

Nov. 14, 1944.

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2,362,643

BREATHING APPARATUS FOR USE UNDER WATER

Filed Jan. 21, 1942

4 Sheets-Sheet 1

Fig-1

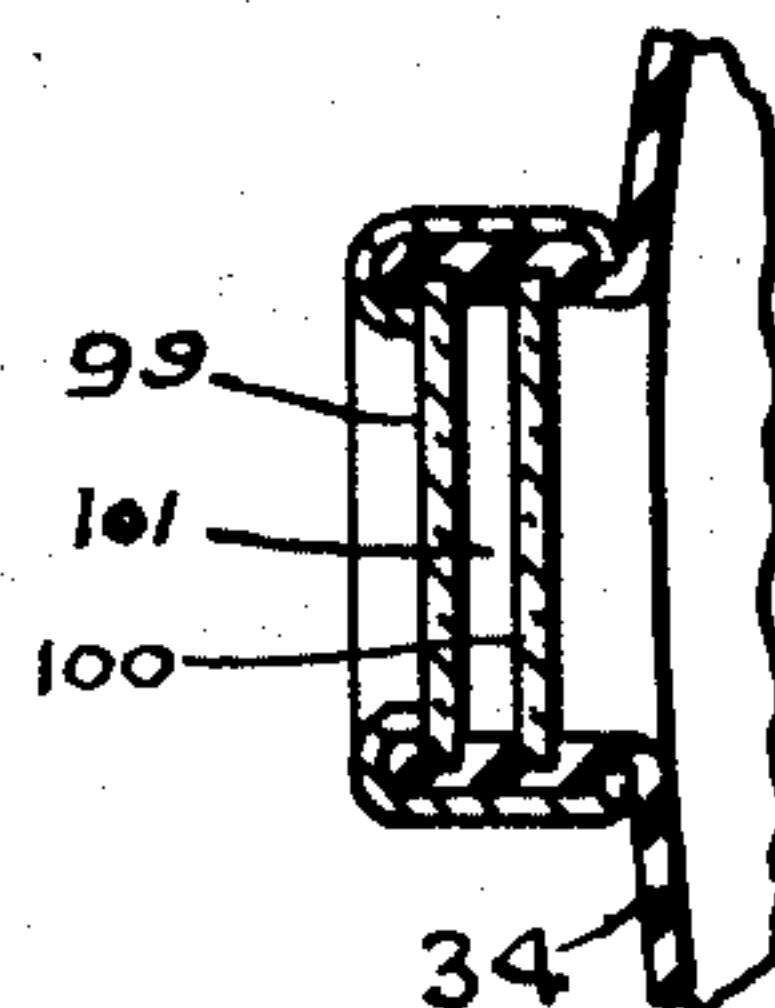
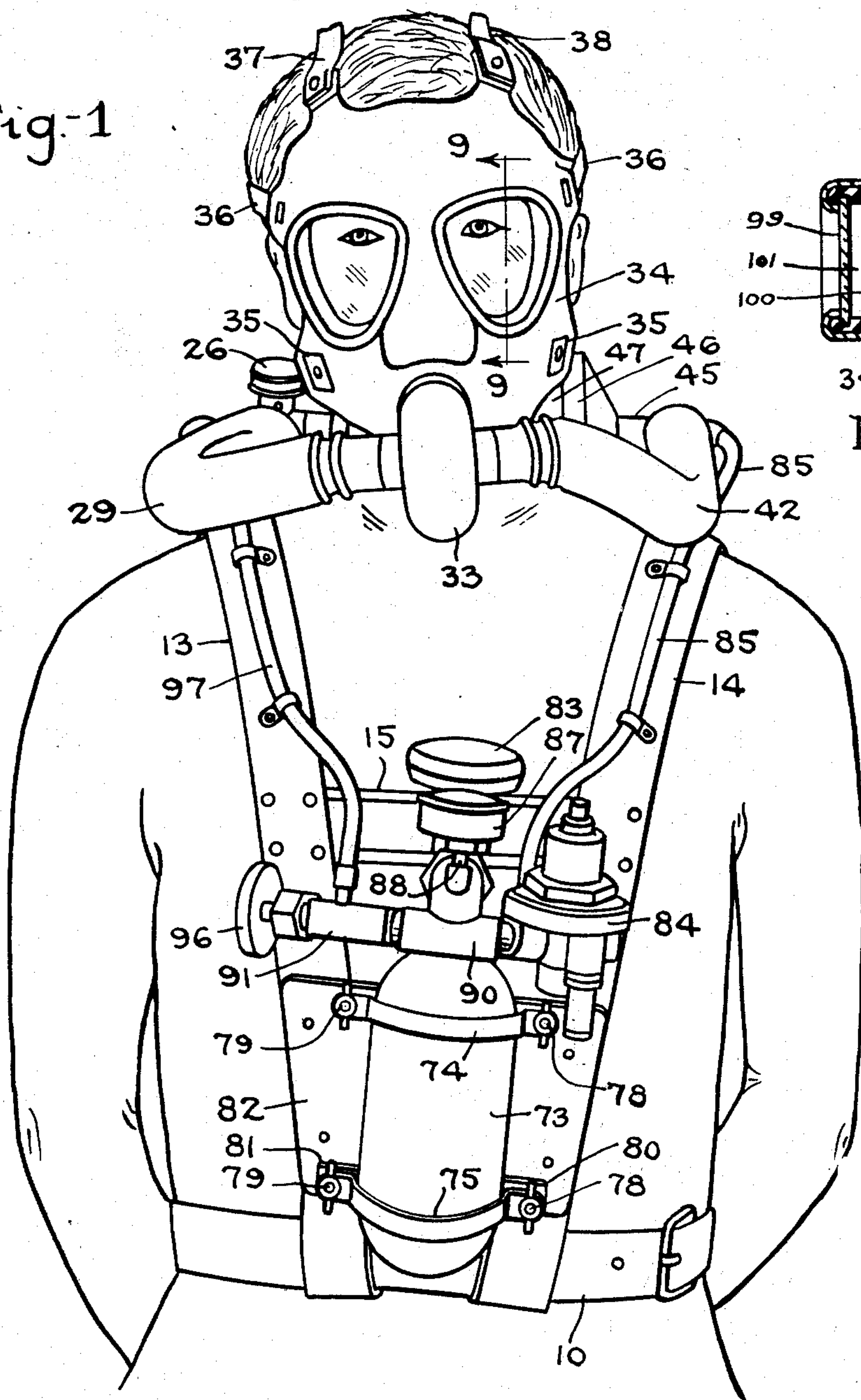


Fig-9

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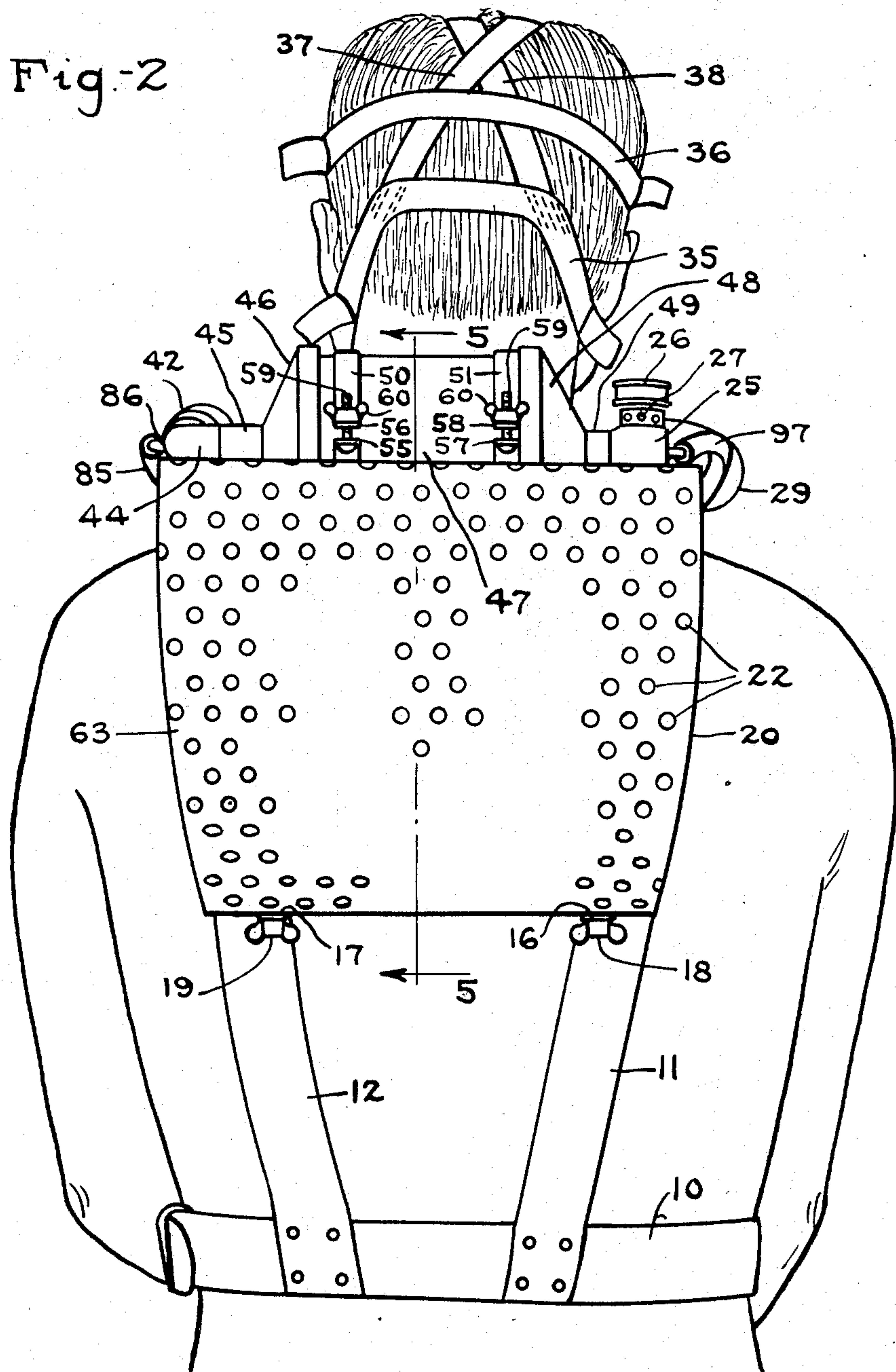
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BREATHING APPARATUS FOR USE UNDER WATER

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4 Sheets-Sheet 2



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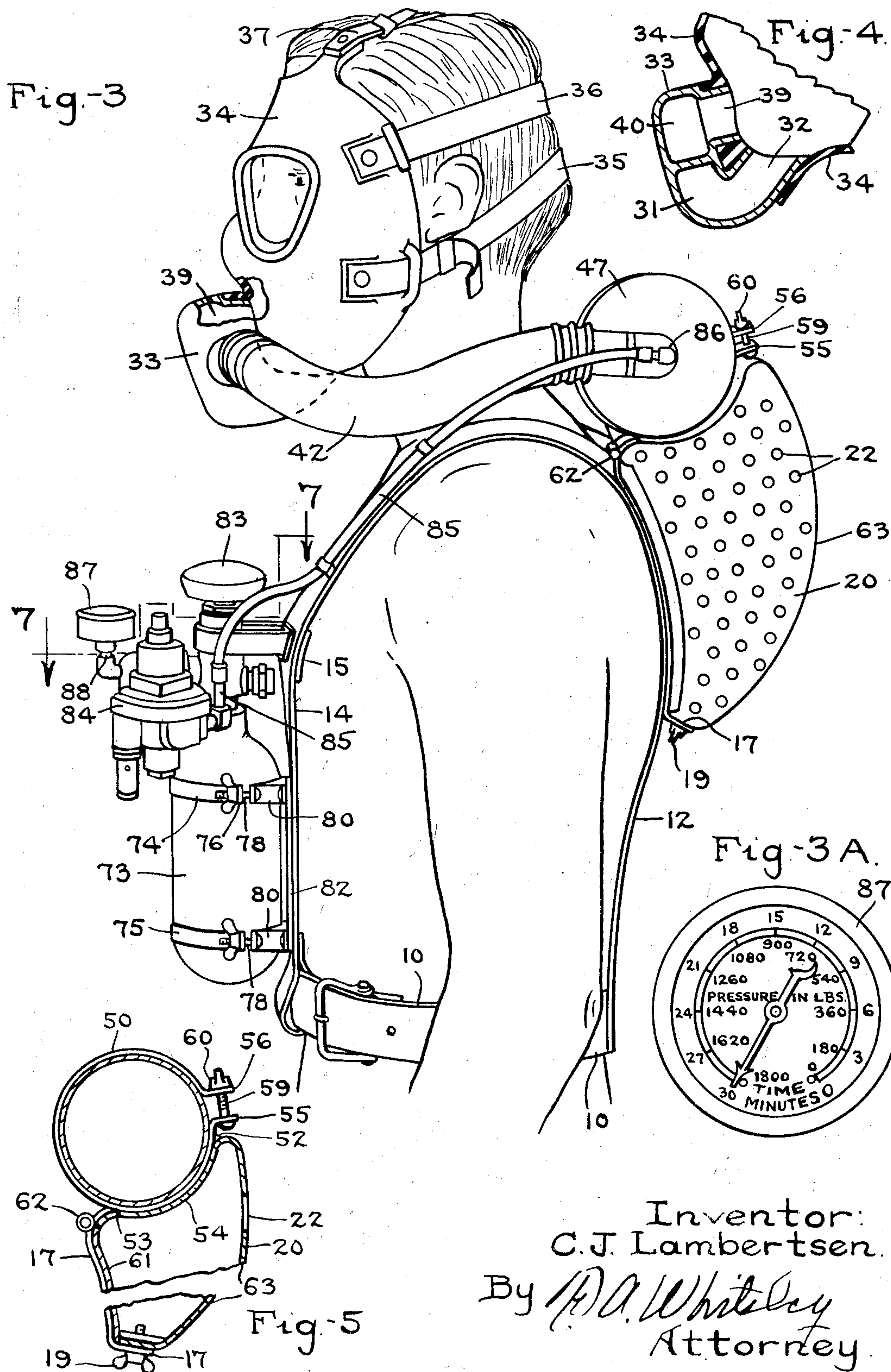
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BREATHING APPARATUS FOR USE UNDER WATER

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4 Sheets-Sheet 3



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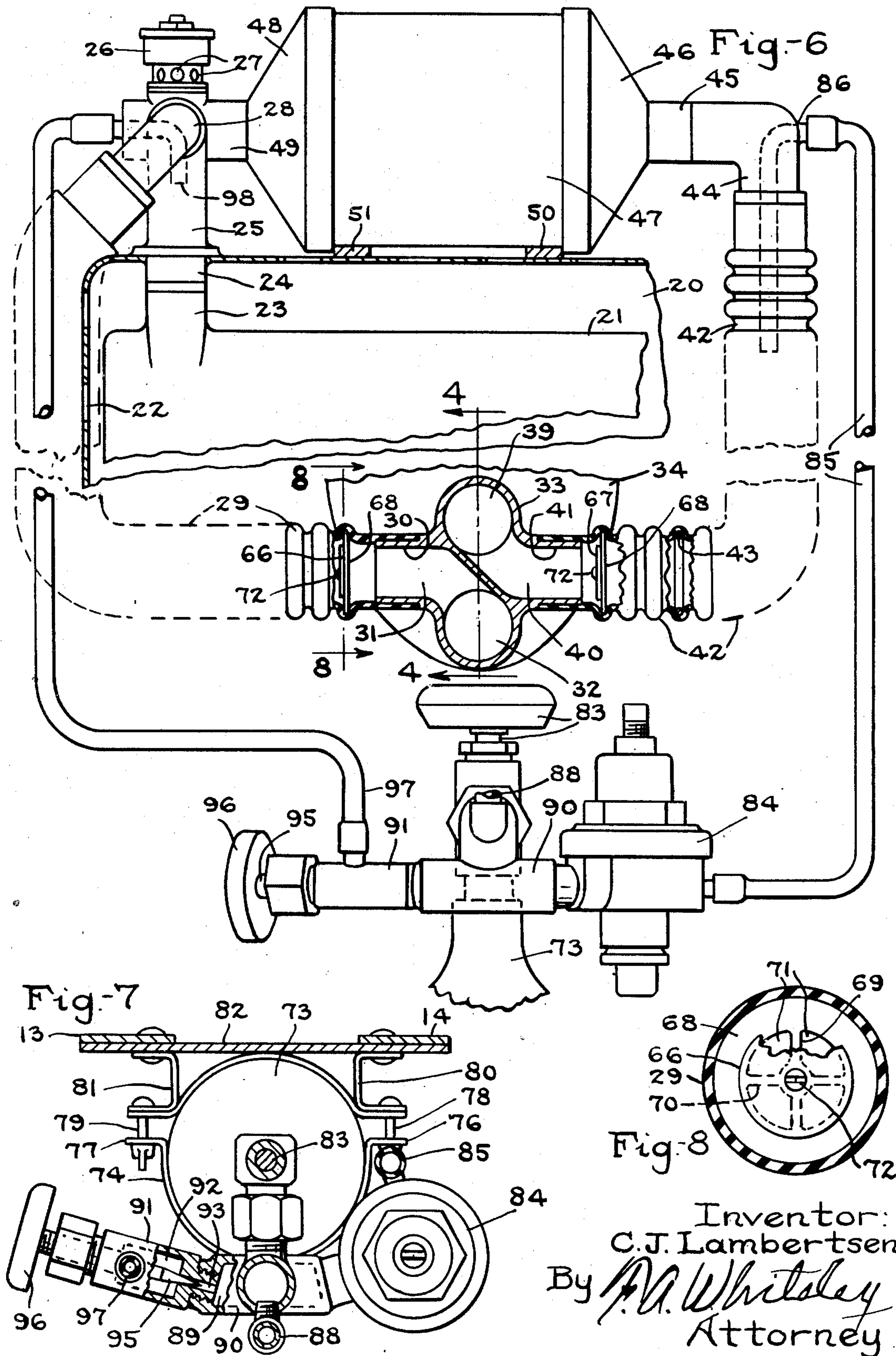
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BREATHING APPARATUS FOR USE UNDER WATER

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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

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BREATHING APPARATUS FOR USE
UNDER WATER

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Application January 21, 1942, Serial No. 427,604

2 Claims. (Cl. 128—142)

My invention relates to breathing apparatus for use under water and has for its object to provide a breathing apparatus adapted to be attached to the wearer including means for supplying oxygen for a certain period of time and means for controlling the breathing of said oxygen for effecting removal of carbon dioxide therefrom and permitting exhaust of excess part of exhalation into the water. The apparatus can be quickly applied and with it a guard or diver may descend to a depth of water greater than sixty feet and remain at such depth for considerable periods of time long enough to make a proper search for the recovery of bodies or of persons who had gone down and might be drowned or be drowning, to search for other objects to travel under water relatively long distances and for similar purposes.

This application is an improvement upon the invention of my application Serial Number 370,242, filed December 16, 1940. As pointed out in that application there are many conditions and situations in which diving apparatus as the term is ordinarily understood cannot be available for use, for such apparatus requires a sealed diving suit and helmet and suitable air pumps for supplying air to the wearer and assistants to operate the pumps. Diving apparatus of this type obviously cannot be available in a very large number of situations such as above outlined, particularly in inland regions. The improvements of my apparatus as appears in this application particularly adapt it to meet requirements where such regulation diving apparatus is unavailable, since my apparatus is relatively inexpensive, can be quickly put on and taken off, needs no aid of assistants and is adapted to provide suitable oxygen enriched breathing mixture for all periods of time necessary for the type of examinations and searches and recoveries above noted. It has the additional very great advantage over the suit and air pump types of diving apparatus that it is entirely dissociated from water surface supports of any kind so the wearer may travel for very considerable distances independently of any boat or other craft on the surface.

It is therefore a particular object of my invention herein described to provide improved means adapted to be readily secured to the body of the wearer which will include a sufficient supply of oxygen and means to permit the same to be breathed over a definite period of time when the wearer is immersed in water.

It is a further object of my invention to provide a mask having united therewith a breathing out-

let substantially in the plane of the mouth with exhalation and inhalation tubes leading therefrom, the exhalation tube going directly to the rebreathing bag, and a relief valve structure in the exhalation tube together with an inhalation tube leading from the mouth device through a soda lime container and thence either independently or through connection with the exhaling tube going to the rebreathing bag.

It is a further object of my invention to provide a protective casing for the rebreathing bag of such size and large area of wall surface and of perforations therethrough that there will be substantially no confining of water within the protective cover and the rebreathing bag can expand and contract freely as the water enters and leaves the protective casing.

It is a further and highly important object of my invention to provide a relative arrangement of oxygen casing, rebreathing bag protective casing, soda lime container and other parts connected with or attached to the harness so that the entire apparatus as worn will have a balanced distribution of weight such that a wearer will find it simple and easy to maintain proper position in the water while going down into the water and coming up from it.

In this connection it is a further object of my invention not only to distribute the weight as above indicated, but to adjust it so that when the apparatus is on a wearer immersed in the water the water displacement of body and apparatus will substantially equal the weight of body and apparatus so that the wearer can easily go up or down with normal swimming action as conditions may require. This gives a balanced buoyancy in all normal positions of use.

It is a further object of my invention to so position the rebreathing bag on the back that its opening to the breathing passages and the rebreathing bag as a whole are between level planes, substantially those enclosing the lungs when the wearer is standing erect, which produces a better condition for respiration under water, where considerable differences in pressure result from a few inches difference in depth, and which relationship of rebreathing bag level to lung level tends to permit use of the diving unit under water without respiratory fatigue.

It is a further object of my invention to provide pressure-controlled feed of oxygen directly to the passageway leading from the soda lime container and rebreathing bag to the inhalation passageway or to the inside of the mask, and to provide emergency oxygen controlled by a hand-

operated needle valve going direct to the re-breathing bag from where it may be drawn upon for inhalation.

It is a further object of my invention to position the removable oxygen tank at the front of the harness with valve handles for controlling flow of oxygen continuously through the regulator valve or directly for emergency purposes in convenient reach of the wearer, also with a gage which the wearer can see at all times and by which he can determine the pressure of oxygen being delivered, and the duration of any remaining oxygen supply, the latter important to warn the wearer of a time when it will be necessary to leave the water.

It is a further object of my invention to provide a mask structure having the aforesaid breathing passages adjacent the mouth and having means for securing the mask structure firmly upon the head of the wearer together with double glass vision openings, the double glass acting to prevent clouding of such vision openings, and to provide means in association with said mask to prevent inlet of water about the margins of the mask contacting the face, and to hold the mask from collapsing against the breathing passages in the event that pressure inside the mask is caused to fail by reason of the wearer operating in a head down or inverted position.

Other objects of my invention are to provide metal rings in the breathing tube corrugations to prevent collapse of tubing on inhalation without detracting from their lightness and flexibility, to make the lightness of the unit such as to enable the wearer to swim on the surface of the water, the arrangement of the breathing tubes at the sides of the neck which permits a free movement of the head in any direction, formation of fins on the absorber to provide more efficient heat radiation when the device is employed as an industrial gas mask, and a warning whistle which may sound as pressure in the oxygen cylinder reaches a predetermined low point.

The full objects and advantages of my invention will appear in connection with the detailed description thereof and the novel features by which the aforementioned desirable results are obtained will be particularly pointed out in the claims.

In the drawings illustrating an application of my invention in one of its forms:

Fig. 1 is a front elevation view of the apparatus as worn.

Fig. 2 is a rear elevation view of the apparatus as worn.

Fig. 3 is a side elevation view of the apparatus as worn with some parts broken away and in section.

Fig. 3A is a plan view on an enlarged scale showing the calibrations on the pressure gage.

Fig. 4 is a fragmentary side elevation view taken on substantially the line 4—4 of Fig. 6.

Fig. 5 is a side sectional elevation view taken on line 5—5 of Fig. 2 with some parts broken away and drawn together.

Fig. 6 is a part diagrammatic front elevation view of some of the parts as the same are related to each other and with parts broken away and in section.

Fig. 7 is a part sectional plan view of the oxygen delivering apparatus taken on line 7—7 of Fig. 3.

Fig. 8 is a view of a check valve mechanism taken on line 8—8 of Fig. 6.

Fig. 9 is a section taken on line 9—9 of Fig.

1 showing the double lens structure of the eye openings of the mask.

As illustrated my apparatus comprises a harness having a belt 10, rear shoulder straps 11 and 12 secured to the back portion of belt 10, and continuing over the shoulders to front straps 13 and 14 secured at their lower portions to belt 10 by loops for free-slipping movements and held together adjacent their central parts by a cross belt 15. Secured to angle pieces 16 and 17 on back straps 11 and 12 by means of thumb screws 18 and 19 is a case 20 of a shape clearly indicated in Figs. 2 and 3 and of relatively large internal capacity and within this case is housed a rebreathing bag 21. The rebreathing bag case 20 has relatively large external wall area which is provided with numerous apertures 22 through the ends and back, as clearly shown in Figs. 2 and 3. The rebreathing bag is provided with a neck 23 which fits over a nipple 24 extending from a passageway 25 surmounted by a release valve 26 of the type shown in the above identified application such that exhalation wherein a predetermined pressure has been built up may pass through apertures 27 leading outside the apparatus even when under water, without admitting any water thereto. A branch pipe 28 extends from the pipe 25 and is connected by a corrugated tubing 29 with a nipple 30, Fig. 6, within which is a passageway 31 leading to an exhaling opening 32 from inside a breathing extension 33 secured to the lower portion of a face mask structure 34 which is adapted to be secured firmly upon the head of a wearer by means of a system of straps 35, 36, 37 and 38, Fig. 2.

Through the extension 33 leads a second inhaling opening 39 which connects with a second passageway 40 through a nipple 41 with a light flexible corrugated tubing 42 similar in general character to the corrugated tubing 29. It will be noted that I may apply to the inside of tubing 29 and 42 metal rings indicated in the broken away portion at 43 of Fig. 6, which metal rings enable a corrugated tubing of light and freely flexible construction to be employed without being subject to collapse from water pressure when the internal pressure is reduced by inhalation, or when diver assumes inverted position.

The tube 42 connects with an elbow piece 44, Figs. 2 and 6, which in turn connects at 45 with the conical end 46 of a canister 47. The other end 48 of the canister 47 connects by a branch pipe 49 with the pipe 25 leading to rebreathing bag 21.

The canister 47 is thus in circuit with rebreathing bag 21 and inhaling tube 42. Within canister 47 will be placed a body of some carbon dioxide absorbent, such as soda lime, so that the contents of the rebreathing bag breathed through said canister and soda lime on inhalation will be freed of its carbon dioxide content. The canister 47 is removably held in place by a pair of strap members 50 and 51. These straps are welded or otherwise secured at points such as 52 and 53 to the curved top wall 54 of the rebreathing bag case 20 enclosing the rebreathing bag. The respective sets of ends 55, 56 and 57, 58 of straps 50 and 51 are secured together about the canister 47 by means of screw bolts 59 extending through said ends and drawn together by thumb nuts 60, as clearly shown in Figs. 2 and 5. As shown in Fig. 5, the back part 61 of the protective rebreathing bag case 20 has the straps 16 and 17 thereof hinged at 62 and held to the front part 63 of casing 20 by means of a thumb screw

64 on the front part 63. This enables the two parts to be separated when desired to permit withdrawal and change of the rebreathing bag structure from inside the case 20.

It will be noted that the rebreathing bag 21 in its casing 20, which supports the canister of soda lime, comes, in the erect position of the wearer, see Fig. 2, substantially between the level planes which embrace the lungs of the wearer. This is a desirable and highly important position of the rebreathing bag relatively to the lungs as it will keep pressures on the rebreathing bag and on the lungs substantially the same. If this were not so, at considerable depths, breathing might become laborious or even impossible.

It is important also to note that the arrangement of the rebreathing bag relative to the lungs is such that in all normal and usual positions of the body when the wearer is swimming or diving, there will be little difference in depth under the water of the rebreathing bag and of the lungs of the wearer. This is important because the chest body walls and the flexible walls of the rebreathing bag are both exposed to the pressure of the surrounding water which might be up to fifty pounds per square inch, or greater, in excess of atmospheric pressure. Breathing both on exhalation and inhalation is compensated by the substantial equality of pressure produced by the relative position as to depth under water of the rebreathing bag and the lungs. That is, on inhalation the expansion of the chest against water pressure is compensated by the same pressure upon the flexible rebreathing bag, and on exhalation the forcing of the gas into the rebreathing bag against surrounding water pressure is compensated by the pressure upon the chest walls aiding that action.

It is also important to note that in the above arrangement, gases from the rebreathing bag are drawn through the absorber canister. Exhalation takes place directly to the rebreathing bag, as it is important not to increase by frictional resistance the labor required for exhalation against the water pressure on the rebreathing bag. On inhalation the water pressure upon the flexible rebreathing bag will aid in the movement of the gas from the rebreathing bag in overcoming the frictional resistance of passing through the absorber material in the absorber canister.

This provides a substantially closed breathing circuit wherein all exhalation gases inhaled pass through the soda lime container where they will certainly be freed from carbon dioxide. As shown in Fig. 6, a check valve 66 blocks the exhaling passageway 29 against movement of gases throughout upon inhalation, and a check valve 67 blocks the movement of gases through passageway 42 upon exhalation. The edge view of these check valves is shown in Fig. 6 and a plan view is shown in Fig. 8. In either case the check valve comprises a plate 68 formed with cross webs 69 and 70, Fig. 8, and intervening passageways 71. The flap valve 66 is secured to the crossing webs 69 and 70 and by means of a screw 72. It follows that gas pressure in passageway 42 against the negative pressure in passageways 39, 40 induced by inhalation, will push the flap valve 67 to uncover the openings 71 and permit the flow of gases from tube 42 into the mouth and lungs of the wearer. At the same time the negative pressure in exhaling passageways 32 and 31 will cause flap valve 66 to clamp tightly upon openings 71 and prevent any inhalation gases coming through tube 29.

With a reverse pressure brought about by exhalation the pressure in passageways 31 and 32 will cause flap valve 66 to uncover openings 71 and permit flow of gas through exhalation passageway first to fill rebreathing bag 21 and then to go to atmosphere through pressure release valve 26 to escape through the water.

An oxygen tank 73 is mounted upon front straps 13 and 14 by means of a pair of semi-circular bands 74 and 75 which have ears 76 and 77 connected by bolts 78 and 79 which in turn are connected with brackets 80, 81 and an intervening plate 82 with the front straps 13 and 14, as best shown in Fig. 7. The oxygen tank 73 is thus readily removable and exchangeable and is carried at the front of the body in relation to the soda lime container 47 and rebreathing bag casing 20 so as to substantially balance the weight of the entire apparatus when taken in conjunction with the mask structure held upon the face. The flow of oxygen from the tank is controlled by a valve 83 of well-known construction which opens the oxygen to flow through a regulating valve 84 also of known construction. From the regulating valve 84 the oxygen flows through a tube 85 to a point 86 where it enters the passageway 44, as indicated in dotted lines in Fig. 6. The oxygen tube preferably may be carried through tube 42 to a point close to inhalation valve 67 where the oxygen always will go at the front of the inhalation stream to the breathing passages of the wearer. A gage 87 of well known construction has its stem 88, Figs. 3 and 7, connected with a chamber 89 in casing 90, Fig. 7, from which the oxygen goes to the regulating valve mechanism 84.

Connected with chamber 89 is a valve construction 91, Fig. 7, having therein a chamber 92 connected by means of a bore passageway 93 with the chamber 89. The passageway 93 is adapted to be blocked more or less by needle valve construction 95 controlled by valve handle 96.

From chamber 92 a tube 97 is adapted to convey oxygen through a member, indicated in dotted lines at 98 on Fig. 6, into the chamber leading into rebreathing bag 21, or if desired, the member 96 may be extended entirely into the rebreathing bag. This provides emergency oxygen if, for any reason, it may be needed. In all cases the valves 83 and 96 and the gage 87 are directly in view of the wearer of the appliance. The gage will at all times inform the wearer of the pressure of oxygen in the tank and the amount remaining to be consumed. In practice opening of valve 83 from the tank 73 will merely cause oxygen to be supplied at a fixed rate from the regulator valve 84. This will be the normal operation of the apparatus. If, however, more oxygen is needed for any reason, a simple turning of the valve handle 96 will move needle valve 95 out so as to provide the needed additional oxygen.

The above noted apparatus has very great advantages in use. It is, of course, intended for operations under water over a time necessarily limited by the amount of oxygen which may be carried in the small tank 73. And the manner in which I mount the oxygen tank, the control means therefor, and the gage for showing the condition of the oxygen tank is such as to be within easy range of vision of the wearer and easily manipulated by the wearer's hands. The gage will show when the pressure of the oxygen is running low.

As shown in Fig. 3A the gage 87 is calibrated 75 to show the pounds pressure of the oxygen be-

ing delivered from the oxygen tank 73 and also the normal duration of supply from the maximum when the valve 83 is first operated to turn the gas into chamber 80 to the minimum as the supply of oxygen is exhausted and its pressure falls to zero.

The mask structure itself is adapted to be held by the system of strapping tightly against the face so as to seal against ingress of the surrounding medium such as water, when submerged. The pressure of atmosphere outside of the mask, and even more, the pressure of water when submerged, will aid in effecting complete sealing action. In order that fogging may be avoided when going into cold water I provide vision openings covered with two layers of glass 99 and 100 sealed into the mask frame with a space 101 between them. This space is substantially air tight and prevents accumulation of moist air between the glasses and so prevents a clouding or fogging effect on the inside of the outer glass which will naturally be cold when in the water.

There is, of course, some release of heat in the absorption of carbon dioxide in passing through the soda lime container 47. But when the apparatus is used under water the cooling effect of the water will be amply sufficient to remove this heat.

The advantages of my invention have been heretofore pointed out in more or less detail in the specification. The fundamental advantage is that an apparatus is provided which may quickly and easily be put in position on the wearer and which enables descent in the water to substantial depths without the use of air pumps or heavy sealed metal helmets. The apparatus is wholly self-contained. It provides means for satisfactorily breathing with adequate supply of oxygen in a substantially closed breathing circuit wherein carbon dioxide is continuously being removed. The arrangement of the breathing lines, separate and independent passages for exhalation and inhalation, makes this closed circuit not only effective but easy for breathing. The rebreathing bag being positioned in a rigid case cannot be ruptured or torn, and the size of the case and the large area of openings through it insures uniform water pressure during expansion and contraction of the rebreathing bag.

The apparatus can be used effectively to very considerable depths, such as sixty to eighty feet and up to over one hundred feet, and for long periods of time in excess of one hour, without any contact with the surface of any sort and without serious discomfort to the wearer or respiratory difficulties. And this, while the body assumes all normal positions, such as going down vertical, feet first, and going down vertical, head first, and the normal lateral swimming movements with the limbs either above or below the head of the wearer.

I claim:

1. Breathing apparatus for use under water, comprising a mask adapted to be supported on the face of the wearer and form a breathing chamber at the front of the face and to seal the same against inlet of water when a swimmer wearing the apparatus is subject to water pressures up to pressures at very considerable depths, separate and distinct inhaling and exhaling tubes extending directly from the lower part of the chamber, a rigid perforated casing, a flexible rebreathing bag held therein and connected with the exhaling and inhaling passages, means supporting the casing upon the back of the wearer as the apparatus is worn so that the rebreathing bag and the container will be held when the wearer is in an erect position within limits defined by horizontal planes passing through the upper and lower parts of the lungs, a soda lime container supported by the casing and connected directly in the inhaling passage, means for causing the gases of the rebreathing bag upon inhalation to go through the soda lime container and upon exhalation to go to the rebreathing bag, a tank of oxygen supported in front and toward the waistline as the apparatus is worn, and means for delivering oxygen therefrom into the inhalation passageways beyond the soda lime container.

2. Breathing apparatus for use under water, comprising a supporting harness embodying a belt and shoulder straps connected with the front and back of the harness forming a support for the breathing apparatus, a tank of oxygen connected with the front of the harness and supported thereby toward the waistline, a perforated rigid casing secured to the upper part of the harness on the back as worn, a flexible rebreathing bag in said casing supported thereby in a position such that when the apparatus is worn and the wearer is in erect position the lower part of the bag will be held substantially between horizontal planes between which is the main body of the lungs of the wearer, a soda lime container positioned directly upon the rebreathing bag casing, a mask and separate inhaling and exhaling tubes leading from the mask over the respective shoulders, the exhaling tube having independent direct connection with the rebreathing bag and the carbon dioxide absorber and the inhalation tube having independent direct connection with the carbon dioxide absorber and indirect connection with the rebreathing bag, means for delivering oxygen from the oxygen container into one of said tubes, and valve mechanism carried by the mask for producing a closed breathing circuit through the rebreathing bag, the soda lime container and back to the mask, with the absorber and rebreathing bag at the back in weight-balancing relation to the tank of oxygen at the front when the apparatus is upon the body of a wearer in swimming position.

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