May 21, 1963 J. K. HULBERT 3,090,345

HYDRODYNAMIC PROPULSION SYSTEM

Filed Feb. 19, 1962 3 Sheets-Sheet 1

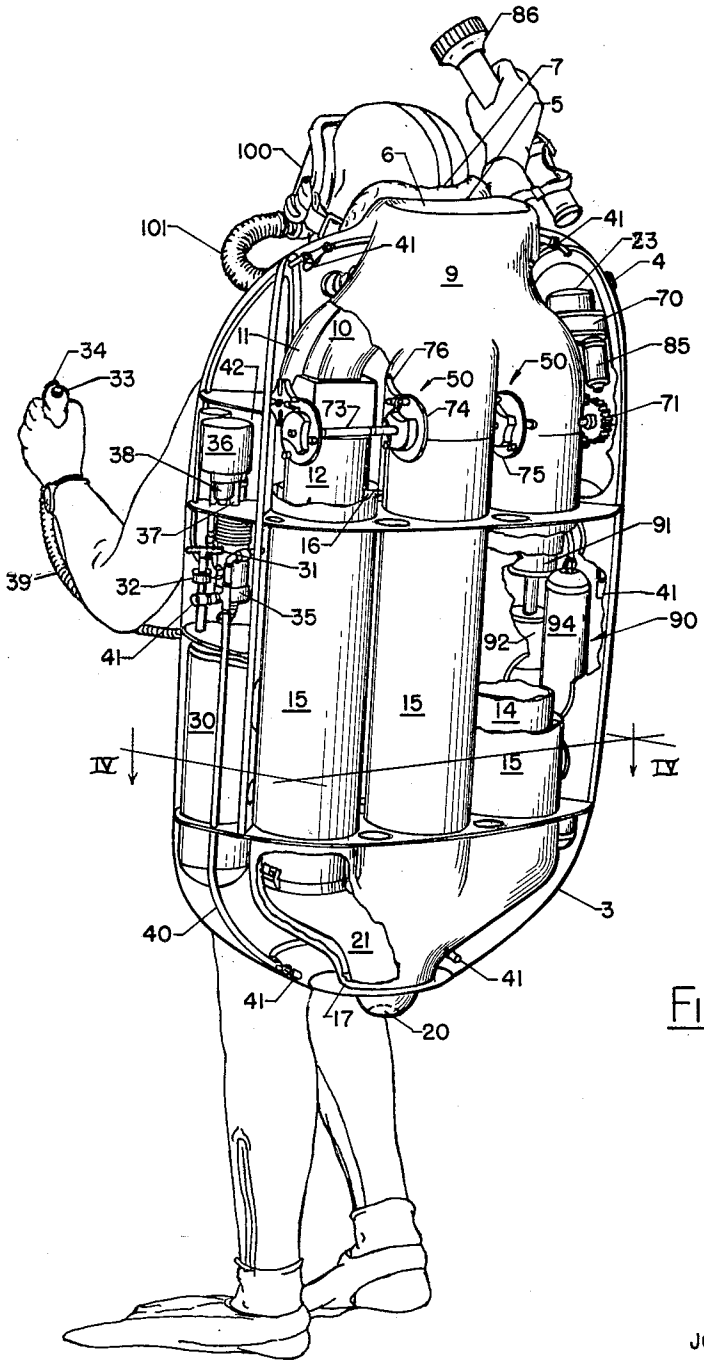


FIG. 1

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HYDRODYNAMIC PROPULSION SYSTEM

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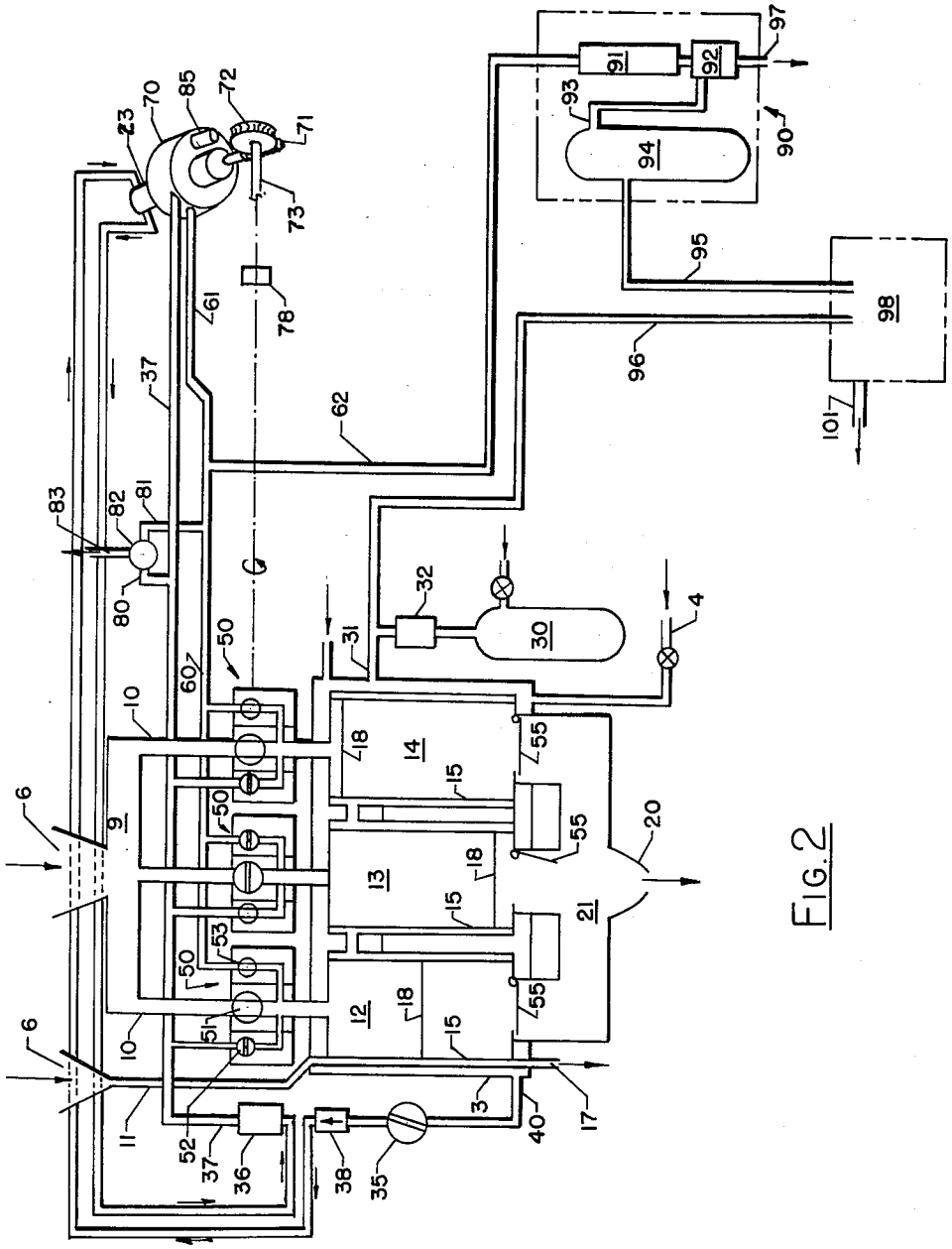


FIG. 2

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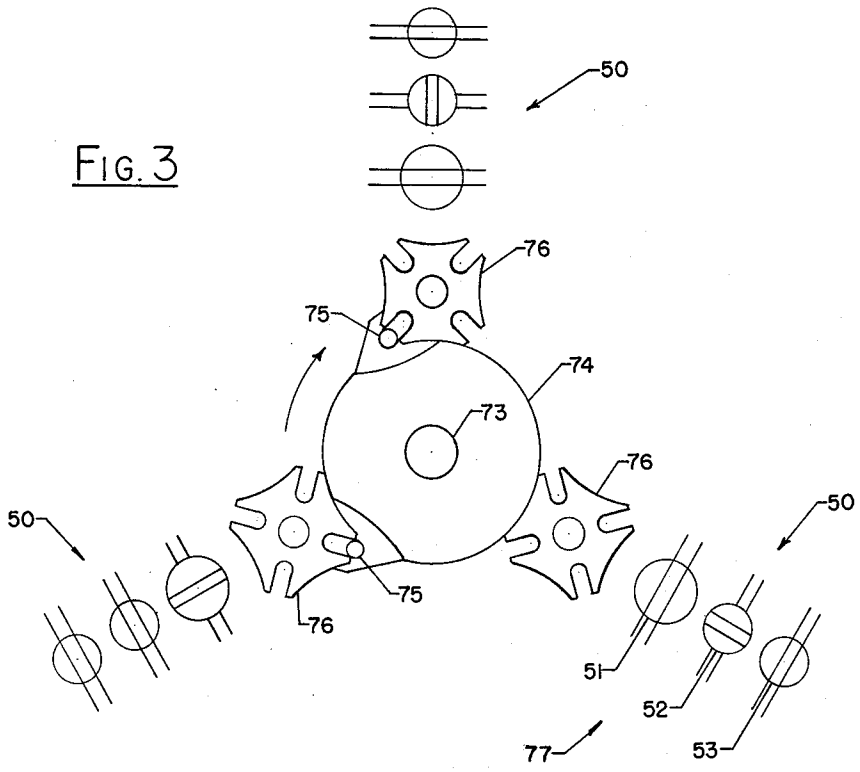
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HYDRODYNAMIC PROPULSION SYSTEM

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FIG. 3



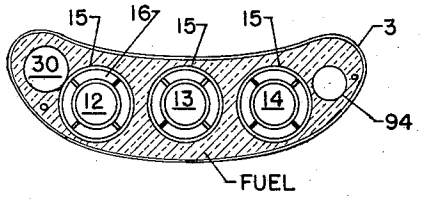


FIG. 4

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United States Patent Office 3,090,345 Patented May 21, 1963

3,090,345

HYDRODYNAMIC PROPULSION SYSTEM

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Filed Feb. 19, 1962, Ser. No. 173,906
8 Claims. (Cl. 115—6.1)

This invention relates to marine propulsion devices and also to devices such as are suitable for attachment to personnel engaged in water surface or underwater "diving" or exploration or other tasks for military or scientific or commercial purposes.

Heretofore, for the aforementioned purposes, devices such as miniature submarines of considerable weight and bulk, or heavy sled-like arrangements, or hand-held, battery-powered propulsion devices of relatively short endurance have been employed; and such devices have been operationally dependent upon the use of bulky and heavy high-pressure air tanks. Operations employing such type prior devices have been severely handicapped and limited because of lack of capabilities for fully effective operations and/or underwater survival of associated personnel during extended periods of submersion. Also, the propulsion systems of all known prior devices produce considerable noise, as well as nearly defined wakes, thus making unwanted detection rather easy. These are of course extremely serious disadvantages when for example the device is to be employed by military personnel.

A primary object of the present invention is to provide an improved, completely self-contained device, adapted to be worn for example by a diver for underwater operations and capable of propelling him over a considerable range while supplying him with means of survival over an extended period of time.

Another primary object of the invention is to provide an improved propulsion engine, operable with equal facility both underwater and on the surface.

Another object is to provide an improved engine as aforesaid which produces a noise well below the ambient sea noise and a visible wake far less than that normally associated for example with "scuba divers."

Still another object of the invention is to provide a device as aforesaid which delivers to the wearer when diving, the necessary breathing gas at a pressure commensurate with the depth at which the device is being used, without use of bulky high pressure air tanks such as are now used for example by scuba divers.

A further object of the invention is to provide a device as aforesaid which also furnishes a supply of heat for warming the diver such as when operating under ice fields or the like.

Another object of the invention is to provide a device as aforesaid which also furnishes the diver with a supply of potable drinking water, such as would be particularly useful during extended periods of submersion in sea water.

A still further object of the invention is to provide a device as aforesaid which delivers electrical energy for operating illuminating or communicating devices, while submerged, or when surfaced, or on dry land.

Other objects and advantages of the invention will be readily discernible to those skilled in this art, particularly when they refer to the drawings and teachings contained in this disclosure. Referring now to the drawings, showing one embodiment of the invention and forming a part of this disclosure:

FIG. 1 is a three-quarter rear view showing a device of the invention, with a portion of the outer casing removed and portions of the interior parts cut away to show the construction thereof;

FIG. 2 is a diagrammatic view of the entire system;

FIG. 3 is a schematic of the valve-driving arrangement of the invention, and

FIG. 4 is a cross-section taken along line IV—IV of FIG. 1.

The invention contemplates broadly that any one of the presently available monopropellant type fuels may be used as the energizing media. However, as shown herein by way of example the device is designed to use hydrogenperoxide (H_2O_2). This permits the exhaust gases to be fully utilized through a reclamation device so that both oxygen (for breathing) and water (for drinking) are made available automatically. The process for reclaiming oxygen and water from the decomposed hydrogenperoxide is well known in the chemical industry, and therefore no invention on my part is claimed for this phase of the system.

As shown in FIG. 1 of the drawing herewith, the device may be constructed to consist of a closed housing or shell **3**, of generally cylindrical form but flattened at one side to comfortably conform to the back of the wearer. This shell is preferably of light-weight fiber glass construction, although other molded plastics or metal or the like may be employed. The shell **3** is formed at its upper extremity with an inlet duct **6** into which the ambient water flows and is distributed by means of a manifold chamber portion **9** and ducts **10** to a series of parallel propulsion chambers **12, 13** and **14**. Also, inlet water is guided thru a second series of ducts **11** to the corresponding propulsion chamber cooling jackets **15**. A head rest **5** is incorporated at the top of the shell **3**, adjacent to the intake **6** and may be padded as indicated at **7** to support the diver's head when tilted backward for full forward vision during long periods of underwater forward travel. The cooling jackets **15** are in spaced relationship to the chambers **12, 13** and **14**, and thus form cooling passages **16** for the passage of ambient water to cool the gas in the propulsion chambers. The cooling water then flows out thru an annulus **17** surrounding the propulsion chamber exhaust nozzle **20** which communicates through means of a duct **21** with the discharge ends of all of the propulsion chambers.

The system fuel supply of liquid form is carried within the shell **3**, filling the voids formed externally of the operative components contained therein. The fuel may be loaded into the shell **3** through a filler opening capped as indicated at **4**. A high pressure helium supply bottle **30** as is shown located within the shell **3** may be employed to control pressurization of the shell **3**, such as to approximately one atmosphere above ambient pressure. As shown in FIG. 2 the pressure supply may communicate with the shell **3** as by means of a conduit **31**; the output pressure of the tank **30** being governed by means of a pressure regulator **32**. Thus, the liquid fuel is caused to flow to the various intakes as will be explained more fully hereinafter, and the expended helium may also be utilized as a gas mixed in proper proportions with oxygen, for breathing purposes as will also be explained more fully hereinafter.

The fuel from the tank **30** is preferably further forced under pressure, as by a pump **23** (FIG. 2) under control of a throttling valve **35**, to flow into and through a catalytic chamber **36** containing a bed of gold and silver plated nickel screen elements as described for example in co-pending application S.N. 841,173, filed September 21, 1959, by Macdonald Sill. The H_2O_2 is thereby decomposed into a gas at relatively high pressure, and is thence distributed by means of a manifold conduit **37** to the propulsion chambers **12, 13** and **14**. A check valve **38** is provided between the throttle valve **35** and the catalyst bed **36** to prevent back pressure from entering the shell **3**. As explained hereinabove, the cooling jackets **15** are provided to prevent the heat generated in

the catalyst bed and in the propulsion chambers 12, 13 and 14 from detrimentally affecting the hydrogenperoxide while in storage. Because of the time lag between the heating of the chamber walls and the exhaust of the thrust-producing water column as will be explained hereinafter, the gas will cool during this phase of operation, hence reducing in volume during the gas exhaust phase. The overall efficiency of the system will be a function of this volumetric decrease and of the proportion of the gas which is condensed to the liquid phase during the water expulsion cycle of the operation.

In order that a diver may maneuver at will without being limited by fuel cavitation problems, a fuel intake manifold system 40 has been provided to supply the pump 22 through the valves 35, 38. This system consists of a conduit assembly having a series of intakes 41 (FIG. 1) so arranged that regardless of the attitude of the diver to the horizontal, at least one of the intakes 41 will be submerged in the liquid hydrogen peroxide. Each intake 41 is preferably equipped with a valve that is gravity-operated to open, so that the intake is open only when directed downwardly into liquid fuel, thereby precluding admission of gas into the system. The throttle valve 35 is controlled by a push button 33 carried in a hand-held lever, and the throttle control may be locked in any position by means of a friction stop 34, so that the diver can set his speed and then release the throttle control so as to free his hands for other work. The control is connected to the valve 35 by means of a standard Bowden flexible cable 39. Maneuverings other than by means of the throttle control are obtained by normal body actions and by the use of conventional flippers worn on the feet.

Referring now to FIG. 2, a diagrammatic view of the device, the propulsion system includes the catalyst chamber 36 wherein the fuel is decomposed and distributed by means of manifold 37 to each of the sequencing valve assemblies shown generally at 50. Preferably, the catalyst bed 36 is heat-insulated from the liquid fuel supply, and for this purpose it may be installed in a fluid-tight chamber 42 separate from the fuel chamber and cooled by circulating water, if desired. The control system is so arranged that, for example, when the water intake valve 51 of the left hand assembly is open, allowing ambient water to flow into its associated chamber 12, the gas pressure valve 52 thereof is closed, thus preventing entrance of gas under pressure into chamber 12. At the same time the exhaust valve 53 is open to allow the residual gas from the previous cycle to escape through the propulsion exhaust conduit 60. Means are provided so that when the water line (18) rises to a predetermined point, water valve 51 and exhaust valve 53 are both closed. Coincidentally gas pressure valve 52 opens, thus pressurizing chamber 12 and forcing the water therein out through chamber 21 and the nozzle 20 thereby creating a propulsive thrust. Check valves are provided as indicated at 55 to prevent water under pressure in chamber 21 from entering an adjacent chamber in a reverse flow pattern.

To eliminate production of a stream of bubbles in the water behind the nozzle 20, the valve 52 is closed when the water line 18 reaches a predetermined point during its propulsion cycle, causing all exhaust gases to pass through conduit 60 where they may be piped to an oxygen-water reclaiming device for further use as explained hereafter. The explanation of the detailed operation of chamber 12 applies also to chambers 13 and 14 which operate in the same manner but sequentially, as governed by the valve assemblies 50 which are operated as will be explained hereinafter. It should also be understood that, while I have shown only three propulsion chambers, any other number may be employed without departing from the scope of the invention. If only one chamber is employed the device will operate with a definite pulsing motion; this pulsing effect being smoothed out as the number of chambers is increased.

Any suitable means may be employed for driving the valves 50 to operate in proper sequence. As shown herein by way of one example, I have employed a gas driven turbine 70 which is powered by gas pressure developed in the catalyst chamber delivered to the turbine through conduit 37 and exhausted through conduit 61 to conduit 62. Inasmuch as turbine 70 operates at extremely high speeds, it will be relatively small in overall dimensions. The output shaft of the turbine 70 is connected by means of a standard worm 71 and gear 72 arrangement to a shaft 73, the speed of which is a direct function of the throttle setting.

Referring now to FIG. 3, it will be seen that shaft 73 carries a cam wheel 74 equipped with two pins 75—75, so arranged as to selectively engage three Geneva wheels 76 for intermittent operation thereof. Or, as shown in FIG. 1, the drive shaft may carry three separate cams engaging axially aligned Geneva wheels. The arrangement selected will be dependent only on the mechanical arrangement best suited for the installation desired. The various valve arrangements 50 of FIG. 3 are shown relative to the water line 18 of FIG. 2, however, I will explain only the arrangement shown generally at 77 wherein the individual valves 51, 52 and 53 are shown in the same relative position as for chamber 12 of FIG. 2. A clutch 78 of any standard type may be installed in the shaft 73 in order to permit operation of the turbine without operating the valve assemblies 50, if so desired. Note that the turbine 70 may also be arranged to drive the fuel pump 23 (FIG. 2).

Also, as shown in FIG. 2, hot gas from conduit 37 and relatively cooler gas from conduit 60 may be conducted through conduits 80 and 81 respectively, to a temperature regulating valve 82 and thence through a conduit 83 for use in a jacket-heated type diver's suit. The valve 82 is manually adjusted so to maintain any desired temperature, and such arrangement is particularly useful when diving in ice water or working under ice flows. The system may also include means for generating electrical current for illumination and/or communication purposes. For example, a small alternator 85 may be mounted on the turbine 70 and geared thereto by means of any suitable gear train (not shown) and wired for example to a hand carried lamp 86 (FIG. 1).

The invention also provides an almost inexhaustable supply of breathing oxygen without use of large, high-pressure oxygen bottles such as are usually associated with scuba diving apparatuses. A device such as shown in FIG. 1 may easily contain as much as a cubic foot of hydrogenperoxide, which will furnish a supply of oxygen sufficient to maintain a man under water for a period in excess of ten days. To this end an oxygen generating device may be included as shown generally at 90 and a heat exchanger 91 operating to cool the gas issuing from exhaust conduit 62, thereby causing the decomposed H_2O_2 to separate into H_2O and O. The H_2O and O mixture is then conducted to a water separator 92 equipped with a water drain 97 and a conduit 93 to conduct the oxygen to a lightweight storage container 94. In order to use this oxygen for breathing at extreme depths, it must be mixed with helium in proper proportions. Therefore, the oxygen is piped through a conduit 95 to a gas mixing device 98 into which helium is delivered by means of a by-pass conduit 96. The mixing device 98 may be of any suitable form presently available on the open market. The helium and oxygen breathing mixture is then conducted to the diver's mask 100 (FIG. 1) by means of conduit 101. The supply of fresh drinking water available at conduit 97 may be collected in a plastic bag or the like, and used as needed during prolonged periods of submersion in salt water.

As mentioned hereinabove, a device of the invention may contain a sufficient supply of H_2O_2 to be employed

as an oxygen generating device for use for example by a diver accidentally trapped below the surface, or by military personnel engaged in enemy action. This ability to remain quiet and sustain life under such circumstances day after day will give the diver a far greater chance of survival than possible with any other available type equipment. Furthermore, when used for propulsion, the noise generated by the mechanism of the invention will be of such low order of magnitude as to blend readily into the ambient sea noises, and hence will be difficult to detect by sonar or other listening devices. Also, the trail left by the oxygen exhaust is far less than that left by propellers and the like, and can be still further reduced if desired by employing an exhaust nozzle fitted with a screen containing great numbers of small diameter exhaust ports, thereby preventing the formation of large bubbles. Since sea water is generally deficient in oxygen, the small bubbles of oxygen from the exhaust will, in practically all cases, dissipate within a few feet of the exhaust nozzle.

The entire assembly of the invention is readily strapped to the diver's back by means of straps and quick disconnect buckles or the like, whereby the diver may quickly jettison the device in an emergency. A decided advantage of the invention resides in the fact that no bulky, high-pressure containers are required, since the system will work most efficiently at a pressure of only one atmosphere above the pressure of ambient water, regardless of the depth and the corresponding pressure under which it is being used. Hence, the breathing oxygen is always under exactly correct pressure, and the diver may change depth more rapidly than when using any other presently available apparatus.

Although only one form of the invention has been illustrated and described in detail herein, by way of example, it will be understood that various changes may be made therein without departing from the spirit of the invention or the scope of the following claims.

I claim:

1. A self-contained monopropellant energized propulsion unit for personnel engaged in underwater maneuvers, said unit comprising a casing adapted to be strapped against a person's back and having therein a propulsion engine comprising a cylinder having a discharge end opening at the lower end of said casing and an inlet port at the upper end of said casing, a multiposition valve controlling said inlet port, an ambient water inlet conduit leading from the upper end of said casing to said control valve, a gas supply conduit in communication with said control valve, a catalyst chamber disposed within said gas supply conduit, a hydrogenperoxide liquid supply stored within said casing and in communication with said supply conduit, means for displacing said hydrogenperoxide to move through said supply conduit and through said catalyst chamber whereby gas evolves for delivery to said control valve, and means for alternatively setting said control valve at water inlet and gas inlet positions whereby said cylinder is alternatively filled with ambient water and then with evolved gas displacing the water from said cylinder and thereby producing intermittent propulsion thrusts of water against the ambient water at said discharge opening.

2. A propulsion unit for personnel engaged in marine maneuvers, said unit comprising a casing adapted to be strapped upon a person and having therein a propulsion engine comprising a cylinder having a discharge end opening at one end of said casing and an inlet port at the other end of said casing, a multiposition valve controlling said inlet port, an ambient water inelt conduit leading to said control valve, a gas supply conduit in communication with said control valve, a catalyst chamber disposed in the line of said gas supply conduit, a decomposable liquid stored within said casing and in communication with said supply conduit, means for displacing said liquid to move through said supply conduit

and through said catalyst chamber whereby gas evolves for delivery to said control valve, and means for alternatively setting said control valve at water inlet and gas inlet positions whereby said cylinder is alternatively filled with ambient water and then with evolved gas displacing the water from said cylinder and thereby producing intermittent propulsion thrusts of water against the ambient water at said discharge opening.

3. A self-contained propulsion unit for personnel engaged in marine maneuvers, said unit comprising a casing adapted to be strapped upon a person and having a propulsion engine comprising a cylinder with a discharge end opening and an inlet port, a multiposition valve controlling said inlet port, an ambient water inlet conduit leading to said control valve, a gas supply conduit in communication with said control valve, a catalyst chamber disposed within said gas supply conduit, a decomposable liquid stored within said casing and in communication with said supply conduit, means for displacing said liquid to move through said supply conduit and through said catalyst chamber whereby gas evolves for delivery to said control valve, and motor means driven by pressured gas from said cylinder for rotating said valve and alternatively setting said valve at water inlet and gas inlet positions whereby said cylinder is alternatively filled with ambient water and evolved gas displacing the water from said cylinder and thereby producing intermittent propulsion thrusts of water against the ambient water at said discharge opening.

4. A self-contained propulsion and survival unit for personnel engaged in marine maneuvers, said unit comprising a casing adapted to be strapped upon a person and having therein a propulsion engine comprising a cylinder having a discharge end opening at one end of said casing and an inlet port at the other end of said casing, a multiposition valve controlling said inlet port, an ambient water inlet conduit leading from the upper end of said casing to said control valve, a gas supply conduit in communication with said control valve, a catalyst chamber disposed within said gas supply conduit, a hydrogenperoxide liquid supply stored within said casing and in communication with said supply conduit, means for displacing said hydrogenperoxide to move through said supply conduit and through said catalyst chamber whereby gas evolves for delivery to said control valve, motor means for alternatively setting said control valve at water inlet and gas inlet positions whereby said cylinder is alternatively filled with ambient water and then with evolved gas displacing the water from said cylinder and thereby producing intermittent propulsion thrusts of water against the ambient water at said discharge opening, and means drawing upon said gas supply to generate oxygen and water, and means separating said oxygen and water and delivering them separately for personnel breathing and drinking purposes.

5. A self-contained propulsion unit for personnel engaged in underwater maneuvers, said unit comprising a casing adapted to be strapped against a person's back and having therein a propulsion engine comprising a plurality of cylinders each having a discharge end opening at the lower end of said casing and an inlet port, a multiposition valve controlling each of said inlet ports, an ambient water inlet conduit leading from the upper end of said casing to each of said control valves, a gas supply conduit in communication with each of said control valves, a catalyst chamber disposed within said gas supply conduit, a hydrogenperoxide liquid supply stored within said casing and in communication with said supply conduit, means for displacing said hydrogenperoxide to move through said supply conduit and through said catalyst chamber whereby gas evolves for delivery to said control valves, and means for sequentially and alternatively setting each of said control valves at water inlet and gas inlet positions whereby said cylinders are sequentially filled alternatively with ambient water and then with

evolved gas displacing the water from said cylinders and thereby producing intermittent propulsion thrusts of water against the ambient water at said discharge opening.

6. A self-contained monopropellant-energized underwater propulsion unit for personnel engaged in underwater maneuvers, said unit comprising a casing adapted to be strapped against a person's back and having disposed therein a propulsion engine comprising a plurality of cylinders each having a discharge end opening at the lower end of said casing, check valves at said discharge openings, an inlet port at the upper end of each cylinder, a valve controlling each of said inlet ports, an ambient water inlet conduit leading from the upper end of said casing to said control valves, a gas supply conduit in communication with said control valves, a catalyst chamber disposed in the line of said conduit, a propellant supply stored within said casing and in communication with said supply conduit, means for displacing said propellant to move through said supply conduit and through said catalyst chamber whereby gas evolves for delivery to said control valves, means for alternatively setting said control valves at water inlet and gas inlet positions whereby said cylinders are sequentially and alternatively filled with ambient water and then with evolved gas displacing the water from said cylinders, thereby producing overlapping propulsion thrusts of water against the ambient water at said discharge opening.

7. A self-contained propulsion and survival unit for personnel engaged in marine maneuvers, said unit comprising a casing adapted to be strapped upon a person and having therein a propulsion engine comprising a plurality of cylinders each having a discharge end opening at one end of said casing and an inlet port, a multiposition valve controlling each of said inlet ports, an ambient water inlet conduit leading from the upper end of said casing to said control valves, a hot gas supply conduit in communication with said control valves, a catalyst chamber disposed within said gas supply conduit, a hydrogenperoxide liquid supply stored within said casing and in communication with said supply conduit, means for displacing said hydrogenperoxide to move through said supply conduit and through said catalyst chamber whereby hot gas evolves for delivery under pressure to said control valves, motor means driven by said pressured gas for sequentially and alternatively setting said control valves at water inlet and hot gas inlet and

cooled gas outlet positions whereby said cylinders are sequentially and alternatively filled with ambient water and then with evolved gas displacing the water from said cylinders thereby producing overlapping intermittent propulsion thrusts of water against the ambient water at said discharge opening and cooled scavenged gas discharges through said valves, means drawing upon said gas supply to generate oxygen and potable water, means separating said oxygen and water and delivering them separately for personnel breathing and drinking purposes, an electric generator driven by said motor means and energizing an illumination device, and a mixing valve conveying both hot and cooled gas from said supply conduit and from said control valves to a personnel heating device.

8. A self-contained propulsion and survival unit for personnel engaged in marine maneuvers, said unit comprising a casing adapted to be strapped upon a person and having therein a propulsion engine comprising a cylinder having a discharge end opening at one end of said casing and an inlet port at the other end of said casing, a multiposition valve controlling said inlet port, an ambient water inlet conduit leading from the upper end of said casing to said control valve, a gas supply conduit in communication with said control valve, an exhaust gas conduit in communication with said control valve, a catalyst chamber disposed within said gas supply conduit, a decomposable liquid supply stored within said casing and in communication with said supply conduit, means for displacing said liquid to move through said supply conduit and through said catalyst chamber whereby gas evolves for delivery to said control valve, motor means for alternatively setting said control valve at water inlet and gas inlet and gas exhaust positions whereby said cylinder is sequentially filled with ambient water and then with evolved gas displacing the water from said cylinder and thereby producing propulsion thrusts of water against the ambient water at said discharge opening, the gas within said cylinder being subsequently exhausted through said exhaust conduit to an oxygen-water reclaiming device operable to generate oxygen and potable water therefrom, and means separating said oxygen and water and delivering them separately for personnel breathing and drinking purposes.

No references cited.