April 15, 1941. I. H. VESTREM 2,238,759

DIVING APPARATUS

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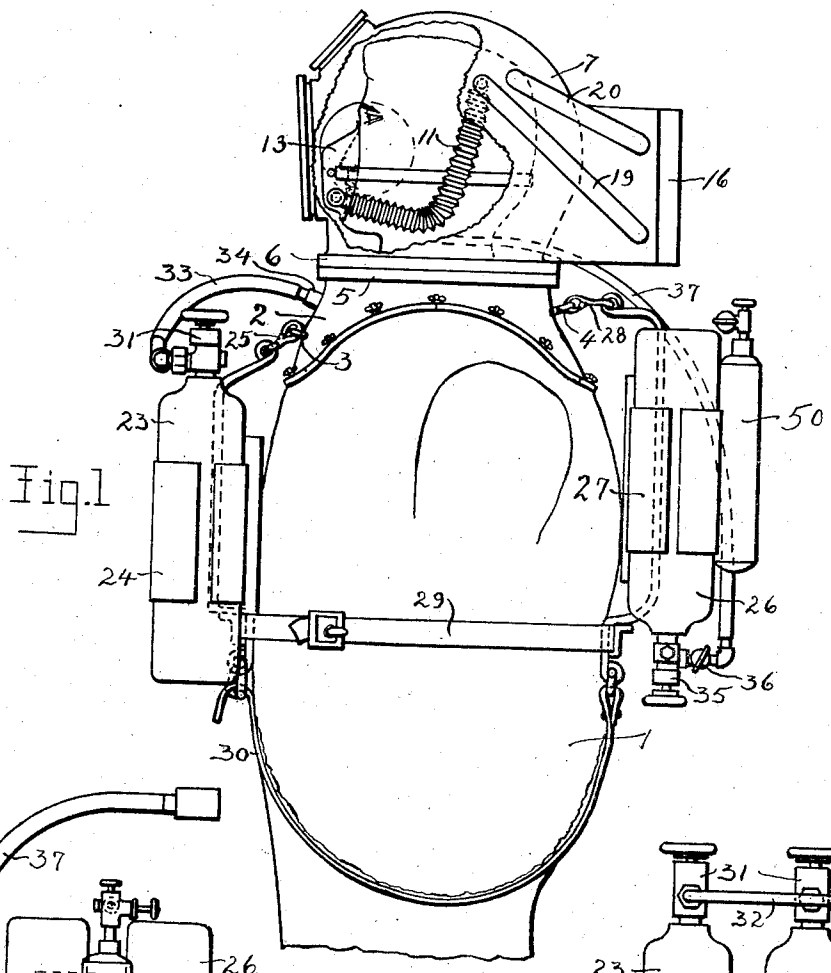


Fig. 1

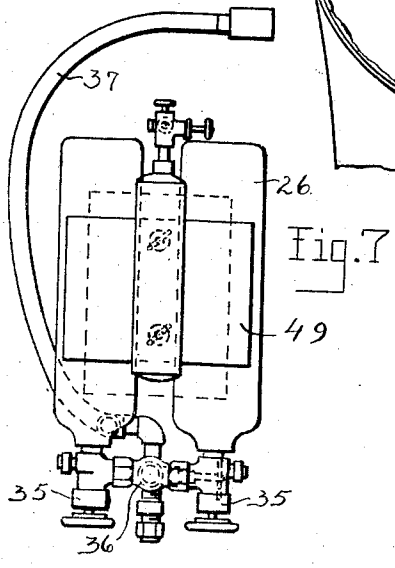


Fig. 7

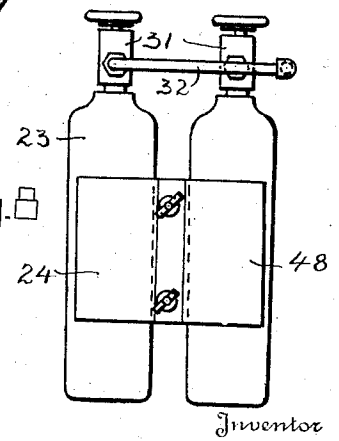


Fig. 8

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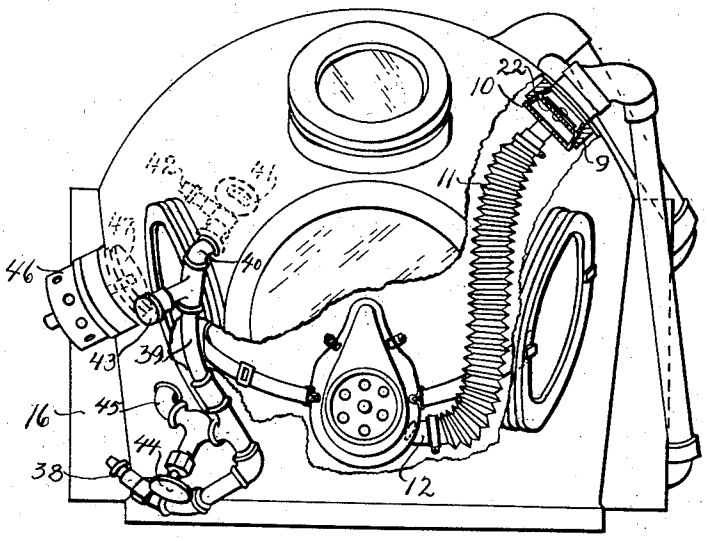
Attorney

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Fig. 2



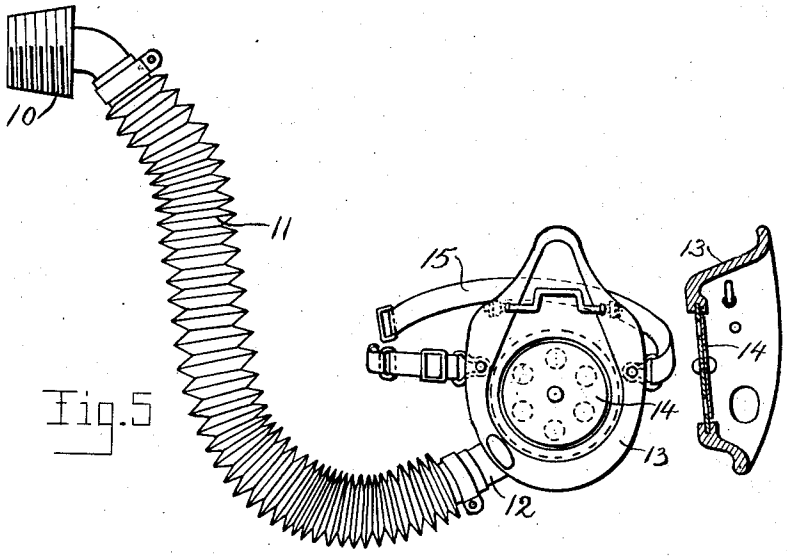


Fig. 5

Fig. 6

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DIVING APPARATUS

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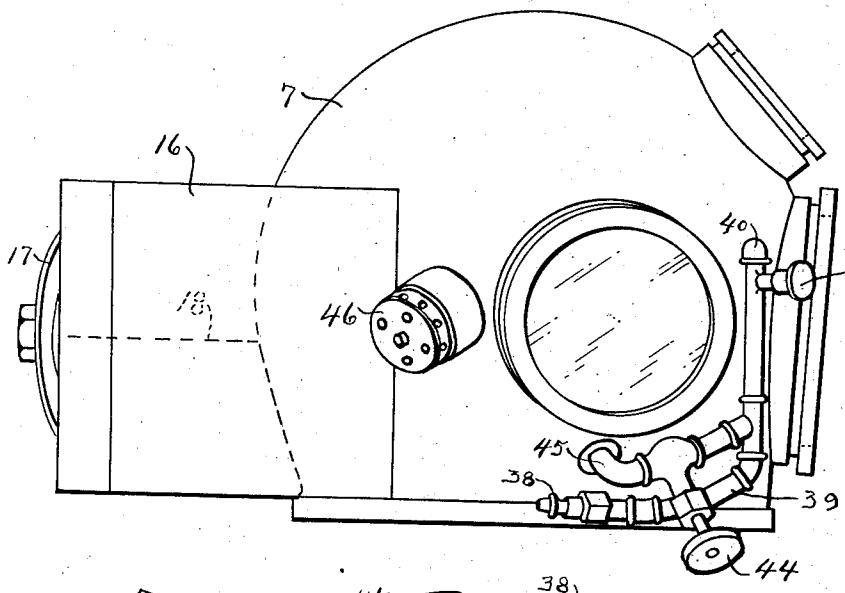


Fig.3

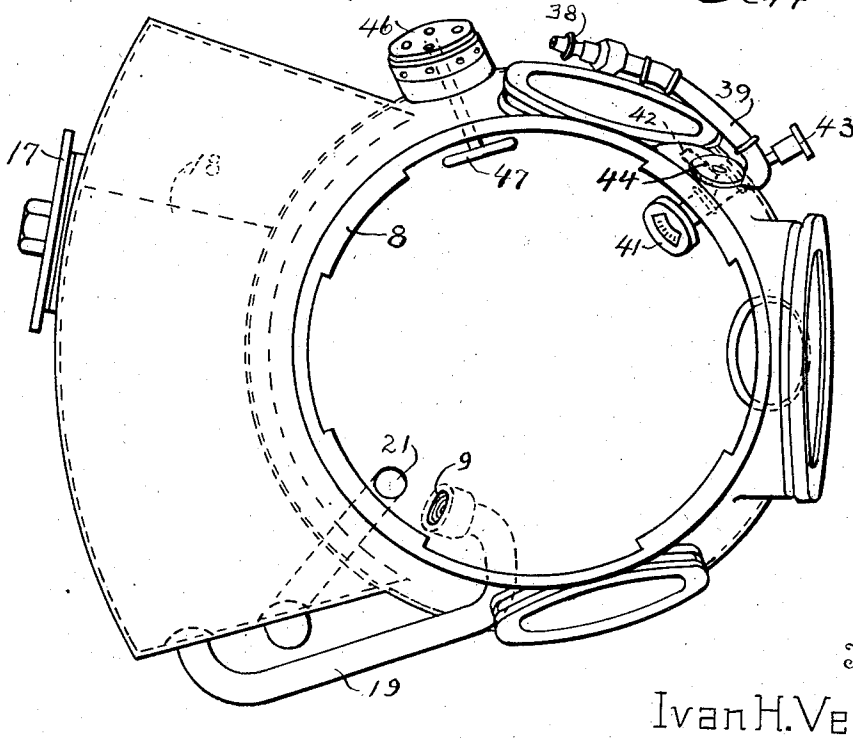


Fig.4

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Patented Apr. 15, 1941 2,238,759

UNITED STATES PATENT OFFICE

2,238,759

DIVING APPARATUS

Ivan Hans Vestrem, Cedar Keys, Fla., assignor of one-sixth to Manuel Kepote, Cedar Keys, Fla., one-sixth to Gus Cocoris, one-sixth to George Mavros, one-sixth to James Alafantis, all of Tarpon Springs, Fla., and one-sixth to Jack I. Bolton, Milwaukee, Wis.

Application July 21, 1939, Serial No. 285,693

3 Claims. (Cl. 61—70)

This invention relates to helmets for diving in deep water and has for its primary object the provision of means for supplying to the helmet a factitious atmosphere which will not readily be absorbed by the blood or tissues when the diver is working under high pressures. A further object is the provision of means for removing the exhaled carbon dioxide without contamination of the atmosphere and for supplying additional oxygen to replace that consumed by the diver in the process of respiration. A still further object is the provision of these and other advantages in a self-contained device which will not require the use of an air hose leading from the surface of the water to the helmet.

For many years, divers in the sponge industry in Florida have been using the conventional diving apparatus which comprises a canvas-rubber suit, a copper helmet, and an air hose supplying air compressed by a pump upon the deck of the boat from which the diver operates. Divers must walk miles on the bottoms searching for sponges to detach them and send them up to the surface. Their work sends them down as deep as sixty to eighty feet. At the pressure required to furnish a continuous supply of aid to divers at such depths, nitrogen is absorbed by the blood and thus carried to other body tissues. Hard work under such pressure produces a condition which increases in danger with the length of time so spent.

When a diver comes out of this region of high compression, the absorbed, dissolved, or occluded nitrogen tends to escape, and if this action is allowed to take place too rapidly after too long a period of submersion at the high pressure resulting in a large absorption of gas, the consequences may be very serious. The "bends," as the various symptoms are called, range from a slight itching sensation to blocking of nerve centers, paralysis, heart trouble, and sometimes death or permanent injury. It is not practicable to use decompression apparatus with the loss of time that results, so the divers set certain limits on the time that they will stay below and they avoid the greater depths in which are to be found many of the finest sponges.

The device of the present invention provides means by which a mixture of oxygen and helium may be used in place of air, the mixture being breathed over and over again, oxygen being added at about the same rate that it is consumed in the process of respiration, while the carbon dioxide from the lungs is removed chemically by passing the exhaled breath through a chamber containing an absorbent with which the carbon dioxide will combine. Divers can thus work longer and harder while breathing this mixture of helium and oxygen, because the solubility of helium in the blood and its occlusion by the tissues is very much less than that of nitrogen at the same pressure and the divers may also take advantage of increased oxygen percentages whenever dives of over one hundred feet are desirable or necessary. If it becomes necessary to decompress from deep dives, there is available a supply of pure oxygen to help the blood stream throw off the helium and carbon dioxide through the lungs.

The elimination of the air hose not only relieves the diver of the labor of dragging the extra weight around, but removes a source of danger. Accidents to the air hose have often been fatal to the diver.

In the drawings illustrating a preferred embodiment of the invention, Figure 1 is a side elevation of the upper part of a diving suit showing the helmet and tanks in position; Fig. 2 is a front view of the helmet with a portion broken away to show the face mask or respirator and its attachment to the helmet; Fig. 3 is a right side elevation of the helmet; Fig. 4 is a bottom view of Fig. 3; Fig. 5 is a rear elevation of the respirator; Fig. 6 is a vertical section through the nose piece of the respirator; Fig. 7 is an elevation, as seen from the side which is normally next to the body, of the oxygen tanks; and Fig. 8 is a front elevation of the tanks that hold the mixture of helium and oxygen.

The diving suit 1 may be of any ordinary or suitable construction and it has secured thereto by a water-and-gas-tight connection, a breast plate 2 which is provided at front and rear with rings or loops 3 and 4 for the suspension of the gas tanks. At the top, the breastplate has a circular flange 5 to receive the bottom flange 6 of a helmet 7, which will usually be made of copper for use in sea water. The flanges 5 and 6 are secured together in a well-known manner by interfitting lugs such as are shown at 8 in Fig. 4.

In the top of the helmet, above the left side of the diver's head, is a screw-threaded socket 9 to receive a threaded valve casing 10 to which is attached a corrugated or bellows-like rubber tube 11 having at its lower end a fitting 12 secured in the side of a rubber face mask 13 which has an inspiratory valve at 14. The diver carefully adjusts this respirator mask to his face and secures it in place by a strap 15 which passes back of the head. This is done as the helmet is held over the head by the diver's tender and when the mask is fitted, the helmet is set upon the flange of the breast plate and secured thereto. Formed upon or attached to the rear of the helmet is a container 16, which, in use, is filled with absorbent soda lime, a caustic soda mixture with quicklime, which readily takes up moisture and carbon dioxide. A filler cap 17 provides access to the container opposite a partition 18 which extends longitudinally of the container for two-thirds or more of its length. A tube 19 extends from the socket 9 to the lower portion of the left

wall of the container and a tube 20 connects the upper portion of the left wall with an inlet 21 in the helmet. Exhaled air containing carbon dioxide will thus pass through tube 11 to and through the expiratory valve 22 in the casing 10, thence through the tube 19 into the lower portion of the container 16 where it must travel through the soda lime, both below the partition and above the partition before it is returned into the helmet at the inlet 21. The carbon dioxide and moisture from the breath will unite with the caustic soda and lime, but the chemically inert helium and uncombined oxygen will pass through unchanged.

The front tanks 23 are held together by a clamp 24 having a snap fastener 25 which engages within the ring or loop 3 and the rear tanks 26 are held together by a clamp 27 which has a snap fastener 28 engaging the rear ring or loop 4 on the breast plate.

A belt 29 around the body of the diver holds the lower ends of the tanks in place and a strap 30 passed between the legs of the diver holds the breast plate and helmet from lifting too high when the suit is inflated and beneath the water.

Each of the tanks 23 has a valve 31 connected to a manifold 32 which is connected by a tube 33 with a fitting 34 forming an inlet into the breast plate 2. The gas mixture of helium and oxygen can be admitted at will when needed, to the desired degree of pressure to keep the suit inflated by opening either valve 31, as necessitated by the pressure at the depth at which the diver is working. The rear tanks 26 have valves 35 connected to a regulator or reducing valve 36 to lower the high gas pressure of the tanks to a working pressure. A rubber hose 37 connects this regulator with a snap-on fitting 38 on the right side of the helmet, and a pipe 39 leads from the fitting 38 to an elbow 40 on the helmet connected on the inside of the helmet with a pressure gage 41 and an orifice 42 for the admission of a small quantity of oxygen continuously into the helmet to agree with the rate at which oxygen is used up in respiration. A valve 43 controls this inlet. A larger valve 44 allows pure oxygen to be admitted rapidly into the helmet through an elbow 45 whenever the suit is to be inflated, in an emergency, or during decompression.

An exhaust valve 46 operated by a head piece 47 can be opened by sidewise pressure of the diver's head if desired. The pressure inside the suit is normally kept greater than the pressure outside to keep the weight of the helmet and tanks off the diver's shoulders. The buoyancy of the inflated suit requires the diver to wear weighted shoes to hold his feet down and lead weights 48 and 49 are attached to the tank assemblies in front and rear as additional ballast to keep the diver down and in balance.

A small tank for holding compressed air or any other compressed gas such as carbon dioxide may be attached as at 50 to the rear tank assembly, as a means for supplying a continuous flow of gas to give a signal upon the surface of the water to indicate to those on the boat where the diver is located on the bottom.

Enough gas can be carried in the tanks for the full period a diver should remain below at one stretch. By careful use, very little helium needs to be lost, and the oxygen tanks at high pressure will contain a sufficient supply to compensate for that used in respiration for a long while.

The gas mixture for diving to one hundred feet should be about 37.5% helium to 62.5% oxygen, the gases being preferably carefully mixed well in advance of their use in a storage tank, before being compressed into the small tanks 23. Helium seems to mix relatively slowly with oxygen and this procedure allows time for thorough uniformity of admixture.

The ability to supply additional oxygen at will and rapidly, and the relatively small waste of helium are features of considerable advantage. Because of the much slower rate of absorption of helium by the blood, divers can work safely at greater depths and for much longer periods of time without danger of the "bends." It will also be evident that the diver has much greater freedom of movement with the present device than when he is forced to drag around a heavy air hose, and the flexible respirator tube permits free movement of the diver's head and absence of strain as compared with those devices in which the diver is compelled to hold a mouthpiece mounted rigidly on the helmet, in his teeth or with his lips and thus to turn the whole body in order to turn the head.

The annual cost of air hose is a very considerable part of the cost of operation, and this device saves all that expense besides the cost of running the pump.

It will be evident that many changes in details of construction and in the proportions and manner of arrangement of parts may be made without departure from the invention as claimed.

I claim:

1. A diving apparatus comprising a helmet, a pressure tank communicating therewith for supplying at will a mixture of helium and oxygen, a second pressure tank communicating with said helmet and having two control valves, one to supply a small quantity of oxygen continuously to compensate for amounts converted into carbon dioxide, and the other to supply a large amount of oxygen at will.

2. A diving apparatus for use under water, comprising a helmet, a pressure tank communicating therewith and containing a mixture of helium and oxygen under pressure, a second pressure tank communicating with the helmet and containing oxygen under pressure, means for removing carbon dioxide from exhaled gases, and a third tank containing a compressed gas and having means for releasing said gas continuously to provide a signal upon the surface of the water.

3. A diving apparatus comprising a helmet, a pressure tank containing helium and oxygen under pressure, and communicating with the helmet, a valve for controlling said tank, a second pressure tank containing oxygen under pressure and communicating with said helmet and a valve for controlling said second tank to supply a small quantity of oxygen continuously to the helmet to compensate for that used in respiration, a respirator for attachment to the head of the diver and a flexible tube carried thereby and provided with an expiratory valve, a chamber with which said valve communicates, said chamber containing a substance capable of uniting with carbon dioxide, said chamber having an outlet communicating with said helmet, and a second valve for the oxygen to supply a relatively greater quantity at will.

IVAN HANS VESTREM.