Feb. 24, 1959 R. GALEAZZI 2,874,692

OPEN-CYCLE BREATHING EQUIPMENT, PARTICULARLY FOR SKIN-DIVERS

Filed Sept. 14, 1955 3 Sheets-Sheet 1

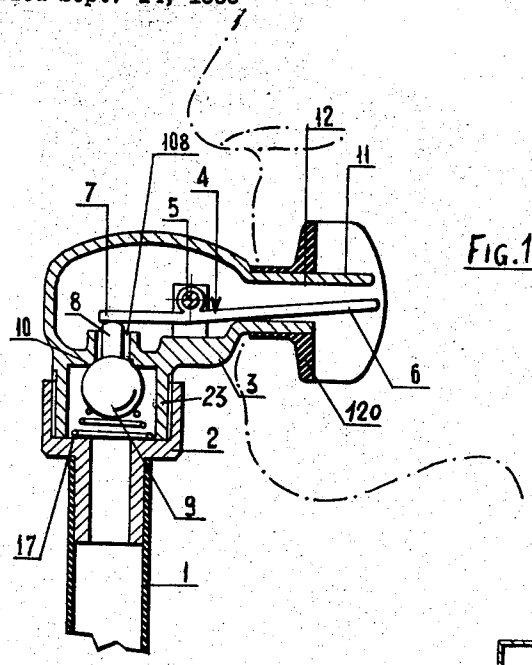

FIG. 1

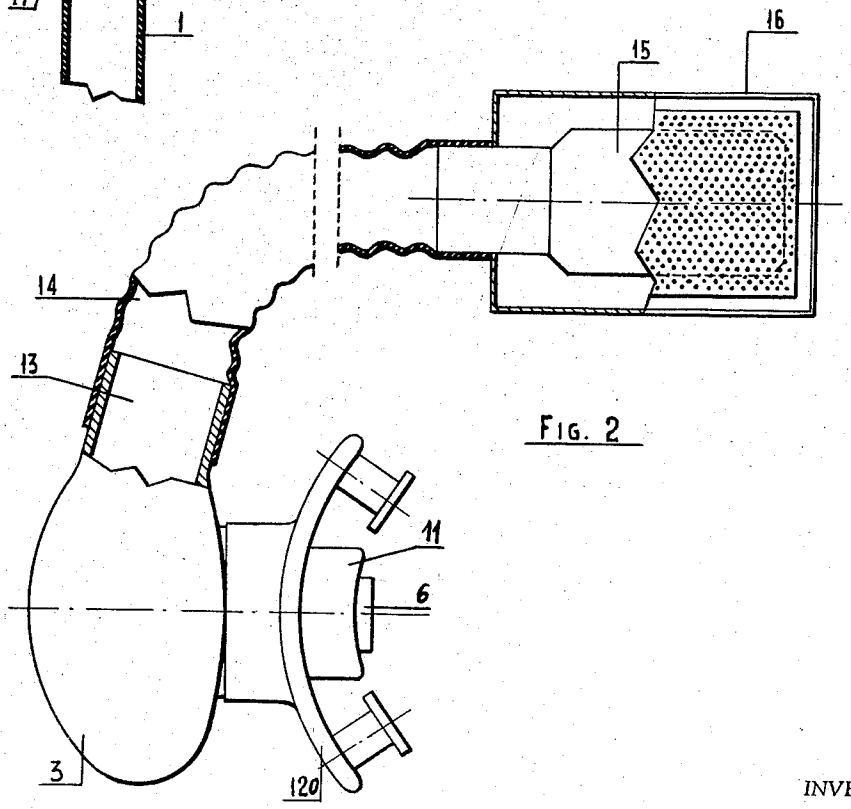

FIG. 2

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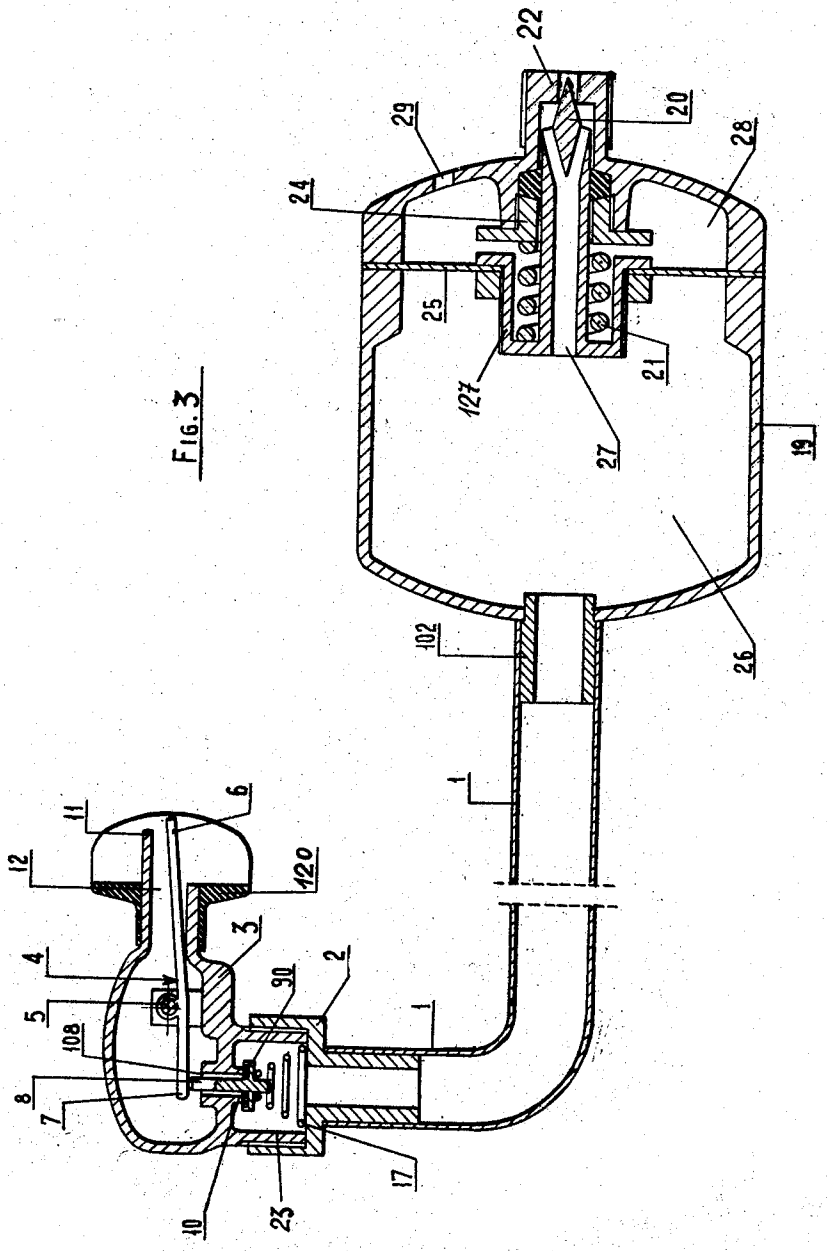
FIG. 3



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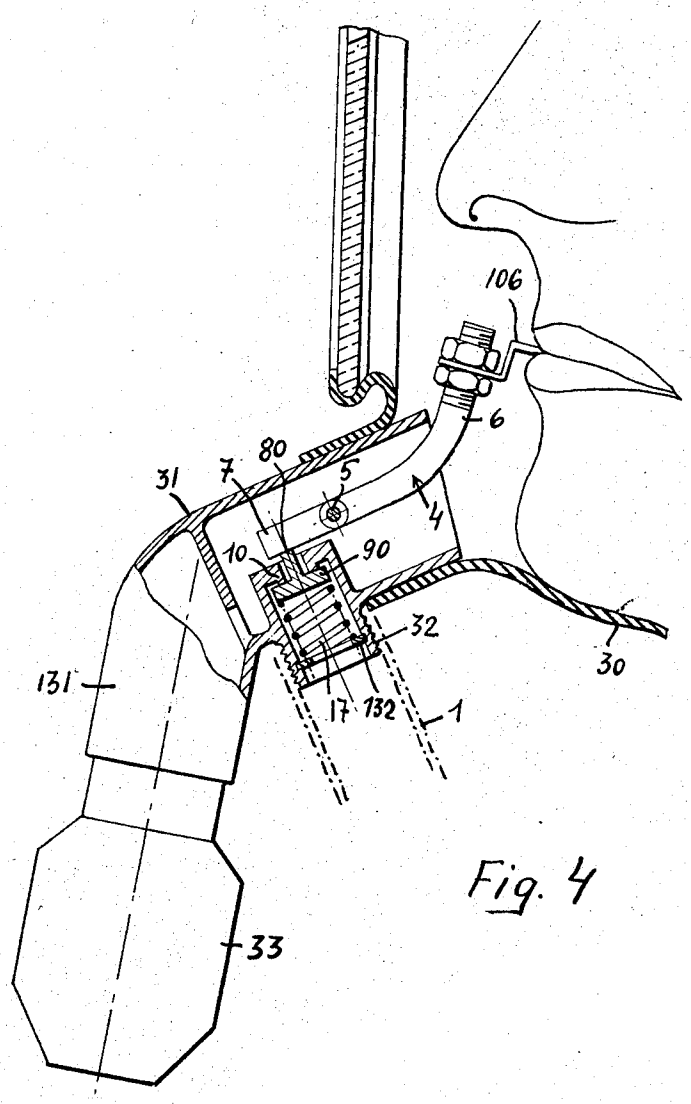

Fig. 4

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OPEN-CYCLE BREATHING EQUIPMENT, PARTICULARLY FOR SKIN-DIVERS

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Claims priority, application Italy September 25, 1954
5 Claims. (Cl. 128—142)

This invention relates to open-cycle breathing equipment and particularly to underwater breathing equipment for skin-divers or "frogmen" viz. by divers who, without a diving suit, remain under water for considerable time (up to some hours according to the diver's ability and the diving depth).

The main object of the invention is to provide in open-cycle breathing equipment an "air"-intake valve or "breathing valve" (whereby the term "air" is used to comprise not only the air proper, but breathing mixtures of oxygen with helium, argon or other diluent gases) which is positively controlled from the user's mouth, by the user's tongue, teeth or lips, according to its construction, thus avoiding either an undue excessive air consumption, as is the case in the continuous air flow breathing equipments, or an objectionable breathing valve control by hand.

Another object of the invention is to provide an underwater breathing equipment in which the outlet piece of the air-intake tube or "breathing tube" is attached to a conventional diver's mask and thus needs not to end with an objectionable mouthpiece, while the breathing valve is provided with a control lever which is easily controllable by the diver's tongue, teeth or lips.

Still another object of the invention is to provide a differential valve particularly adapted for use on underwater breathing equipment, of the kind above-referred to, which ensures that the air which is fed to the intake tube has always a predetermined pressure in excess (say 1–2 atmospheres) of the pressure due to the head of water at which the diver is working, thus avoiding the noxious effects due to the variation of the pressure in the air-bottles during the use.

Other objects and advantages will become apparent from the following specification in conjunction with the accompanying drawings in which:

Figure 1 is a section through an embodiment of an air-outlet piece of a breathing equipment, provided with a tongue- or teeth-controlled breathing valve.

Figure 2 is a plan view of the same air-outlet piece and breathing valve, together with a part of the flexible exhaust tube and with the exhaust valve inserted in an air bubble-fractionating perforated canister, said parts being also shown partly in section and partly broken away.

Figure 3 shows in section a second embodiment of air outlet piece of breathing equipment provided with a controlled breathing valve attached to the intake tube and carrying a differential pressure-reducing valve, and

Figure 4 is a section through another outlet piece of a breathing equipment, fitted to a diver's mask.

With reference to the drawings, **1** is the air-intake or breathing tube of a breathing equipment and which is connected to a source of air under suitable pressure, which may be either an air pump or compressed air bottles, which may be both of conventional construction, and therefore need not to be shown or described.

In the embodiment shown in Figures 1 and 3 the tube **1** is connected to a nipple forming an extension of an internally screw-threaded cylinder **2** in which an open-ended cylindrical flange **23** of a hollow air-outlet piece **3** is screwed. The part from which this cylindrical flange projects has a centrally perforated hub **10** the end of which that opens into said cylindrical flange **23** is formed as a valve seating. Between this seating and the bottom

part of the cylinder **2** a spring **17** and a ball valve **9** are inserted so that said valve **9** is urged against said seating of the hub **10** and closes one end of the bore **108** of said hub. In this bore **108** a stem **8** integral with said ball valve **9** is slidably mounted with sufficient clearance and it is of such a length as to project for a short distance above the upper end of said hub **10**.

In the outlet piece **3**, above said flange **23**, a chamber is formed in which a double-armed lever **4** is pivotally mounted on a pivot **5** fastened to said outlet piece **3**. One arm **7** of said lever projects above the end of the valve stem **8** while the other end **6** projects out of an open part **12** of said outlet piece which is provided with a projecting member **11** and on which a conventional rubber mouthpiece **120** is fitted.

Of course, instead of a ball valve, any other type of self-closing valve might be employed. Thus in Figure 3 the ball valve is replaced by a plate valve **90**, the remaining parts being exactly alike those shown in Figure 1.

These valves, which for simplicity shall be called "breathing valves" are controlled from the user's mouth, preferably by the user's teeth, which easily shifts upwardly the lever end **6**, thus depressing the valve stem **8** and opening the valve intermittently, when he wants to inhale fresh air. After some exercise, this control movement of the teeth becomes almost automatic.

According to the embodiment shown in Figure 4, the hollow outlet piece **31** containing the lever **4**, which controls the air-intake or breathing valve **90**, is shaped as a curved rigid tube tightly fitted by one of its ends to a corresponding opening of a conventional diver's mask **30**. Thus the air outlet piece of this breathing equipment opens into the mask and not directly into the user's mouth. In the upper part of said tubular outlet piece **31** a small cylinder **32** having its axis substantially at right angles to the axis of the said upper tubular part is formed integrally or is tightly fitted. This cylinder projects inside and outside the outlet piece **31**. The inside part is closed by a centrally perforated bottom **10** through which projects the stem of a breathing valve **90** pressed by a spring **17** retained in the cylinder by a split ring or the like **132**. The outside projecting end of said cylinder **32** serves as connecting nipple for the breathing tube **1**. In the upper cylindrical casing part the usual tongue-, lips- or teeth-controlled lever **4** is mounted, whose control end, **6**, in the example as shown, is screw-threaded and carries a small control strip **106** which may be fastened at an adjustable height between a pair of nuts.

The tubular outlet piece **31** beyond the bent part ends with a tubular projection **131** constituting a saliva collector and ending with a discharge valve **33**.

In both embodiments, as shown in Figure 2 the outlet piece is provided with a tubular connection **13** ending with an outlet valve **15** which is enclosed in a perforated box or canister **16**, designed for subdividing the large air bubbles let out through the valve **15** into a large number of very small air bubbles.

Between the source of air supply (usually steel bottles containing air or air-like mixtures at pressures of up to 200 atmospheres) and the air intake a suitable differential valve must be inserted which supplies air at a constant pressure of 1–2 atmospheres in excess of the pressure of the head of water above the diver. A differential valve particularly adapted for use with the breathing equipment just described is shown attached to the valved mouthpiece shown in Figure 3.

This consists of a suitably large container **19** divided by a membrane **25** into two separate chambers **26** and **28**. The membrane is traversed by a tube **27** one end of which is fastened to or integral with a flanged cup **127** tightly attached to said membrane. The free end

of the tube **27** passes through a packing gland **24** and its very end is made as valve head, for example as pin valve **20**, co-acting with a seat formed at the interior of the nipple **22** which can be connected to a conventional source of compressed air (not shown). A spring **21**, whose force is exactly adjusted in advance, is inserted between the bottom of the cup **127** and the gland **24** and keeps normally opened the valve **20**. The chamber **28** is in communication with the exterior through the holes **29**, while the chamber **26** is provided with a nipple **102** which is connected to the air feed tube **1**.

The operation is apparent: The force of the spring is adjusted so that when the air pressure in the chamber **26** is in excess of a predetermined pressure (for example 1 to 2 atmospheres) above that of the external pressure filling the chamber **28**, this excess of pressure promotes the closure of valve **20**. When however this excess of pressure sinks under a predetermined limit (for example 1 atmosphere), the spring **21** opens said valve **20**, which remains open until the predetermined working pressure has been built up in the chamber **26**.

From the foregoing, it is apparent that the breathing equipment is particularly adapted for skin divers as it permits to open a mouth-controlled breathing valve each time the diver wants to effectively inhale fresh air, thus avoiding an excessive air consumption and increasing the efficiency time of the bottles containing the compressed air. Furthermore, a differential valve has been provided which, by working in combination with the mouth-controlled breathing valve permits of feeding fresh air at the constant required plus pressure above that due to the head of water at which the diver works.

I claim:

1. An open-cycle breathing equipment, particularly for skin-divers, comprising a flexible breathing tube, means for feeding compressed air to the flexible breathing tube, an outlet piece fitted at the end of said breathing tube; a breathing valve fitted in said outlet piece and so constructed as to remain normally closed and to close in the direction of flow of said compressed air from the said breathing tube toward the said outlet piece, a lever fitted in said outlet piece and having a part co-acting with said breathing valve and adapted to open same, said lever having a part projecting outwardly of the said outlet piece shaped to fit into a user's mouth and to be moved under control of a mouth part (tongue, teeth or lips) of the user so as to open said breathing valve and allow the same to be closed at will, and an outlet valve for exhaled air fitted on said outlet piece in a position as not to be intercepted by said breathing valve, said breathing valve being a ball valve and having a stem integral with the ball valve and projecting into said outlet piece.

2. A breathing equipment according to claim 1, in which the said outlet piece is in form of a tubular member and is tightly fitted to a portion of a diver's mask adjacent a mouth position of the mask, the outer end of said lever being screw-threaded; a pair of screw nuts screwable on said threaded lever part and a control member adapted to be held in position between said screw nuts and to be adjusted along said screw-threaded lever part so as to be in the best position to be controlled by a part of the diver's mouth, preferably by the diver's teeth.

3. A breathing equipment according to claim 1, in which between a source of compressed air and the breathing tube a membrane valve is fitted whose membrane is on one side adapted to be under the combined influence of the outside pressure and of a spring, and on the other side under the influence of a compressed air pressure and which membrane carries a valve acting on the inlet of said compressed air source which valve opens, and puts the source of air pressure into communication with the said side of the membrane under the influence of the air pressure until the pressure of said air exceeds the outside pressure by a predetermined amount, and when such predetermined excess of air pressure has been built up, it acts on the membrane to close the said valve carried thereby and intercept the communication with said source of compressed air.

4. An open-cycle breathing equipment, particularly for skin-divers, comprising a flexible breathing tube, means for feeding compressed air to the flexible breathing tube, an outlet piece fitted at the end of said breathing tube; a breathing valve fitted in said outlet piece and so constructed as to remain normally closed and to close in the direction of flow of said compressed air from the said breathing tube towards the said outlet piece, a lever fitted in said outlet piece and having a part co-acting with said breathing valve and adapted to open same, said lever having a part projecting outwardly of the said outlet piece adapted to fit into a user's mouth and to be moved under control of a mouth part (tongue, teeth or lips) of the user so as to open said breathing valve and allow same to be closed at will, and an outlet valve for exhaled air fitted on said outlet piece in a position as not to be intercepted by said breathing valve, said outlet being in the form of a tubular member and being tightly fitted to a portion of a diver's mask adjacent a mouth position of the mask with the outer end of said lever being screw-threaded; a pair of screw nuts screwable on said threaded lever part and a control member adapted to be held in position between said screw nuts and to be adjusted along said screw-threaded lever part so as to be in the best position to be controlled by a part of the diver's mouth, preferably by the diver's teeth.

5. An open-cycle breathing equipment, particularly for skin-divers, comprising a flexible breathing tube, means for feeding compressed air to the flexible breathing tube, an outlet piece fitted at the end of said breathing tube; a breathing valve fitted in said outlet piece and so constructed as the remain normally closed and to close in the direction of flow of said compressed air from the said breathing tube towards the said outlet piece, a lever fitted in said outlet piece and having a part co-acting with said breathing valve and adapted to open same, said lever having a part projecting outwardly of the said outlet piece adapted to fit into a user's mouth and to be moved under control of a mouth part (tongue, teeth or lips) of the user so as to open said breathing valve and allow same to be closed at will, and an outlet valve for exhaled air fitted on said outlet piece in a position as not to be intercepted by said breathing valve, there being between a source of corpressed air and the breathing tube a membrane valve whose membrane is on one side adapted to be under the combined influence of the outside pressure and of a spring, and on the other side under the influence of a compressed air pressure, and which membrane carries a valve acting on the inlet of said compressed air source which valve opens and puts the source of air pressure into communication with the said side of the membrane under the influence of the air pressure until the pressure of said air exceeds the outside pressure by a predetermined amount, and when such predetermined excess of air pressure has been built up, it acts on the membrane to close the said valve carried thereby and intercept the communication with said source of compressed air.

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