

March 3, 1959

E. GAGNAN

2,875,756

OPEN CIRCUIT BREATHING APPARATUS

Filed Feb. 7, 1955

2 Sheets-Sheet 1

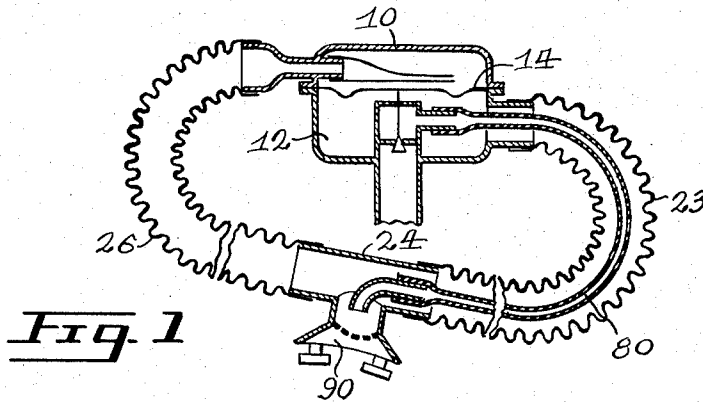


Fig. 1

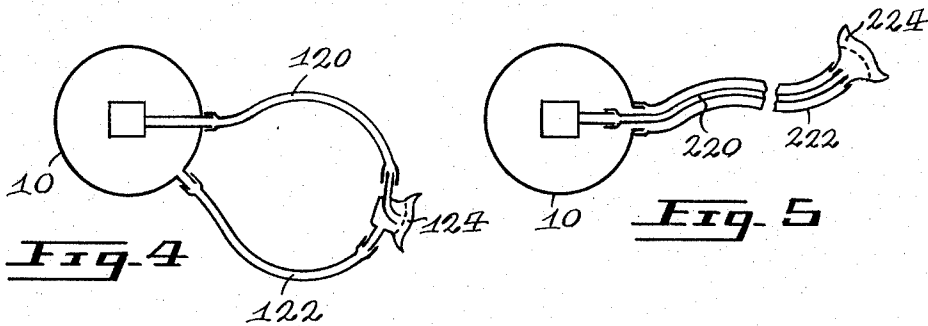


Fig. 4

Fig. 5

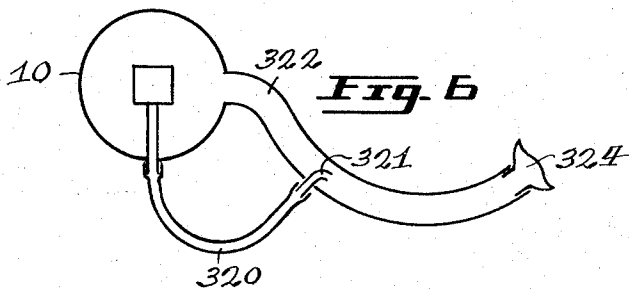


Fig. 6

Inventor
EMILE GAGNAN

By *W. A. Swabey*
Attorney

March 3, 1959

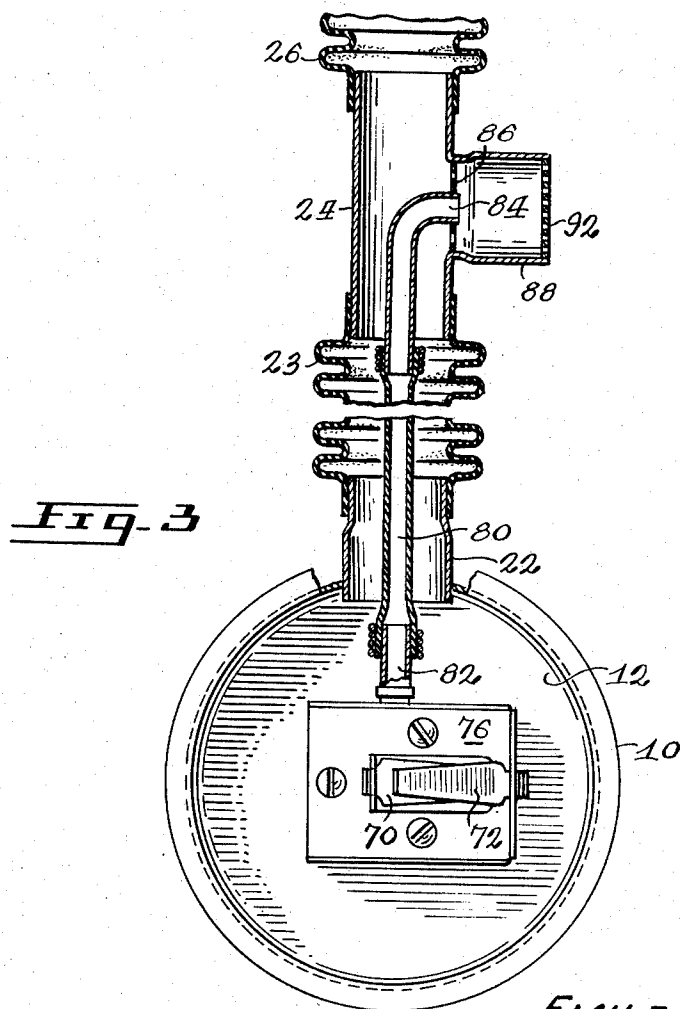
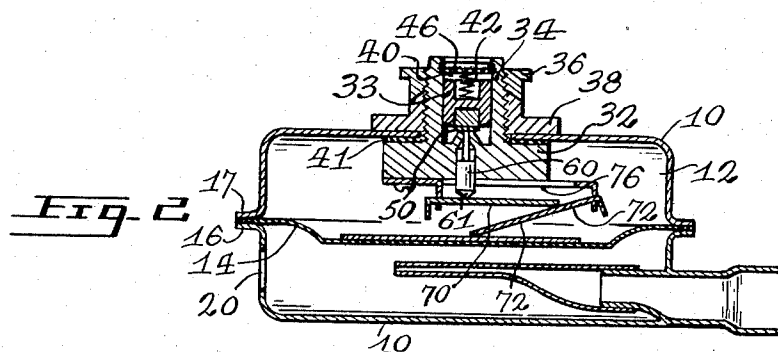
E. GAGNAN

2,875,756

OPEN CIRCUIT BREATHING APPARATUS

Filed Feb. 7, 1955

2 Sheets-Sheet 2



Inventor
EMILE GAGNAN

By *Alb. Swaby*
Attorney

1

2,875,756

OPEN CIRCUIT BREATHING APPARATUS

Emile Gagnan, Montreal, Quebec, Canada, assignor to
La Spirotechnique Societe Anonyme, Paris, France

Application February 7, 1955, Serial No. 486,540

4 Claims. (Cl. 128—142)

The present invention relates to improvements in the open circuit type of respiratory apparatus in which a breathable gas, for example, air compressed under a very high pressure in a cylinder, is expanded in a pressure regulator to a pressure substantially equal to that of the unbreathable medium wherein the apparatus is being used, and fed under this balanced pressure to the user who expels the breathed gas directly into the medium.

The usual pressure regulator in an apparatus of this type includes a chamber provided with a diaphragm, the outer face of which is subjected to the pressure of the ambient medium. The consequent deformation of the diaphragm controls a valve which feeds the gas under pressure into the regulator chamber. This valve is constructed and regulated so as to open as soon as the pressure inside the chamber falls to a certain value below the pressure of the outside medium and it closes as soon as the pressure within the chamber is at least equal to the outside pressure. The user can only breathe in the air previously fed to this chamber which is conducted to his mouth by a single air conduit which necessarily is of large diameter so as to give an adequate supply, and of sufficient length to extend from the regulator to adjacent the mouth of the user.

These conditions give rise to the following effects:

Due to the section of the air conduit, a pressure drop occurs between the regulator chamber and the mouth of the user creating for him an additional effort in breathing. In addition to that effort, when the apparatus is used in diving, the diver must also usually contend with the difference in pressure between that acting on the regulator and the center of his lungs, as long as the regulator, located on the diver's back, is normally located above his body in the water. Accordingly, the breathing of the diver is facilitated if a raise of pressure is provided in the air conduit to counteract these pressure differences.

The present invention aims to obviate this drawback and also, in some of its embodiments, to eliminate the effect of the load losses in the air intake conduit which makes it possible to use pipes having a small diameter for connecting the pressure regulator to the mouth piece. To this end the invention is characterized in that, in a respiratory apparatus comprising: a mouth piece, a diaphragm type regulator controlling an outlet valve for a breathable gas under pressure, a conduit for leading to the mouth piece or mask the gas delivered by the valve and a valve for breathing out to the ambient medium, the air intake conduits extends from the very outlet of the valve and in connecting by a balancing conduit, separate, at least in part, from the air intake conduit, the mouth piece or mask and the diaphragm chamber for balancing the pressures therein.

There results from this definition of the principle of the invention that both the air intake and balancing conduits, when they are entirely separate, may, without any inconvenience, have a small section, since:

The air pressure at the outlet from the valve being

2

always considerably higher than the balancing pressure to be ensured in the mask or mouth piece, the arrival of air in the latter will always be capable of maintaining therein this balancing pressure whatever the load losses may be in the air intake conduit.

The invention is capable of various forms of embodiment and in particular of those in which one or the other of the following features are applied:

(a) The two conduits for in-breathing and balancing are separate over their entire length.

(b) In one preferred form the two separate conduits are coaxially arranged, the inner conduit constituting the in-breathing conduit and the annular space between the two conduits constituting the balancing conduit.

(c) The gas outlet valve is set up on a box contained in the chamber adjacent to the diaphragm of the regulator and delivers the breathable gas directly into a conduit connected with the mouth piece or mask.

(d) In apparatus of the type embodying the invention, it frequently happens that pulsations occur which are disagreeable to the user of the apparatus. These pulsations are mainly due to the fact that the flow of air from the air delivery means to the respiratory tracts of the user is relatively unobstructed. To avoid this the present arrangement preferably provides a screen or perforated plate which is disposed transversely to the flow.

(e) The air delivery conduit is disposed in a position relative to the air intake and exhaust member connected to the respiratory tracts of the user so that the stream of air delivered from the air intake conduit is directed to the respiratory tract of the user at an increased pressure while no increase in pressure is transmitted to the balancing circuit.

This application is a continuation-in-part of United States patent application Serial No. 434,859 filed June 7, 1954.

With particular reference to the accompanying drawings, there is shown by way of illustration preferred embodiments of a respiratory apparatus, wherein examples are illustrated of a pressure air delivery means in accordance with the invention, and in which:

Figure 1 is a diagrammatic view of a preferred form of a breathing apparatus embodying a pressure controlling arrangement in accordance with the invention.

Figure 2 is an enlarged cross sectional view in side elevation of the pressure regulator showing the diaphragm and inlet valve arrangement in more detail.

Figure 3 is a diagrammatic view, in plan, of the pressure regulator with a preferred arrangement of a direct feed air conduit to show the relative position of the inner terminal end relative to the air intake and exhaust member of the mouthpiece or mask.

Figure 4 is a diagrammatic view of an alternative regulator and air distribution arrangement wherein the air intake conduit leads separately to the air distribution member connectable to the respiratory tract of the user with a supplementary balancing conduit leading back to the regulator chamber.

Figure 5 is a diagrammatic view of an alternative arrangement similar to the preferred arrangement shown in Figure 3 wherein the terminal end of the air delivery tube is disposed in alignment with the intake orifice of the air distribution member.

Figure 6 is a diagrammatic view of a further alternative arrangement wherein the air delivery tube is separate and is introduced to the air intake conduit at a point intermediate the regulator and the air distribution member with the terminal end of the air delivery tube directed along the axis of the air conduit.

As shown generally in Figure 1, and more specifically in Figures 2 and 3, a respiratory apparatus of the type

3

wherein the present invention is embodied includes a regulator casing 10 having an inner chamber 12, the upper deformable wall of which is constituted by a flexible diaphragm 14. The diaphragm 14, as shown, is clamped along its periphery between a flange 16 of the top portion of the casing 10 and a corresponding flange 17 of the casing bottom portion. The top portion of the casing 10 includes numerous openings 20 to allow the pressure of the surrounding medium, the unbreathable atmosphere, or water in the gas of a diving apparatus, to react on the outer face of the diaphragm.

The casing 10 includes an outlet nipple 22 to which the outer air intake conduit 23 is attached and extends to one side opening in a T fitting 24 extending from the mouthpiece 90. A similar exhaust conduit 26 extends from the other side opening of the fitting 24 to a connection with a flapper type exhaust valve located in the upper portion of the regulator casing 10.

In the construction shown in Figures 2 and 3, the air inlet valve is mounted within a valve box 32 secured to the bottom of the lever portion of the casing 10. The valve box 32 is provided with a threaded tail piece 34 which passes through a central opening provided in the casing 10 and is retained in position by a lock nut 36. An outer sealing flange 38 is placed between the bottom of the casing 10 and the lock nut 36 and a sealing gasket 41 is placed between the valve box 32 and the inside of the casing 10 respectively to complete the seal.

The valve box 32 shown includes a lower recess 33 extending through the box tail piece 34 and a valve block 40 is slidably mounted in the recess. A coil spring 42 is provided in the recess 33 between the block 40 and a perforated plate 46 closing off the outer end of the valve box tail piece. A valve seat 50 is provided on the lower portion of the valve box 32 at the inner end of the recess 33 and the spring 42 normally acts so as to resiliently urge the valve block 40 against the valve seat. A further coaxial recess leads from the recess 33 through the valve seat 50 to the upper surface of the valve box 32. This recess is shaped so as to have a lower portion of reduced diameter adjacent the valve seat 50 and an upper portion of greater diameter adapted to accommodate the main body of a needle pusher 60. The needle pusher 60 includes a lower stem portion which fits through the recess portion and rests on top of the valve block 40. A suitable outlet passage connects the valve recess upper portion with the air delivery conduit.

In the construction shown, the deflection of the diaphragm 14 is transmitted to the portion 61 of the needle 60 through a pair of co-operating lever arms 70, 72 which are each pivotally supported at one end on a supporting bracket 76 mounted on the valve box 32 so that the lever arm 70 overlaps the top of the needle 60 and the lever arm 72 overlaps the lever arm 70. A source of gas under pressure, in this case a high pressure air cylinder is connected to the valve tail piece 34 by suitable means (not illustrated).

In accordance with the present invention, the air under pressure delivered through the valve arrangement described, and under the influence of the inhalation of the user, is not discharged directly into the inner chamber 12 adjacent the diaphragm 14 as is known in prior apparatus of this type.

In the present arrangement, means are provided for directing the air under pressure delivered through the inlet valve through a separate conduit directly connected at one end to the inlet valve with the other end extending exteriorly of the regulator to a position where it is adapted to deliver a flow of air under pressure towards the portion of the apparatus connected to the respiratory tracts of the user. This flow of air is directed by the air delivery conduit in a direction opposed to the flow of the exhaust air coming from the user's respiratory tracts towards the balancing circuit of the apparatus.

In one preferred arrangement shown in Figure 2, this

4

is accomplished by an interior air delivery conduit 80 which extends through the conduit 23 from an air delivery nipple 82, connected directly to the outlet passage 62 of the valve box 32, to a tubular air delivery member 84 mounted within the T fitting 24. The member 84 is supported within the fitting 24 by a supporting bracket 86 mounted across the fitting portion 88. The bracket 86 supports the end 85 of the member 84 concentrically of the portion 88 so that the stream of air delivered through the air delivery tube is directed towards the usual mouthpiece or mask fitting through which the user of the apparatus breathes.

In the construction shown, the mouthpiece 90 is connected directly to the fitting portion 88. A screen or grill 92 is mounted across the open end of the fitting portion 83 to partially deflect and break up the air flow so as to avoid vibrations or pulsations of the apparatus in use. While it is not illustrated in detail, it is also contemplated that a further conduit or extension could be placed between the fitting portion 84 and the actual mouthpiece, or mask, in the case where such an arrangement would be more convenient.

Since the exterior conduit 23 is of greater diameter than the interior air delivering conduit 80, the annular space between these conduits provides a space for air to pass to balance the circuit.

As an alternative arrangement, as shown generally in Figure 4, a similar effect can be achieved if an air delivery conduit 120 is connected directly from the air inlet valve as previously described with the terminal end again disposed in a position relative to the air intake and discharge portion of the apparatus whereby the stream of air is directed towards the respiratory tracts of the user. In this arrangement, instead of a co-axial exterior conduit, a separate balancing conduit 122 is utilized which extends from the mouthpiece 124 or equivalent to the inner chamber of the regulator.

The construction shown generally in Figure 5 is quite similar to that shown in Figures 2 and 3 with the exception that the discharge end of the air delivery conduit 220 is disposed in front of the mouth piece 224. The action is the same since the stream of air from the conduit 220 is directed towards the inhalation of the user with the exterior conduit 222, being connected to the inner chamber of the regulator to balance the circuit.

In the still further arrangement shown generally in Figure 6, the air delivery conduit 320 is connected directly to the air inlet valve as before but is connected into the air intake conduit 322 at a point intermediate its connection with the regulator inner chamber 12 and the mouthpiece 324. In this construction the discharge end 321 of the air delivery conduit 320 is directed along the axis of the conduit 322 so that the air at increased pressure is still directed towards the inhalation point of the apparatus. The balancing of the circuit is of course maintained through the conduit 322.

In all of the constructions described it will be appreciated that a main feature resides in the fact that a separate conduit delivers a flow of air, at a higher pressure than the balancing pressure, more or less directly towards the mouthpiece, or the equivalent, of the breathing apparatus, in a direction opposed to the flow of the exhaust air from the user of the apparatus into the mouthpiece towards the balancing circuit of the apparatus. In other words, the user inhales air at an increased pressure, while no increase in pressure is transmitted to the balancing circuit.

I claim:

1. In an open circuit breathing apparatus for divers, in combination, a pressure regulator including an inner chamber, an inlet valve in said chamber for a breathable gas fed from a pressure source, valve controlling means mounted in said regulator including a diaphragm having an outer face exposed to ambient pressure, an air inhalation and exhaust member adapted for attachment to

5

the respiratory tracts of the diver, a balancing pipe between the inner chamber of the regulator and said member, and an air delivery conduit having one end connected to the air discharge of the inlet valve and the other end projecting at least partially within and adapted to act in cooperation with said balancing pipe as an injector device for simultaneously supplying the diver with breathable gas and increasing the suction effect in said inner chamber.

2. A respiratory apparatus as claimed in claim 1, in which the air delivering conduit extends inside the balancing pipe by leaving in said balancing pipe an annular space for connecting the inner chamber of the regulator and the inhalation and exhaust member attached to the respiratory tracts of the diver.

3. A respiratory apparatus as claimed in claim 1, in which the air delivering conduit is separate from the balancing pipe throughout its length and its outlet end consists of a nozzle entering the balancing pipe and being arranged coaxially to said balancing pipe and directed so as to increase the suction effect in the inner chamber of the regulator as soon as said nozzle delivers air under pressure.

4. In an open circuit breathing apparatus for divers, in combination, a pressure regulator including an inner chamber, an inlet valve in said chamber for a breathable

6

gas fed from a pressure source, valve controlling means mounted in said regulator including a diaphragm exposed to ambient pressure, an air inhalation and exhaust member adapted for attachment to the respiratory tracts of the diver, a balancing pipe between the inner chamber of the regulator and said member, an air delivery conduit of a lesser diameter than said balancing pipe and extending from the outlet of the inlet valve to said member inside said balancing pipe, the outlet of the air delivery conduit consisting of a nozzle adapted to constitute, in cooperation with the air inhalation and exhaust member, an ejector for simultaneously supplying the diver with air and increasing the suction effect in the inner chamber of the pressure regulator, and a perforated screen provided between the outlet of said nozzle and the entrance of the diver's respiratory tracts.

References Cited in the file of this patent

UNITED STATES PATENTS

2,616,442 Holmes ----- Nov. 4, 1952

FOREIGN PATENTS

538,809 Germany ----- Nov. 19, 1931
138,350 Australia ----- Aug. 16, 1950
663,202 Great Britain ----- Dec. 19, 1951