Sept. 30, 1958 F. HUMBLET 2,854,001

BREATHING APPARATUS

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FIG. 1

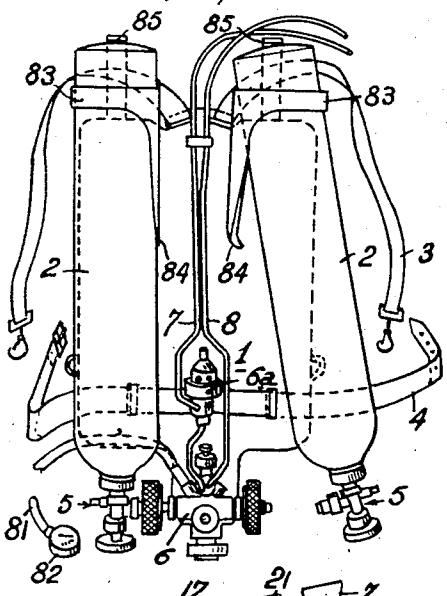
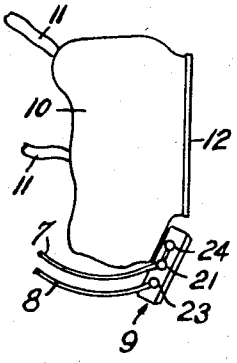


FIG. 2



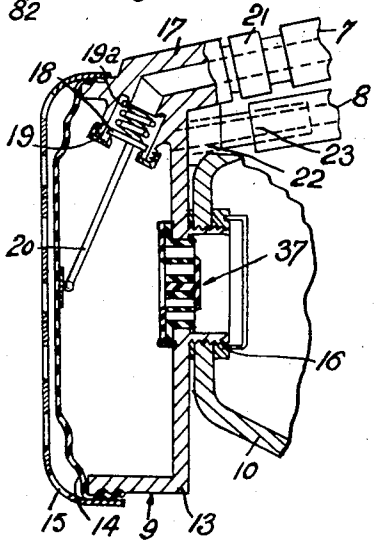


FIG. 3

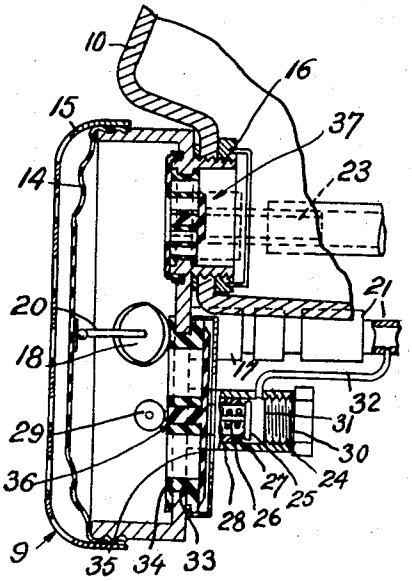


FIG. 4

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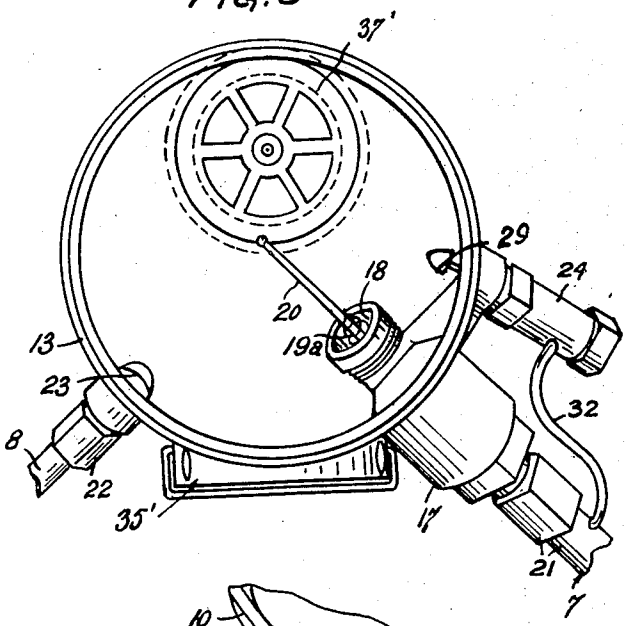
Fig. 5



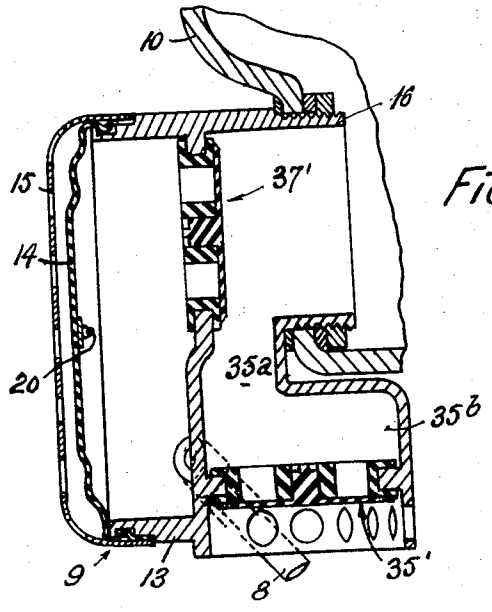


Fig. 6

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FIG. 7

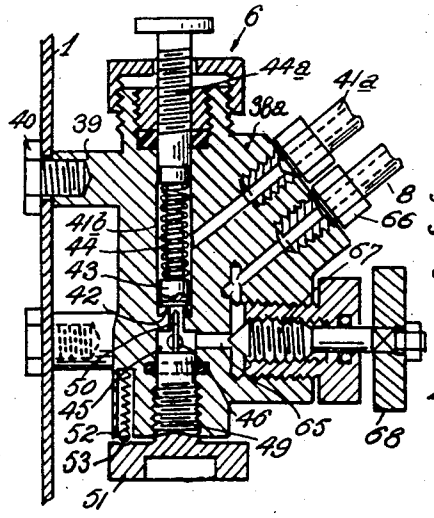

FIG. 8

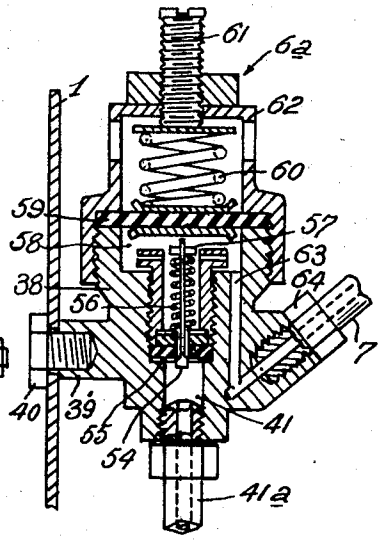

FIG. 9

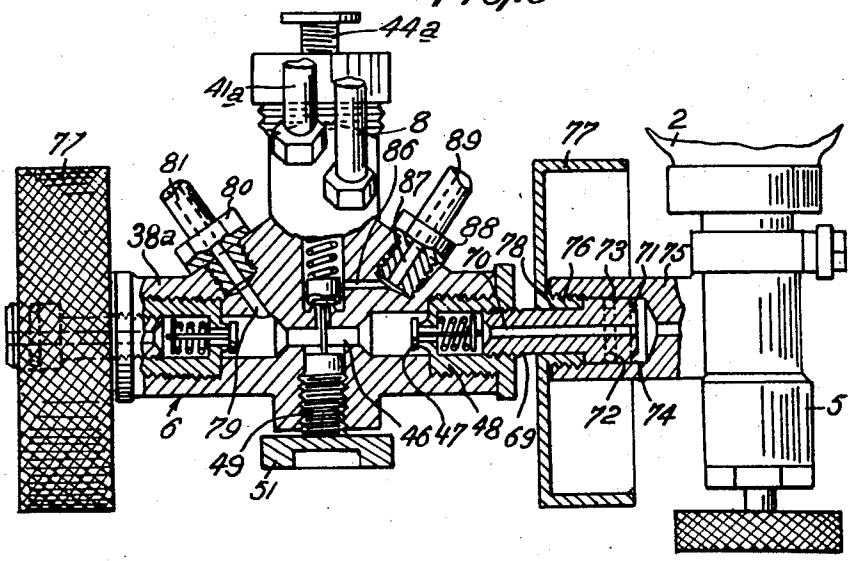

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FIG. 10

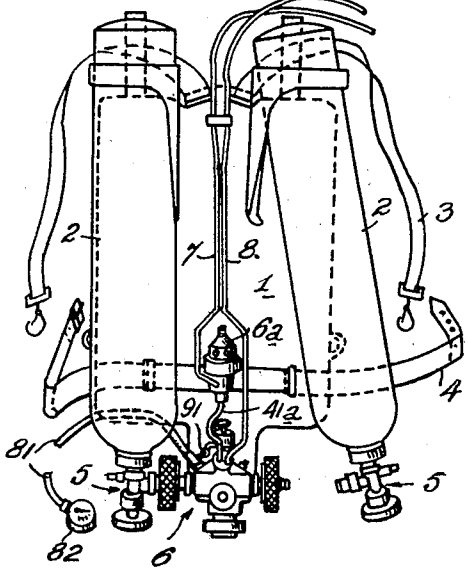

FIG. 11

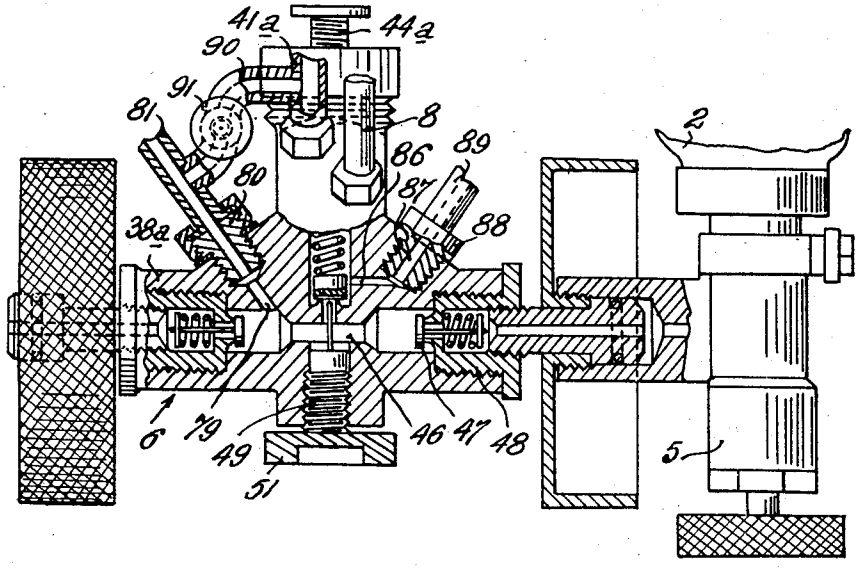

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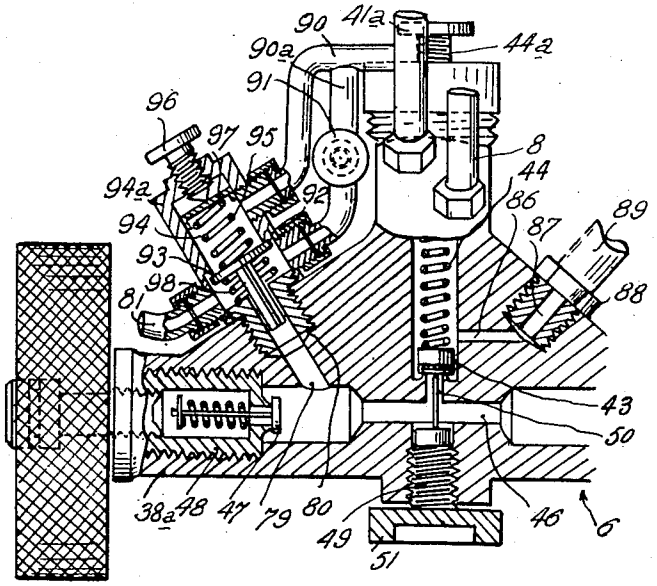
FIG. 12



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United States Patent Office

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BREATHING APPARATUS

François Humblet, Brussels, Belgium

Application May 23, 1955, Serial No. 510,230

Claims priority, application Belgium May 31, 1954

12 Claims. (Cl. 128—142)

The invention relates to breathing apparatus operating in open circuit which may be used on land and under water, and are generally called amphibious operating apparatus.

Apparatus of this kind are known which comprise one or several bottles or storage tanks containing air or other gas under pressure, for example an initial pressure of the order of 150 kgs. and of which the storage bottles or tanks are connected by means of removable couplings to a main pressure-reducing device wherein the pressure is lowered to an intermediate value, say of the order of 7 kgs., the said main pressure-reducing device itself being connected to a secondary pressure-reducing device, which may be arranged on the breathing mask and wherein the gas pressure is reduced to the usable pressure, said secondary pressure-reducing device being moreover arranged to operate on the demand of the user, that is in accordance with its respiratory movements.

The known apparatus of this kind have various disadvantages. For example the breathing mask is made of opaque material which not only limits the visibility but is a serious inconvenience to the user; various locations have been used for the secondary pressure-reducing device without due consideration to the pressure to which it may be subjected by the surrounding medium, particularly in diving, or to the influence of the dead space in the breathing mask and its connections with the pressure-reducing device.

Again, in some cases pressure differences may act on the inhaling and exhaust valves, while at the time the gas pressure in the bottle or tank being used has been lowered to the extent that the secondary pressure-reducing device will no longer be normally supplied, the end of this period of use of the gas supply, and hereafter called normal period of use, is imposed to the user with comparatively brutishness by a marked inhaling difficulty. Moreover the arrangement of the relief valve is not always judiciously effected to enable said valve to efficiently perform its duty. Finally the duration of use is limited to the capacity of the bottles or tanks initially equipping the breathing apparatus and due to the dispersion of the controls, the use of these apparatus is rendered difficult.

The invention aims to remedy these various drawbacks.

According to one feature of the invention, aside from the usual window, the breath mask is made of transparent or at least translucid material, this providing to the user either an increased field of vision or the possibility to see or to realize the presence of obstacles or dangers, thus aiding materially to increase the assurance of its movements, its security and its well being.

According to another feature of the invention, the secondary pressure-reducing device is arranged on the breathing mask at a location as closely as possible adjacent to the respiratory tracks, if desired while reducing the inner dead space of the breathing mask by the addition of a valve on the inhaling path of the air, the inhaling and exhaust valves being in any case arranged at substantially the same level near that of the respiratory tracks.

To give warning of the soon coming exhaust of the bottle or tank in service and avoiding the unpleasant effect of a sudden resistance to inhaling at the end of the aforesaid normal period of use of the gas supply and thus eliminating the danger which may be the result thereof, it is contemplated to operate a warning device, particularly of the acoustic type and audible under all the conditions of use as soon as the end of the aforesaid period approaches, permitting the user to take any desired step before a serious breathing difficulty takes place. Such a step may be, according to the invention, the forced opening of a gas inlet valve located upstream of the usual inlet valve to the main pressure-reducing device, which upstream inlet valve may be associated with a user actuated by-pass, or an automatic by-pass device or both, or also the operation of a relief valve which especially for this purpose is directly supplied in gas from the bottles or tanks, this arrangement additionally enabling to by-pass entirely both the main and secondary pressure-reducing mechanisms.

Other features and advantages of the invention will appear from the following more detailed description of certain preferred constructions given by way of examples only and illustrated by the diagrammatically annexed drawings, in which:

Fig. 1 is an elevation view of the breathing apparatus showing the assembly of the bottles or tanks and the main pressure-reducing device with their mutual connections.

Fig. 2 is a side elevation view of the breathing mask;

Figs. 3 and 4 show, partly in section, the secondary pressure-reducing device with the inhaling and exhaust valves;

Figs. 5 and 6 show in front and sectional view a second embodiment of the secondary pressure-reducing device.

Fig. 7 is a sectional view of a connection device for the bottles or tanks also showing the arrangement of the valve located upstream of the main and secondary pressure-reducing mechanisms;

Fig. 8 shows an axial section of the main pressure-reducing device;

Fig. 9 is another sectional view of the connection device of the bottles or tanks and the upstream valve;

Fig. 10 is a view similar to Fig. 1 showing the arrangement of a manually actuated by-pass device for the upstream valve;

Fig. 11 shows the arrangement of Fig. 9 and the manually operated by-pass device; and,

Fig. 12 shows in part the arrangement of Fig. 9 and the arrangement of an automatic and a manually operated by-pass device.

With reference to the drawings, **1** designates a supporting plate on which are mounted gas bottles or tanks **2** and other elements of the apparatus to be described later, and which is secured to the back of the user by means of straps **3** and a belt **4**.

The bottles or tanks **2** are provided with the usual valves or cocks **5** and are connected via a connection device **6** to a main pressure reducing device **6***a* connected by means of the distributing pipes **7** and **8** to a secondary pressure-reducing device **9** supported on the breathing mask **10** which is secured on its head by the user through any convenient system of resilient straps or bands **11** and is provided with an observation window **12**.

Independently of the window **12** the breathing mask **10** is made of a transparent or at least translucid material which otherwise has the required properties of flexibility and resiliency for closely fitting the outline of the user face.

Certain plastic materials answer these conditions while

being moldable and thus permitting a cheap manufacture of the breathing masks; for example polyvinyl resins may be used for this purpose.

Owing to this arrangement, even if the vision is not completely distinct through the walls of the breathing mask proper, the observation possibilities of the user are materially improved, that is to say that even through walls that are translucid only, the user will be able to realize the presence of obstacles or the coming on of a danger, thus avoiding the apprehension thereof, and providing him with an increased assurance and power of action.

The secondary pressure-reducing device **9** of the breathing mask **10** is mounted in a location as close as possible to the respiratory tracks, for example, as shown in Fig. 2, on the front part of the breathing mask below the window **12**, providing on the one hand for a complete clearance of the vision field and on the other hand avoiding that—as will more clearly appear later—the exhausted gas bubbles escaping through the exhaust valve incorporated in this pressure-reducing device should pass in front of the window **12** when the user is diving.

The pressure-reducing device shown with the inhaling and exhaust valves in Figs. 3 and 4, is formed with a casing **13** in front of which is secured a flexible diaphragm **14** protected by means of a perforated cover **15**, and having a rear hollow and screw threaded extension **16** enabling it to be suitably secured in an opening of the breathing mask **10**.

A nozzle **17** moulded integral with or secured to the casing **13** on the one hand serves to accommodate an inlet valve **18** pressed and centered on a seat **19** by means of a spring **19***a* and the stem **20** of which cooperates with the diaphragm **14**, and on the other hand receives the end connection **21** of the air pipe **7** coming from the pressure-reducing device **6***a*.

A second nozzle **22** of the casing **13**, also moulded therewith or secured thereto opens without obstruction in the inside of the casing and receives the end connection **23** of the air pipe **8** coming from the connection device **6**.

A third hollow nozzle **24** moulded with or secured to the casing **13** serves as a housing for a valve **25** that a spring **26** tends to move away from its seat **27**, the passage **28** extending from the seat **27** connecting with an acoustic warning device, such as a whistle, indicated at **29** and arranged in the inner space of the casing **13** or, if desired, inside the breathing mask **10**. A plug **30** closes the housing, and the space **31** between the valve **25** and the plug **30** connects through a pipe **32** of small cross section with the connection **21** of the pipe **7**.

Within a circular opening **33** of the back wall of the casing **13** is tightly accommodated the mount **34** of an exhaust valve of suitable type, for example formed by means of a thin disc **35** of rubber or like material retained in the mount **34** by means of a central extension **36**.

However other arrangements could naturally be used; particularly, a valve loaded with an adjustable spring could be provided, for example in order to be able to place the inner space of the breathing mask under a slight overpressure.

Preferably a similarly arranged, but double acting, valve is arranged in the hollow extension **16** as indicated at **37**.

Again in the arrangement according to the Figures 5 and 6, may be found the casing **13** and the nozzles **17**, **22** and **24**, the valve **18** and the acoustic warning device **29** with the same functions as before, but the exhaust valve **35'** is arranged in a downwardly directed extension **35***b* communicating through the passage **35***a* with the inner space of the breathing mask.

This arrangement has the advantage that in case water enters the breathing mask during diving, it will automatically pass in the extension **35***b* and be evacuated to the outside by the operation of the exhaust valve **35'**.

An inhaling valve **37'** similar structually to the valve **35'** may be provided as before between the inner spaces of the casing **13** and of the breathing mask.

Referring now to Figures 7 to 9, the main pressure-reducing device **6***a* is formed as a hollow body **38** provided with two or three hollow internally threaded protrusions **39** through which it is secured to the plate **1** by means of screws **40** or the like. In the body **38** is formed a bore **41** to the lower end of which connects a gas supplying pipe **41***a*. At the upper end of the bore **41** is arranged the valve **54** of the pressure-reducing device which cooperates with a seat **55** and is loaded with a spring **56** the tension of which is adjustable by means of a nut **57** screwed on the stem of the valve **54**. This stem extends in a chamber **58** to a flexible diaphragm **59** closing the chamber **58** and externally subjected to the ambient pressure and the action of a spring **60** the tension of which may be adjusted by means of the screw **61** passing through a cover **62** screwed on the body **38** and retaining the diaphragm **59** in position.

From the chamber **58** a channel **63** leads to a connection **64** to which is secured the pipe **7** connected to the nozzle **17** accommodating the air inlet valve **18** of the secondary pressure-reducing device of the breathing mask.

It will be understood that the diaphragm **59** being subjected to a pressure which is a function of the ambient pressure, the valve **54** will be opened to an extent in relation with this ambient pressure and thus will allow for the passage of more or less gas coming from the bore **41** when the valve **43** (Fig. 7) is moved away from its seat as described hereafter.

The pipe **41***a* is connected on the other hand to a bore **41***b* of the connection device **6** the body **38***a* of which is also secured to the supporting plate **1** by means of hollow protrusions **39** and screws **40**.

The bore **41***b* terminates at its lower end with a valve seat **42** with which cooperates a valve **43** loaded by a spring **44** the tension of which may be adjusted by means of the screw **44***a* closing the upper end of the bore **41***b*. The central opening of the seat **42** enables the bore **41***b* to communicate with a chamber **45** to open the passages **46** supplying the gas from the one or the other bottle or tank **2** via a loaded valve **47** supported in a removable socket **48** (Fig. 9).

The chamber **45** is closed by means of a screwed plug **49** furnished with a rod **50** and an operating head **51** in such a manner that a rotation of about 360° of the plug causes the rod **50** to be sufficiently raised to move the valve **43** away from its seat **42**, a locking device, such as a ball lock **52**, cooperating with notches **53** of the head **51** when occupying its extreme positions of rotation. Other arrangements could be provided; for example the rod **50** could be slidably mounted within a guide of the body **38***a* and be actuated by means of a cam or an eccentric member.

In the chamber **45** opens an additional passage **65** extending to a connection **66** to which is secured the pipe **8** connected to the breathing mask, the said passage **65** being closed by a needle-screw **67** having an operating head **68**, the arrangement allowing for the direct passage of the gas from the chamber **45** in the breathing mask under the control of the needle valve **67**.

For connecting the bottles or tanks **2** to the connecting device **6**, each of the sockets **48** is furnished with a bit **69** having an axial passage **70** and a widened head **71** in a circumferential groove **72** of which is arranged a packing **73** of ring shape and circular cross section made of a resilient or similar material, which packing cooperates with a smooth finished part **74** of a screw threaded socket **75** on the screw threaded portion of which may engage the screw threaded hub **76** of an operating hand wheel **77** freely rotatable on the smooth portion **78** of the tip **69**. The socket **75** is made integral

with or secured to the usual closure valve 5 of the bottles or tanks 2. Alternatively, the packing 73 could be accommodated in a circumferential groove of the smooth finished part 74; moreover, the hub 76 of the hand wheel 77 could be provided with the female member and the socket 75 with the male member of the screw connection.

In one or the other of the passages 46, between the valves 47, opens a passage 79 leading to a connection 80 to which is connected a pipe 81 leading to a pressure gauge 82 (Fig. 1).

To facilitate the mounting of the bottles or tanks, particularly when replaced by the user, provision is made (Fig. 1) for guiding their end remote from the valve 5 in a stirrup 83 fitting in part their cross sectional outline and having a depending branch 84 so oriented that when the bottle or tank contacts therewith said bottle or tank occupies the correct alignment for connection with the connecting device 6. Then, for adjusting the correct connecting level, there is provided a stop 85 arranged on the plate 2 or forming part of the stirrup 83 and with which the bottom of the bottle or tank contacts at said level. Fig. 1 shows that the bottle or tank is engaged in the stirrup 83 by an oblique movement from below upwards till its bottom contacts with the stop 85 and then moved against the depending branch 84 for its engagement with and connection to the connecting device 6.

Bottles or tanks normally loaded with gas having been mounted on the apparatus, if the user equipped with the apparatus and provided with the breathing mask opens the valve 5 of one of the bottles or tanks, the gas passes while opening the corresponding valve 47, to the chamber 45, from this chamber to the bore 41*b* while raising the valve 43, then through pipe 41*a* to the pressure-reducing device 6*a* and through the opening of the valve 54 into the chamber 58 and to the nozzle 17 via the passage 63, the connection 64 and the pipe 7. On an inspiration of the user, the valve 37 where provided opens and the depression being communicated to the inner side of the diaphragm 14 externally subjected to the ambient pressure, the sinking of the diaphragm opens the valve 18 and allows the air to pass in the casing 13 in accordance with the demand of the user, the diaphragm resuming its previous position with the closure of the valve 18 at the end of the inspiration.

On the expiration, the valve 37 of the Figs. 3 and 4 and then the valve 35, or the latter alone in the Figs. 5 and 6, open to permit the escape of the expired air, the cycle being repeated until the pressure in the bottle or tank in use has been lowered to such an extent that the spring 44 loading the valve 43 tends to predominate and to close the said valve.

From this moment at each inspiration a drop of pressure which progressively increases occurs in the pipe 7 and at the connection 21 and is communicated through the pipe 32 to the space above the valve 25 of the device designed 24, enabling the spring 26 to raise the said valve and causing the operation of the warning device 29. The user is thus warned with the lowering of the pressure in the bottle or tank in use to the extent that the secondary pressure-reducing device will no longer be normally supplied without having a support a respiratory trouble, the small quantity of air which passes directly in the casing 13 or the breathing mask through the pipe 32 to ensure the operation of the warning device not being dissipated but used by the user and moreover assisting to avoid the said respiratory trouble in case of a slightly insufficient load of the spring 26.

Then the user may either actuate the control of the rod 50 in order to raise the valve 43, thus restoring the supply of gas to the secondary pressure-reducing device through the valve 43, or open the needle valve 67 by acting on the operating member 68, this enabling the gas to pass from the chamber 45 via the passage 65 and the pipe 8, directly in the casing 13 and, or the breathing mask.

When the useful content of the bottle or tank in service is exhausted, of which the user will be warned by the operation of the warning device 29 in case the secondary pressure-reducing device has been maintained in circuit, that is if the first of the aforesaid operations has been effected by the user, gas may be obtained from the second bottle or tank, assumed to be normally loaded, by simply opening the valve 5 of the said bottle or tank, the gas thereof opening the corresponding valve 47 to enter the chamber 45 and due to its pressure closing the valve 47 of the exhausted or almost exhausted bottle or tank.

The normal operation of the apparatus is then restored by the reverse operation of the control 51 or 69 previously actuated.

Should it be useful or necessary to replace the exhausted bottle or tank, the user may attempt to do this by simply rotating the corresponding handwheel 77 in the unscrewing direction of the screw threaded connection 76, then moving away laterally the lower end of the bottle or tank to the position shown in Fig. 1 and finally removing it from the guide 83, the fresh bottle or tank being secured in position by the reverse operations already described.

Instead of operating the acoustic warning device 29 by the drop of pressure in the pipe 7 near the connection 21 with the intermittent operation of the said warning device, the warning device could be operated so as to operate in a continuous manner due to the progressive reduction in the gas pressure resulting from the closing stage of the valve 43 from the moment the pressure in the bottle or tank 2 in service is no longer sufficient to retain the said valve in the full opened position.

To this end the said valve may be constructed with a substantial axial length and approximately at a distance from the seat 42 which corresponds to said length, there is provided, Fig. 9, a passage 86 leading through a passage 87 of a connection 88 and a pipe 89 to the device indicated 24 and assumed to be independent, that is to say with the tubular connection 32 to the pipe 7 removed. The tension of the spring 26 loading the valve 25 of the device designed 24 being suitably adjusted, the warning device 29 will operate while the valve 43 moves past the entrance of the passage 86 to set on its seat 42. It is generally desirable in this case to have the bore 41*b* made with a narrowed cross section, not illustrated, near the seat 42 and to open the needle valve 67 for restoring the gas supply for the user, thus avoiding the resumption of the operation of the warning device 29 by a partial raising of the valve 43 through the rod 50.

Situations may occur in practice wherein the audible signal referred to above although emitted by the warning device 29 is not perceived by the user, or that, due to inattention, the user does not take care thereof, or also that the opening device for the valve 43 fails to operate.

Then when the resulting inhaling difficulty takes place, the user may, as aforesaid, operate the member 68 to supply air through the pipe 8 from the chamber 45 directly to the inner space of the breathing mask, but in this case it runs the risk of the equally annoying effects of a gas overfeed while the overpressure then predominating in the breathing mask cause the exhaust valve 35 to be opened resulting in unwanted losses of gas.

It is important to be able to remedy such events and to this end, according to yet another feature of the invention, provision is made to by-pass the valve 43 having reached its closing position, by means of either a manually actuated device or an automatic device or both, retaining in operation the main and secondary pressure-reducing devices.

Simply by way of example, the Figures 10 to 12 of the annexed drawings show how such by-pass devices may be arranged.

As illustrated in these figures, from a passage such as **79** which is in permanent communication with the chamber **45**, and particularly from a preferably stiff end of the pipe **81** leading to the pressure gauge **82**, by means of at least one branch pipe **90** there is formed at least one derivation passage towards the pipe **41***a* leading from the connecting device **6** to the main pressure-reducing device **6***a*, and with each such branch pipe, is associated an obturating device adapted when opened to by-pass the valve **43**.

In the embodiment according to the Figs. 10 and 11, the obturating device is designated **91** and is of the manually actuated type, and preferably formed by means of a needle screw, it being understood that any other type of manually operated obturating device could be used.

In this case, naturally, it will be sufficient for the user to unscrew the needle screw to the necessary extent from its closing position for restoring the desired gas supply under the control of the main and secondary pressure reducing devices.

In the arrangement according to Fig. 12, the automatic obturating device comprises a valve **92** cooperating with a seat **93** of a chamber **94** formed in a casing **94***a* which may be secured, for example tightly screwed on the male part of the connection **80** screwed in the body **38***a*, the said valve being urged to its open position by a spring **95** the tension of which may be adjusted by means of a screw **96** while interposing a bearing and packing member **97**. It may be convenient or necessary also to provide a spring **98** for returning the valve **92** on its seat, and it will be understood that the adjustment is such that the opening of the valve **92** takes place for a pressure in the chamber **45** which is slightly lower than that enabling the closure of the valve **43**.

Under such conditions, the closure of the said valve **43** causes the inhaling difficulty and the operation of the acoustic warning device in either of the manner already described, where upon the action of the spring predominating, the valve **92** opens to restore the flow of air towards the pipe **41***a* via the branch pipe **90**.

As will be seen on the figure, to the part of the chamber **94** which is located upstream of the valve **92**, it is easy and convenient to connect an auxiliary branch pipe **90***a* which is provided with a manually operable obturating device, preferably an obturating device of the needle screw type **91**. Thus in any case the desired flow of air towards the pipe **41***a* is or may be restored.

Assuming the aforesaid operations effected at the time a first bottle or tank is exhausted, the automatic obturating device will close automatically when the second bottle or tank is put in service, and naturally the user will have to close the manually operable obturating device assumed to have been opened, in case he wishes to be advised with the exhaust of the second bottle or tank by the operation of the warning device **29**.

From the foregoing and the figures of the drawings result that the various control members to be actuated by the user are arranged close together in a reduced area and are of easy access.

As already pointed out, the described embodiments are by way of example only and modifications may be made therein as regard the constructional arrangements and details without exceeding the limits of the invention. For example, the pressure-reducing device **6***a* may be arranged in the upper part of the plate **2**, retaining at the level of the valves **5** of the bottles or tanks **2** the connection device **6** for the bottles or tanks and the control member to be actuated by the user.

I claim:

1. A breathing apparatus comprising gas bottles, a main pressure-reducing device, a connection device for said bottles and pipes for coupling said connection device with said main pressure-reducing device, a breathing mask substantially entirely of translucid material, a secondary pressure-reducing device secured in front of the breathing mask, communication defining means between the secondary pressure-reducing device and the inner space of the breathing mask, an inhaling valve and an exhaust valve operatively associated with said mask, and a double acting valve in the said communication defining means.

2. A breathing apparatus comprising gas loaded bottles, a connection device for coupling said bottles, a gas inlet valve in said connection device and means for seating said valve upon a predetermined fall of the gas pressure in the bottles, a main pressure-reducing device, a secondary pressure-reducing device, a breathing mask, an inhaling and an exhaust valve operatively associated with the breathing mask, pipe connections between the said connection device, main pressure-reducing device, secondary pressure-reducing device and breathing mask whereby gas from the bottles may be supplied to said breathing mask under control of the said gas inlet valve, a pneumatically operable warning device operatively associated with the breathing mask and operative means associated with the warning device for operating same on operation of the said seating means of the said gas inlet valve.

3. A breathing apparatus as in claim 2, wherein the warning device operating means comprise a casing, whistle means, a communication passage between said casing and said whistle means, a valve for closing said passage and a predetermined resilient load for said valve, a chamber adjacent said valve in said casing, and a communication between said chamber and a gas supplying pipe to the breathing mask whereby said whistle means are operated on closure of the said gas inlet valve.

4. A breathing apparatus as in claim 2, comprising an elongated slidable gas inlet valve, a guide section for said inlet valve with a small interspace between them, a casing, whistle means, a communication passage between said casing and said whistle means, a spring loaded valve for closing said passage, a chamber adjacent said valve in said casing and a pipe connection between said chamber and said guide section to operate said whistle means during the travel of said gas inlet valve in the said guide section.

5. A breathing apparatus comprising gas loaded bottles, a connection device for coupling said bottles, a gas inlet valve in said connection device and means for seating said valve upon a predetermined fall of pressure in the bottles, a main pressure-reducing device and pipes for connecting said connection device with said main pressure-reducing device, a breathing mask, a secondary pressure-reducing device on said breathing mask and connection pipes between said main and secondary pressure-reducing devices, an inhaling valve and an exhaust valve operatively associated with the breathing mask, a pneumatically operated warning device operatively associated with the breathing mask, a communication passage of small section between a connection pipe between said main and secondary pressure-reducing devices and the said warning device, and actuating means associated with the said warning device for operating same on operation of the said seating means of the said inlet valve.

6. A breathing apparatus comprising gas loaded bottles, a connection device for coupling said bottles, a gas collecting chamber and a gas inlet valve in said connection device, means for urging said gas inlet valve on its seat upon a predetermined fall of the gas pressure in the bottles and operative from a predetermined minimum value of said gas pressure, a main pressure-reducing device, a secondary pressure-reducing device, a breathing mask, an inhaling an an exhaust valve operatively associated with the breathing mask, pipe connections between the said connection device, main pressure-reducing device, secondary pressure-reducing device and breathing mask whereby gas from the bottles may be supplied to said breathing mask under control of the said gas inlet valve in all loaded condition of the bottles above said

minimum gas pressure, pipe connection means between the said gas collecting chamber and the pipe connection between the connection device and the main-pressure-reducing device and means in the last named pipe connection means for controlling the flow of gas therethrough.

7. A breathing apparatus as in claim 6 comprising manually operable means for controlling the flow of gas in the last named pipe connection means.

8. A breathing apparatus as in claim 6 comprising automatic means for controlling the flow of gas in the last named pipe connection means.

9. A breathing apparatus as in claim 6 wherein the means for controlling the flow of gas through the last named pipe connection means comprise a casing, a communication passage between said casing and said collecting chamber, a valve seat in the casing and a valve cooperating with said seat and adjustable spring means for loading said valve, whereby to allow for the passage of gas from said collecting chamber through the pipe connection upon operation of the means for urging the said gas inlet valve on its seat.

10. A breathing apparatus as in claim 6, comprising a casing, a communication passage between said collecting chamber and one end of said casing, a valve seat intermediate the ends of the casing, a valve cooperating with said seat and adjustable spring means for urging said valve on its seat, whereby to divide the inner space of the casing into one compartment in permanent communication with said collecting chamber, and a second compartment controlled by said valve, a branch pipe leading from said second compartment to the main pressure-reducing device, a branch pipe leading from the said one compartment to the main pressure-reducing device, and a manually operable means for controlling the flow of gas through the last named branch pipe.

11. A breathing apparatus as in claim 6 comprising a direct passage from the said collecting chamber to the breathing mask and manually operable means associated with said direct passage for controlling the flow of gas therethrough.

12. A breathing apparatus comprising gas loaded bottles, a connection device for coupling said bottles, said connection device including a collective chamber, a communication passage between said chamber and each bottle and a spring loaded non return valve in each communication passage, a gas inlet valve in said connection device and means for seating said valve upon a predetermined fall of the gas pressure in the bottles, a main pressure-reducing device, a secondary pressure-reducing device, a breathing mask, an inhaling and an exhaust valve operatively associated with the breathing mask, pipe connections between said connection device, main pressure-reducing device, secondary pressure-reducing device and breathing mask whereby gas from the bottles may be supplied to said breathing mask via said main and secondary pressure-reducing devices, a pneumatically operable warning device operatively associated with the breathing mask, operative means associated with the warning device for operating same on operation of the said seating means of the said gas inlet valve, a direct passage from the said collecting chamber to the breathing mask and manually operable means associated with said direct passage, means for by-passing the said gas inlet valve in said connection device direct to the main pressure-reducing device and control means for the said by-passing means.

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