardly or outwardly. For this purpose, the spring mounting member **72** has diametrically disposed cam lobes **106** and **108** (FIG. 4) on the upper surface of a cylindrical stop flange **110** engaged by the spring **66**. The cam lobes **106** and **108** are substantially of V-shape configuration. These cam lobes cooperate with two pairs of cam slots **112–114** and **116–118** formed at the inner end of the hollow screw **74**. The slots **112** and **114** are located diametrically and the slots **116** and **118** are also located diametrically but in angularly spaced relationship to the cam slots **112** and **114**. The slots **112** and **114** are relatively deep and thus allow the spring mounting member **72** to move outwardly to a maximum extent thus to reduce the tension in the spring **66**. The slots **116** and **118** are relatively shallow and, accordingly, when the lobes **106** and **108** are positioned so as to enter these slots, the spring mounting member **72** is moved forwardly and the spring **66** is consequently tensioned to a larger degree. The cam slots **112–114**, **116–118** are angled to determine stable angular positions of the spring mounting member **72**. Thus until the member **72** is forcibly turned, it stays in place.

The spring mounting member **72** has a stem portion **120** journaled in the cylindrical bore **122** of the screws **74**. The stem carries an O-ring **124** that prevents leakage past the stem. The screw **74** is sealed to the projection **120** by the aid of an O-ring **126**. The upper end of the stem has a cross slot **128** that may be engaged by a coin, screwdriver or other tool for imparting angular movement to the spring mounting member **72**. Suitable legends may be printed on the end of the screw **74** to indicate high or low reserve.

Before the diver descends, he moves the reserve handle **24** to the retracted position of FIG. 1 and selects the degree of reserve that he wishes by rotation of the spring mounting member **72**.

By providing additional pairs of cam recesses, additional reserve selections can be determined.

The inventor claims:

1. In self-contained breathing apparatus a reserve valve mechanism having an inlet cooperable with a supply tank, and having an outlet; means operative upon a reduction in pressure of the supply to interpose an operative restriction between said inlet and said outlet to provide a reserve signal to the user of the near exhaust of breathable gases; manual override means for removing said restriction and to place the inlet and the outlet in substantially unrestricted communication whereby the remainder of breathable gases in said supply tank is freely available to the user; and means for adjusting the value of the pressure reduction at which said restriction becomes operative whereby the user preselects the quantity of breathable gases in said supply tank following the reserve signal.

2. The combination as set forth in claim **1** in which said means operative to interpose an operative restriction comprises a valve closure cooperable with a seat and a compression spring urging the valve to closed position.

3. The combination as set forth in claim **2** in which said adjusting means includes an abutment anchoring one end of said spring, and means for moving the abutment toward or away from said seat to change the tension of said spring.

4. In self-contained breathing apparatus: a valve body; means forming a valve chamber opening exteriorly of the body; means forming a valve seat at the inner end of said valve chamber; said valve body having passage means for conducting breathable gases from a supply tank to said valve seat; means forming an outlet extending laterally of said valve chamber for delivery to the user of the breathing apparatus; a valve member guided in said valve chamber for movement toward and away from said seat for closing and opening communication between said passage means and said valve chamber; a compression spring having an inner end engaging said valve member; a spring mounting member engaged by the outer end of said spring; a hollow closure attached to said body at said opening of said valve chamber, and having a cylindrical bore; said spring mounting member having a substantially cylindrical extension guided in said bore and mounted thereby for angular movement about the common axis of said bore and extension; and cam means operative between said closure and said spring mounting member for changing the axial position of said spring mounting member in accordance with its angular position thereby to determine one of a number of preselected spring pressures on said valve member and thereby the pressure at which the source is incapable of moving said valve member; and manual override means for positively retracting said valve member.

5. The combination as set forth in claim **4** in which said cam means includes a cam lobe formed on said spring mounting member and number of seat forming surfaces on the inner end of said closure located at different longitudinal positions.

6. The combination as set forth in claim **4** in which said spring mounting member has a pair of diametrically disposed angular cam lobes, said closure having a first pair of seat forming notches at its inner end cooperable with said cam lobes to determine one longitudinal position of said spring mounting member, said closure having a second pair of seat forming notches at its inner end angularly spaced from said first pair of seat forming notches and cooperable with said cam lobes to determine another longitudinal position of said spring mounting member.

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