

Aug. 25, 1959

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2,900,977

UNDERWATER BREATHING APPARATUS

Filed May 31, 1955

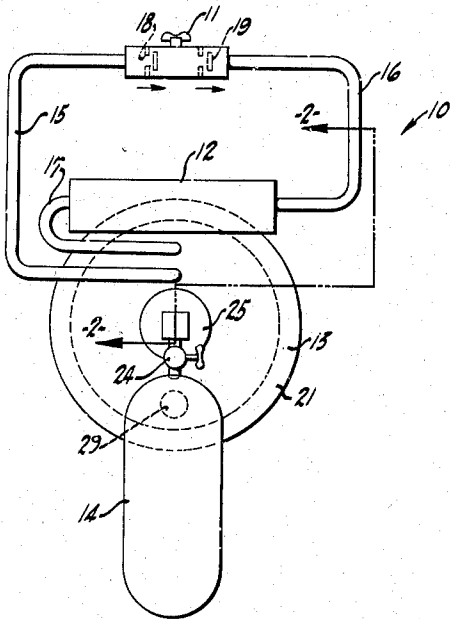


FIG-1

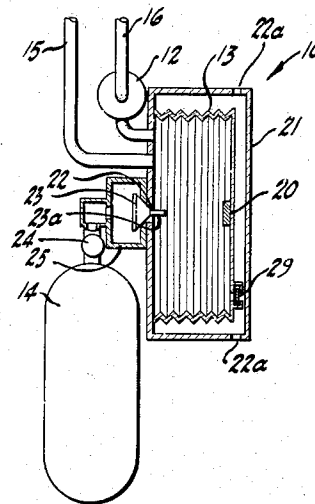


FIG-2

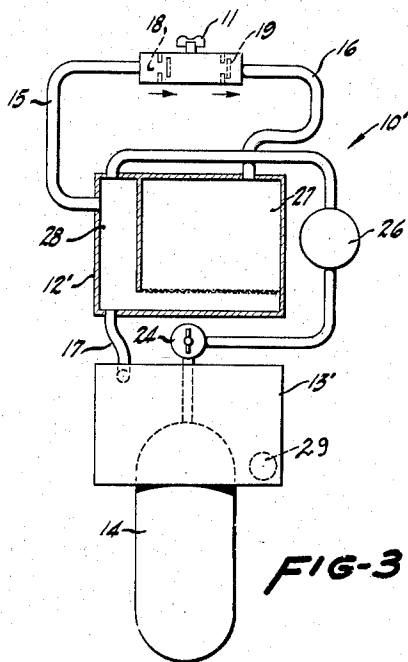


FIG-3

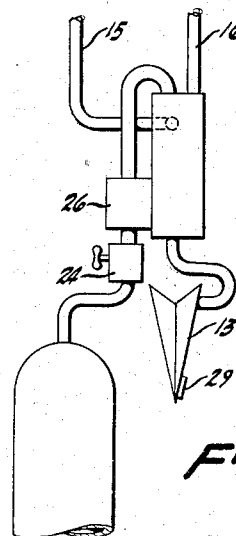


FIG-4

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UNDERWATER BREATHING APPARATUS

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Application May 31, 1955, Serial No. 512,223

1 Claim. (Cl. 128—142)

This application relates to a breathing apparatus. More particularly, the application is directed to a breathing apparatus of the semiclosed circuit type designed for use in skin diving.

The closed circuit type of breathing apparatus is that type wherein all of the air exhaled by the wearer on each breath is purified, collected in a breathing bag, and re-inhaled by the wearer at the next succeeding inhalation. In the open circuit type of breathing apparatus, a pressurized reservoir of air, or oxygen mixed with an inert gas, is provided. Air is drawn from the reservoir on each inhalation through suitable pressure-reducing and demand valves and is exhausted into the ambient medium on exhalation.

The open circuit type of breathing apparatus automatically compensates for differences in pressure as the diver moves downwardly and upwardly. With the use of this type of circuit, the diver may descend to depths of up to 300 feet without worrying about any toxic effect which can be caused by excessive amounts of oxygen under pressures above two atmospheres. However, the open type circuit is very inefficient since all of the air breathed is discarded at every exhalation. This type of system requires large capacity high-pressure storage tanks for deep or sustained diving.

The closed circuit type of breathing apparatus is very efficient, since the same air is purified by having the carbon dioxide removed therefrom and oxygen added thereto from relatively small high-pressure cylinders of pure oxygen. However, the closed circuit type of apparatus does not automatically adjust to different pressures, and the wearer must constantly be changing the bag volume to maintain proper buoyancy and readjusting the oxygen inlet valve to guard against oxygen poisoning.

The semiclosed circuit disclosed herein is a combination of the two circuits described above and incorporates the automatic depth adjusting feature of the open circuit type while increasing the efficiency thereof by rebreathing a substantial portion of the air exhaled, and admitting only enough air from the high-pressure air reservoir to make up the oxygen consumed by the body.

It is well known, that the body uses only about one-fifth of the oxygen taken into the lungs on any one inhalation. Therefore it is possible to rebreathe substantially four-fifths of the air exhaled, and only approximately one-fifth the total volume of an inhalation need be new air admitted to the system; provided, of course, that the carbon dioxide is removed from the rebreathed air. Since this type of circuit uses high-pressure air as does the open circuit type, the danger of oxygen poisoning is absent. The time limit for the use of this semiclosed circuit for a given capacity air cylinder is approximately five times that of the open circuit.

It is the principal object of this invention to provide a breathing apparatus of the semiclosed circuit type, wherein the amount of new air admitted to the system

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at each inhalation is controlled by the volume of the breathing bag.

Another object of the invention is to provide a breathing apparatus such as set forth above, wherein a mechanical inlet valve controls the admission of new air to the system, and wherein said mechanical valve is actuated by the collapse of the breathing bag.

A further object of the invention is to provide a breathing apparatus such as set forth in the first object described above, wherein the admission of new air to the system is controlled by a differential pressure-actuated demand valve located at a point higher on the apparatus than the breathing bag, whereby the hydrostatic pressure on the valve will be less than that on the bag, so that the valve will not open until the bag has been completely collapsed.

The preferred embodiments of the invention are described in the following detailed specification, and illustrated by way of example in the accompanying drawings, wherein:

Fig. 1 is a rear view of one form of breathing apparatus embodying the principles of the invention.

Fig. 2 is a side view of the embodiment shown in Fig. 1, with certain parts being shown in section, taken generally in the line 2—2 of Fig. 1.

Fig. 3 is a rear view of a modification of the breathing apparatus as shown in Fig. 1.

Fig. 4 is a side view of the modification shown in Fig. 3.

Referring now to the drawings wherein similar reference numerals are used to denote the same elements throughout the various views shown, and referring more particularly to Figs. 1 and 2 thereof, the breathing apparatus 10 generally comprises a mouthpiece 11, a carbon dioxide absorbing canister 12, a breathing bag 13, and a high-pressure air cylinder 14.

The mouthpiece 11 is connected to the breathing bag 13 by a flexible tube 15 and to one side of the canister 12 by a flexible tube 16. The other side of the canister 12 is connected to the breathing bag 13 by a tube 17. In order to maintain the correct direction of air flow the tube 15 is provided with a check valve 18 to permit air to pass from the tube 15 to the mouthpiece 11 but not in the opposite direction. Similarly, the tube 16 is provided with a check valve 19 which permits air to pass from the mouthpiece 11 into the tube 16 but not in the opposite direction.

The breathing bag 13 is chosen to be of a size which is slightly smaller in volume than the normal volume of one inhalation breathed by the person using the device. The correct size of the breathing bag may be obtained by selecting one of a proper size from a supply of different size breathing bags of the type illustrated at 13 in Figs. 1 and 2, or the bag may be of the adjustable volume type such as shown at 13' in Figs. 3 and 4 hereinafter described. In any case, it is essential that the bag be somewhat smaller in volume than the normal volume of one breath of the user.

Referring again now to Fig. 2, the breathing bag 13 is of the accordion bellows type, and is provided with a metal striker plate 20 centrally located on the inner surface of the movable wall of the bag. The bag is enclosed in a metal protective housing 21, provided with a plurality of breathing ports 22a to permit the ambient fluids to pass freely in and out of said housing. An exhaust valve 29 is provided on the breathing bag adjacent the lowermost portion thereof to permit the excess air expelled from the lungs to exhaust after the bag 13 is fully expanded.

In order to supply make-up fresh air from the cylinder 14, a port 22 connects the breathing bag 13 to the cylinder 14 through a suitable check valve 23 and pressure-reducing valve 24. The pressure-reducing valve 24 is set to

maintain a pressure in the valve chamber 25 slightly greater than that within the breathing bag 13, and the check valve 23 is normally held in its closed position.

In the use of the device, as disclosed in Figs. 1 and 2, the apparatus is arranged on the back of the wearer with the breathing bag at the same level and as near as possible to the lungs. Air is expelled from the lungs through the mouthpiece 11, the check valve 19, the tube 16, the canister 12, and the tube 17 into the breathing bag 13 and expands the bag. When the bag is fully expanded, the excess air is expelled into the ambient fluid through the exhaust valve 29. Upon inhalation, air is drawn into the lungs from the bag 13 through the tube 15, the check valve 18, and the mouthpiece 11. When the bag 13 is almost completely collapsed, the striker plate 20 strikes the end of the stem 23a and opens the valve 23 to permit air from the cylinder 14 to flow into the bag and replace the air expelled therefrom during the exhalation.

Turning now to the modification shown in Figs. 3 and 4, the breathing apparatus 10' is generally the same as that shown in Figs. 1 and 2 with the exceptions that a different type of canister 12' and breathing bag 13' are shown, and a differential pressure-actuated demand valve 26 is substituted for the mechanically operated valve 23 of Figs. 1 and 2. In this system, the reducing valve 24 is set to maintain a pressure slightly less than that in the circulating system so that the demand valve 26 is normally closed and opens only when the bag 13' is completely empty and further inhalation decreases the pressure in the system below the setting of the pressure reducing valve 24. Differential pressure valves capable of functioning in the manner described above are commercially available and further description thereof is not deemed necessary herein. The demand valve 26 is located so that in the normal swimming or upright position the demand valve will be higher than the breathing bag and therefore at a lower hydrostatic pressure than the breathing bag 13'.

In the operation of the system shown in Figs. 3 and 4, the air exhaled passes through the mouthpiece 11, the valve 19, and the tube 16, into the carbon dioxide absorbing section 27 of the canister 12'. After passing through the carbon dioxide absorbing material, the air passes through the tube 17 into the breathing bag 13' and the excess is expelled through the exhaust valve 29 in the same manner as described above with respect to Figs. 1 and 2.

Upon subsequent inhalation, air passes from the bag 13' through the tube 17 into the plenum chamber 28 of the canister 12'. From the plenum chamber 28, the air passes through the tube 15 and the check valve 18 to the mouthpiece 11. When the bag 13' is completely collapsed, the pressure in the plenum chamber 28 is decreased and the demand valve 26 opens to permit air from the cylinder 14 to enter the plenum chamber.

The bag 13' may be adjusted to conform to the various lung capacities of different individuals by clamping to-

gether the lowermost portion to decrease the effective volume thereof.

From the foregoing description, it may be seen that I have provided a novel semiclosed circuit, self-contained breathing apparatus combining the advantages of automatic depth compensation and freedom from possible oxygen poisoning inherent in the open circuit type of apparatus, and the extended capacity of the closed circuit type of apparatus, while eliminating the dangerous or undesirable disadvantages of each.

Even though two different types of canisters and two types of breathing bags are shown in the two embodiments, it is to be understood that either of the canisters shown, or either of the breathing bags shown, may be employed in each of the two modifications. The essential difference between the modifications is found in the use of either a mechanically actuated or a differential pressure-operated demand valve.

While I have shown and described the preferred forms of the invention, it is obvious that various changes may be made in its construction by those skilled in the art, without departing from the spirit of the invention as defined in the appended claim.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

In a breathing apparatus, a circulating system comprising a mouthpiece, a carbon dioxide absorbing canister, a breathing bag, said breathing bag being smaller than the volume of air breathed during one inhalation of the person using the device, a flexible tube connecting said mouthpiece to one side of said canister, means including a flexible tube connecting the other side of said canister to said breathing bag, means including a flexible tube connecting said mouthpiece to said breathing bag, a check valve in each of said breathing flexible tubes, an exhaust check valve in said breathing bag adjacent the lowermost portion thereof, an air storage cylinder, a conduit connecting said cylinder with said system, a normally closed demand valve in said conduit, said demand valve having a stem protruding into said breathing bag, and a striker plate fixed to the inner surface of said bag opposite said stem, whereby when said bag is collapsed said striker plate will strike said stem to open said valve to permit air from said cylinder to enter said circulating system.

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