

June 17, 1958

R. L. LORENZ

2,839,053

BREATHING APPARATUS FOR DIVERS

Filed Sept. 21, 1953

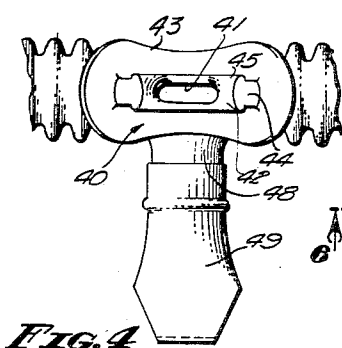


FIG. 4

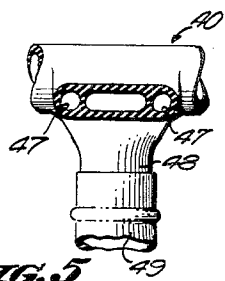


FIG. 5

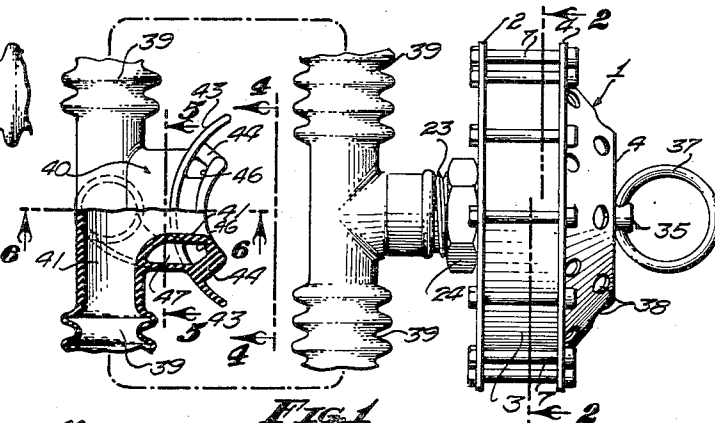


FIG. 1

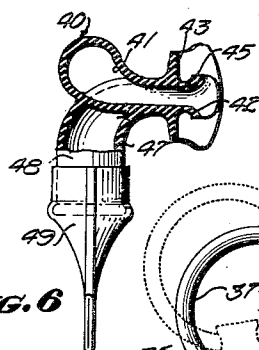


FIG. 6

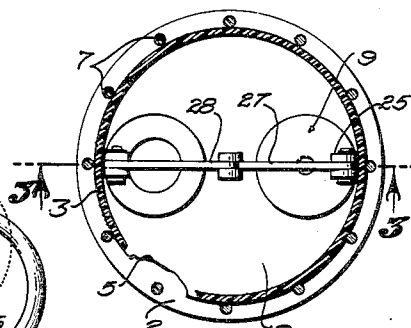


FIG. 2

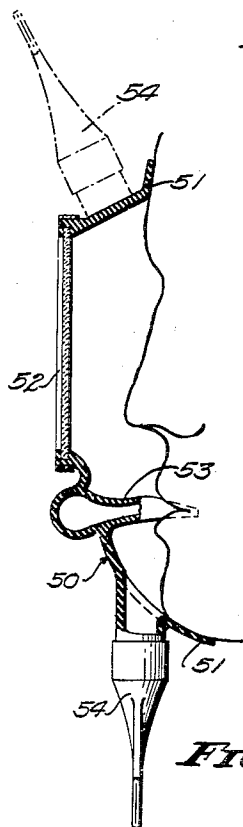


FIG. 7

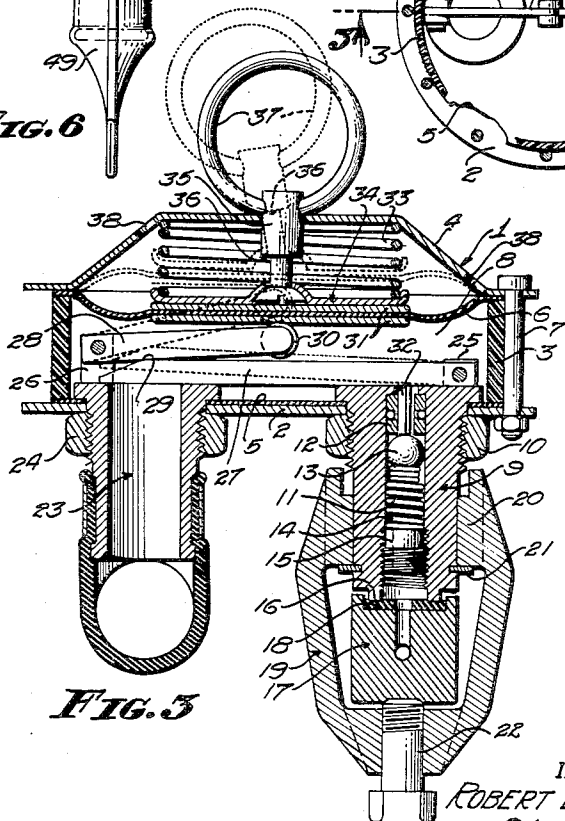


FIG. 3

INVENTOR.
ROBERT L. LORENZ
BY *Lyon & Lyon*
ATTORNEYS

1

2,839,053

BREATHING APPARATUS FOR DIVERS

Robert L. Lorenz, Santa Monica, Calif.

Application September 21, 1953, Serial No. 381,303

13 Claims. (Cl. 128—142)

My invention relates to underwater breathing apparatus and included in the objects to my invention are:

First, to provide an underwater breathing apparatus wherein air is supplied to the diver from a tank carried by the diver and wherein the air pressure supplied varies to correspond to the submergence pressure.

Second, to provide an underwater breathing apparatus which is arranged to supply air at a pressure slightly above submergence pressure, and in such a manner that the diver senses the immediate availability of the air so as to minimize any sense of panic or fear of suffocation, particularly by novice divers.

Third, to provide an underwater breathing apparatus wherein air is delivered to the diver's mouth and incorporates a novel mouthpiece valve controlled by the mouth of the diver so as to be closed at will against the slightly higher pressure of the air supply so that the diver may exhale.

Fourth, to provide an underwater breathing apparatus which normally supplies air continuously, unless withheld at the will of the diver, at a pressure slightly above submergence pressure, and which incorporates a device arranged to shut off the supply of air by altering the pressure at which the air is supplied to a pressure slightly below submergence pressure; thus, permitting the air supply to be shut off when the diver is not submerged to avoid waste of air, while enabling the diver to breathe with only slight discomfort should he submerge without releasing the device.

Fifth, to provide in an underwater breathing apparatus a simplified, inexpensive regulator valve mechanism which is inherently dependable in operation and easily serviced.

With the above and other objects in view as may hereinafter be described reference is directed to the accompanying drawings in which:

Fig. 1 is a top view of my underwater swimming apparatus with the air supply tank omitted and the mouthpiece shown partially in section.

Fig. 2 is a partial sectional partially elevational view of the demand valve taken along the line 2—2 of Fig. 1.

Fig. 3 is an enlarged transverse sectional view through 3—3 of Fig. 2 showing the demand valve in its open position.

Fig. 4 is an elevational view of the mouthpiece taken substantially along the line 4—4 of Fig. 1.

Fig. 5 is a sectional view thereof taken through 5—5 of Fig. 1.

Fig. 6 is a sectional view through 6—6 of Fig. 1.

Fig. 7 is a vertical sectional view of a modified form of mouthpiece which is incorporated in a face mask.

My underwater swimming apparatus includes a demand valve 1, which comprises a bottom plate 2, on which rests a cylindrical section 3 covered by a top plate 4. Interposed between the bottom plate and the cylindrical section is a gasket 5 which may cover the bottom plate. Interposed between the cylindrical section and the top plate 4 is a diaphragm 6. The bottom

2

plate and the top plate protrude radially from the cylindrical section so as to provide flanges through which extend screws 7 to hold the assembly together. The bottom plate diaphragm and cylindrical section define a valve chamber 8.

Mounted offcenter in the bottom plate is a valve fitting 9 having a flange at one end which bears against the gasket 5. The valve fitting protrudes through the bottom plate and is secured thereto by a nut 10.

The valve fitting is provided with a central valve bore 11 constricted at its upper end and directed into the valve chamber 8. Fitted within the valve bore and bearing against its constricted end is a valve seat cylinder 12, having a bore therethrough and provided with a sealing ring which engages the valve bore 11. The inner or lower end of the valve cylinder 12 is engaged by a valve element 13 which may be in the form of a ball. It has been found that a tough plastic material such as "Teflon" provides a satisfactory valve element.

The valve element is backed by a spring 14 the force of which may be adjusted by a tubular nut 15, screw threaded into the lower or outer end of the valve bore 11. The extremity of the valve bore forms a seat 16 against which may be fitted the supply head 17 of a high-pressure air cylinder (not shown). A seal washer 18 is interposed between the seat and the supply head 17.

The supply head may be held in sealing contact by means of a yoke 19 which includes a collar 20 journaled on the outer end of the valve fitting 9. The collar is held by a suitable retainer ring 21. A screw 22 carried by the extremity of the yoke 19 forces the supply head 17 against the seat 16. The connection between the valve fitting 9 and the high-pressure air cylinder may be considered as conventional.

Located in the bottom plate 2, preferably diametrically opposite from the valve fitting 9, is a tubular outlet fitting 23 having a flanged inner end seated against the gasket, and held in place by a nut 24.

The inner end of the valve fitting 9 is provided at its side radially outward from the valve bore 11 with a pair of bearing lugs 25. A similar pair of bearing lugs 26 are located radially outward from the bore of the outlet fitting 23. The bearing lugs 25 receive a pin which journals a lever 27 extending diametrically across the valve chamber 8 with its extremity guided between the lugs 26.

A second lever 28 is journaled by a pin between the bearing lugs 26. The extremity of the lever 27 is bevelled so as to form a bearing edge 29 which engages the under side of the lever 28. The extremity of the lever 28 is located at approximately the center of the valve chamber 8 and may be provided with rollers 30 which engage the inner one of a pair of diaphragm reinforcing plates 31, which clamp the central portion of the diaphragm 6. The lever 27 overlies the valve bore 11 and an operating pin 32 is mounted in the bore of the valve seat cylinder 12 so as to extend between the underside of the lever 27 and the valve element 13.

The leverage provided by the levers 27 and 28 and diameter of the bore in the valve seat cylinder are such that a comparatively small force applied to the rollers 30 of the lever 28 is sufficient to open the valve element 13 against high pressure (as much as 2,000 lbs.) of air in the air cylinder.

The central portion of the top plate 4 is preferably offset upwardly so that a spring 33 may be accommodated between the top plate and the diaphragm. The spring 33 does not bear directly against the diaphragm but bears against a retainer plate 34 overlying the diaphragm. Connected to the central portion of the retainer plate is a pull latch 35 which extends upwardly through the top plate. The pull latch includes a shoulder 36 which is

3

capable of being pulled through the top plate and engage the top plate by tilting the pull latch to one side, as shown by dotted lines in Fig. 3. The protruding end of the pull latch may be in the form of a ring 37 so that it may be easily engaged. Operation of the spring 33 and pull latch will be described in more detail hereinafter.

The top plate is provided with perforations 38 so that the region above the diaphragm 6 may be subjected to water pressure when the demand valve is submerged.

The outlet fitting 23 is connected to a hose 39 or preferably a pair of hose sections which are intended to pass around the head of the diver and are joined to a mouthpiece 40. The hose is preferably moulded of rubber and corrugated to allow axial expansion and permit bending without kinking. The hose and mouthpiece may be integral, as shown, although a separable connection between the hose and mouthpiece may be provided if desired. The mouthpiece includes an intake T 41, the cross portion of which is joined to the two-hose section 39. The stem of the T curves downwardly, then horizontally and is flattened so that it may extend into the diver's mouth. The extremity of the stem is flared as indicated by 42 to form a valve element into which the tip of the diver's tongue may be pressed to close off the flow of air from the valve chamber 8 of the demand valve.

Adjacent but spaced from the flared end 42 there is formed a lip flange 43 which projects upwardly and downwardly from the stem of the intake T, and is curved arcuately so as to fit between the lips and the teeth of the diver. The lateral extremity of the flared end 42 is joined to the lip flange 43 by bite webs 44. A small flange 45 surrounds the flared end of the intake T so that the diver may bite on the webs 44 and hold the mouthpiece in place. Between the bite webs 44 and the sides of the stem of the intake T, there are a pair of vertical passages 46. These communicate with side or outlet passages 47, one on each side of the stem of the intake T. The side passages curve downwardly and converge under the intake T to form an exhalation nipple 48. Fitted over the end of the exhalation nipple is an exhalation valve or "flutter" valve 49 in the form of a rubber tube flattened at its end so that air may be discharged through the valve but water cannot enter it.

Operation of my underwater breathing apparatus is as follows: The demand valve is connected to one or more compressed air cylinders in a conventional manner such as by the yoke 19. The cylinders and valve are carried on the back of the diver and the hose or hose sections 39 are extended around the head of the diver so that the mouthpiece 40 may be fitted into the mouth of the diver.

Before the diver submerges or at such times when the apparatus is not intended to be in operation, the pull latch 35 is drawn upwardly to the dotted line position shown in Fig. 3. In this position, the retainer plate 34 under the spring 33 clears the diaphragm 6, and the supply is shut off when the diaphragm is in its outer or dotted line position. The diaphragm is urged in this position by the pressure of air within the valve fitting 9, which holds the valve element 13 closed. Thus, when the force of the spring 33 is relieved from the diaphragm, the supply valve is normally closed. When the diver is about to submerge, the pull latch is released so that the force of the spring 33 is applied to the diaphragm and the supply valve is open as shown by solid lines in Fig. 3. Air will continue to flow as long as the flared end 42 of the mouthpiece is open. However, the diver may withhold the supply of air by pressing his tongue into the flared end 42. The force of the spring 33 is so predetermined that pressure of a few ounces within the valve chamber above that on the outside of the diaphragm

4

is sufficient to raise the diaphragm against the spring and permit the supply valve to close.

By way of illustration but not of limitation, the demand valve may be so arranged that an excess pressure of eight ounces within the valve chamber is sufficient to close the supply valve. This pressure is low enough that the diver can easily hold the supply in check. The diver inhales while releasing his tongue from the flared end 42 and accepts the air as supplied. The diver exhales by pressing his tongue against the flared end 42 and blowing outward through the vertical openings 46, side passages 47 and exhalation valve 49.

Due to the fact that the outside of the diaphragm 6 is exposed to the surrounding water when the diver is submerged, the pressure within the valve chamber will equal the submergence pressure plus the pressure necessary to overcome the spring 33. Thus, assuming that the diver is not changing his depth faster than the demand valve can compensate, the pressure of the air at the mouthpiece 40 will be slightly above submergence pressure.

It should be observed that in determining a suitable pressure differential account should be taken of the fact that the mouthpiece may be located at a lower level and under slightly greater submergence pressure than the demand valve, due to the fact that the demand valve is on the diver's back and the diver may be facing downward.

When the pull latch 35 is in its latched position the spring 33 is withheld from the diaphragm 6 but the diaphragm is still responsive to submergence pressures. However, the pressure within the valve chamber 8 will be slightly below submergence pressure in an amount corresponding to the force which must be exerted on the rollers 30 to overcome the air pressure against the valve element 13. This pressure differential need be only a matter of two or three ounces. Consequently, even though the diver should fail to release the pull latch it is possible for him to receive an adequate amount of air although at slight discomfort, due to the suction pressure he must create.

Reference is directed to Fig. 7 which illustrates generally a mask 50 which may be substituted for the mouthpiece 40. The mask is adapted to fit over the face of the diver including the eyes, nose and mouth, and is provided with suitable sealing margins 51 which engage the face of the diver. A suitable eye window 52 is provided. In place of the mouthpiece 40, a mouth tube 53 is provided which is connected with the hose 39. The tube is adapted to fit into the mouth of the diver and forms a valve element which is capable of being closed by being clamped between the teeth. Alternatively, the mouth tube may involve a flared end and lip flange such as the flared end 42 and lip flange 43 of the previously described structure.

The lower position of the exhalation valve has the advantage that water which may leak in, and carbon dioxide which tends to settle to the bottom, are driven out with each exhalation. The upper position of the exhalation valve enables the air to discharge above the window so as to avoid the passage of bubbles which might obstruct vision.

The mask 50 is provided with an exhalation valve 54 which may be located forwardly of the lower or chin-engaging section of the mask. Alternatively, the exhalation valve may be located at the top of the mask as indicated in broken lines in Fig. 7. With either arrangement of the exhalation valve, the diver inhales through the mouth and exhales through the nose or mouth; otherwise, the operation is the same as the previously described structure.

Having fully described my invention, it is to be understood that I do not wish to be limited to the details set

forth, but my invention is of the full scope of the appended claims.

I claim:

1. An underwater breathing apparatus, comprising: a demand valve adapted to be connected to a source of high pressure air, and including an air chamber and regular means for supplying air from said source to said air chamber at a pressure substantially equal to the submergence pressure of the water in which said demand valve is immersed; a mouthpiece; an air supply tube leading from the demand valve to said mouthpiece; said mouthpiece including a valve element manipulable by the user to control supply of air from said demand valve to the user's mouth; and an exhalation check valve immediately adjacent said mouthpiece.

2. An underwater breathing apparatus as set forth in claim 1, wherein: said mouthpiece includes means defining an exhalation passage leading from the user's mouth to said exhalation valve.

3. An underwater breathing apparatus as set forth in claim 1, wherein: said mouthpiece is incorporated in a face mask enclosing the nose of the user and said face mask is provided with a port communicating with said exhalation valve.

4. An underwater breathing apparatus, comprising: a demand valve adapted to be connected to a source of high pressure air, and including an air chamber and regular means for supplying air from said source to said air chamber at a pressure substantially equal to the submergence pressure of the water in which said demand valve is immersed; a mouthpiece adapted to fit in the mouth of the user; an air supply tube leading from the demand valve to said mouthpiece; said mouthpiece including a valve element manipulable by the user to control supply of air from said demand valve to the user's mouth; means operable by the user to alter the relative pressure of air supplied by said demand regulator whereby said air may be supplied at a pressure a predetermined value above submergence pressure; and an exhalation check valve immediately adjacent said mouthpiece.

5. An underwater breathing apparatus as set forth in claim 4 wherein: said mouthpiece includes means defining an exhalation passage leading from the user's mouth to said exhalation valve.

6. An underwater breathing apparatus as set forth in claim 4, wherein: said mouthpiece is incorporated in a face mask enclosing the nose of the user and said face mask is provided with a port communicating with said exhalation valve.

7. An underwater breathing apparatus, comprising: a demand valve adapted to be connected to a source of high pressure air, and including an air chamber and regular means for supplying air from said source to said air chamber at a pressure in predetermined excess of the pressure exerted by the water in which said demand valve is immersed; a mouthpiece including a valve element manipulable by the user to control the intake of air to the user; an air supply tube loop communicating at diametrical points with said demand valve and said mouthpiece and forming with the valve chamber of said demand valve a storage reservoir of air at said predetermined pressure; and an exhalation valve immediately adjacent said mouthpiece and separated from said air supply tube loop by said valve element.

8. An underwater breathing apparatus as set forth in claim 7, wherein: said mouthpiece includes means defining an exhalation passage leading from the user's mouth to said exhalation valve.

9. An underwater breathing apparatus as set forth in claim 7, wherein: said mouthpiece is incorporated in a face mask enclosing the nose of the user and said face mask is provided with a port communicating with said exhalation valve.

10. An underwater breathing apparatus, comprising: a demand valve adapted to be connected to a source of high pressure air, and including an air chamber and regular means for supplying air from said source to said air chamber at a pressure in predetermined excess of the pressure exerted by the water in which said demand valve is immersed; a mouthpiece including a valve element manipulable by the user to control the intake of air to the user; an air supply tube loop communicating at diametrical points with said demand valve and said mouthpiece and forming with the valve chamber of said demand valve a storage reservoir of air at said predetermined pressure; an exhalation valve immediately adjacent said mouthpiece and separated from said air supply tube loop by said valve element; and means operable by the user to reduce the pressure of air supplied by said regulator relative to the submergence pressure.

11. An underwater breathing apparatus as set forth in claim 10, wherein: said mouthpiece includes means defining an exhalation passage leading from the user's mouth to said exhalation valve.

12. An underwater breathing apparatus as set forth in claim 10, wherein: said mouthpiece is incorporated in a face mask enclosing the nose of the user and said face mask is provided with a port communicating with said exhalation valve.

13. A demand regulator for underwater breathing apparatus having a mouthpiece and an air supply tube, comprising: a base plate; a pair of tubular fittings secured to said base plate, one of said fittings adapted for attachment to a source of high pressure air, the other adapted for attachment to said air supply tube; a high pressure check valve in the first fitting; levers pivotally supported by said fittings; means operatively connecting said levers with said check valve; a spacer ring seated on said base plate; a diaphragm supported by said spacer ring, one side of said diaphragm forming with said spacer ring and base plate an air chamber, the opposite side of said diaphragm being exposed to the submergence pressure of water in which said regulator is immersed, said diaphragm being operatively connected through said levers to said check valve to maintain in said chamber a pressure substantially proportional to the submergence pressure of the surrounding water.

References Cited in the file of this patent

UNITED STATES PATENTS

439,093	Barian	Oct. 28, 1890
2,303,155	Berge	Nov. 24, 1942

FOREIGN PATENTS

439,183	Great Britain	Dec. 2, 1935
663,202	Great Britain	Dec. 19, 1951
1,023,404	France	Dec. 30, 1952