

March 10, 1964

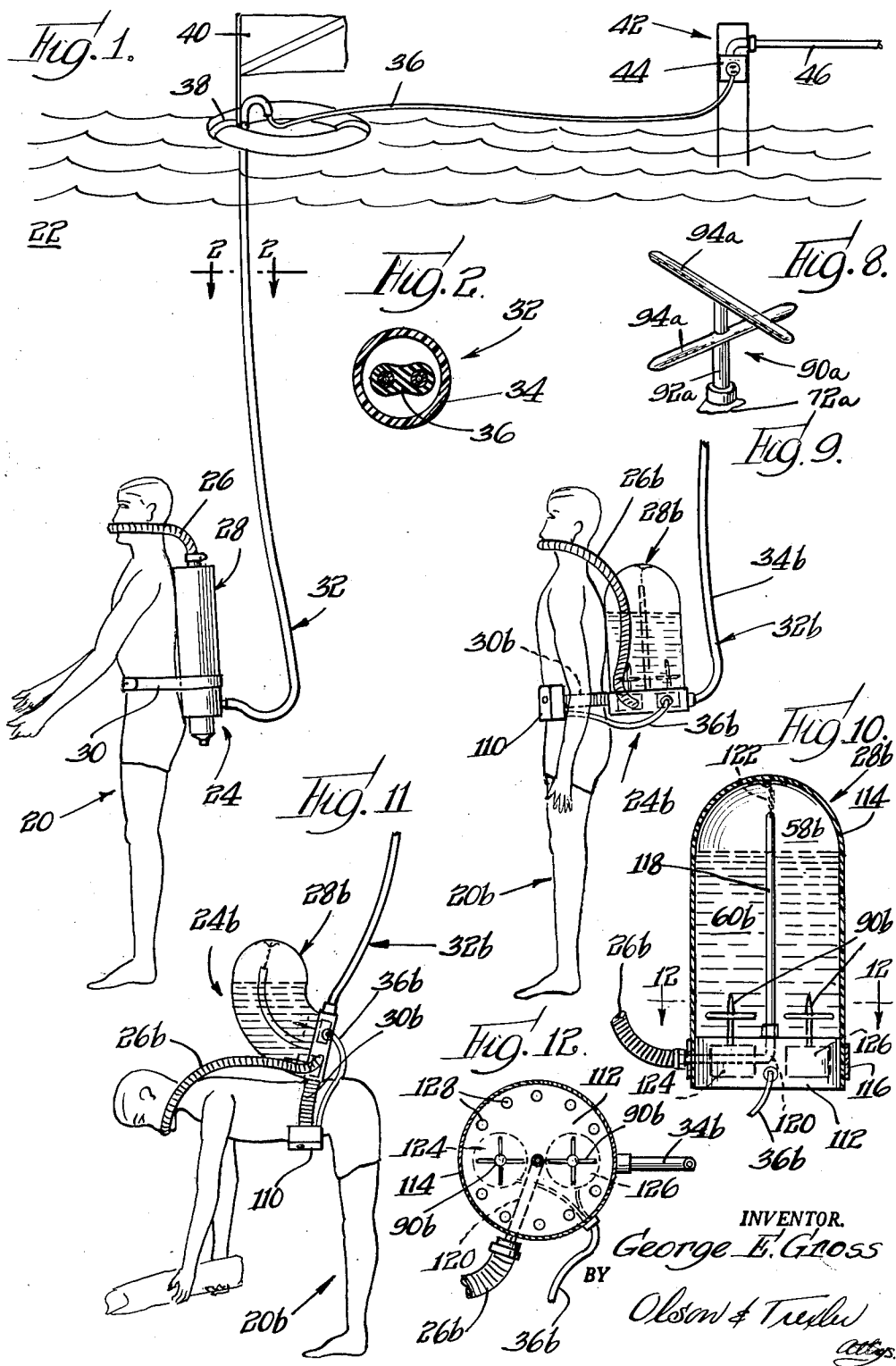
G. E. GROSS

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AIR SOURCE FOR A SKIN DIVER

Filed Sept. 29, 1960

3 Sheets-Sheet 1



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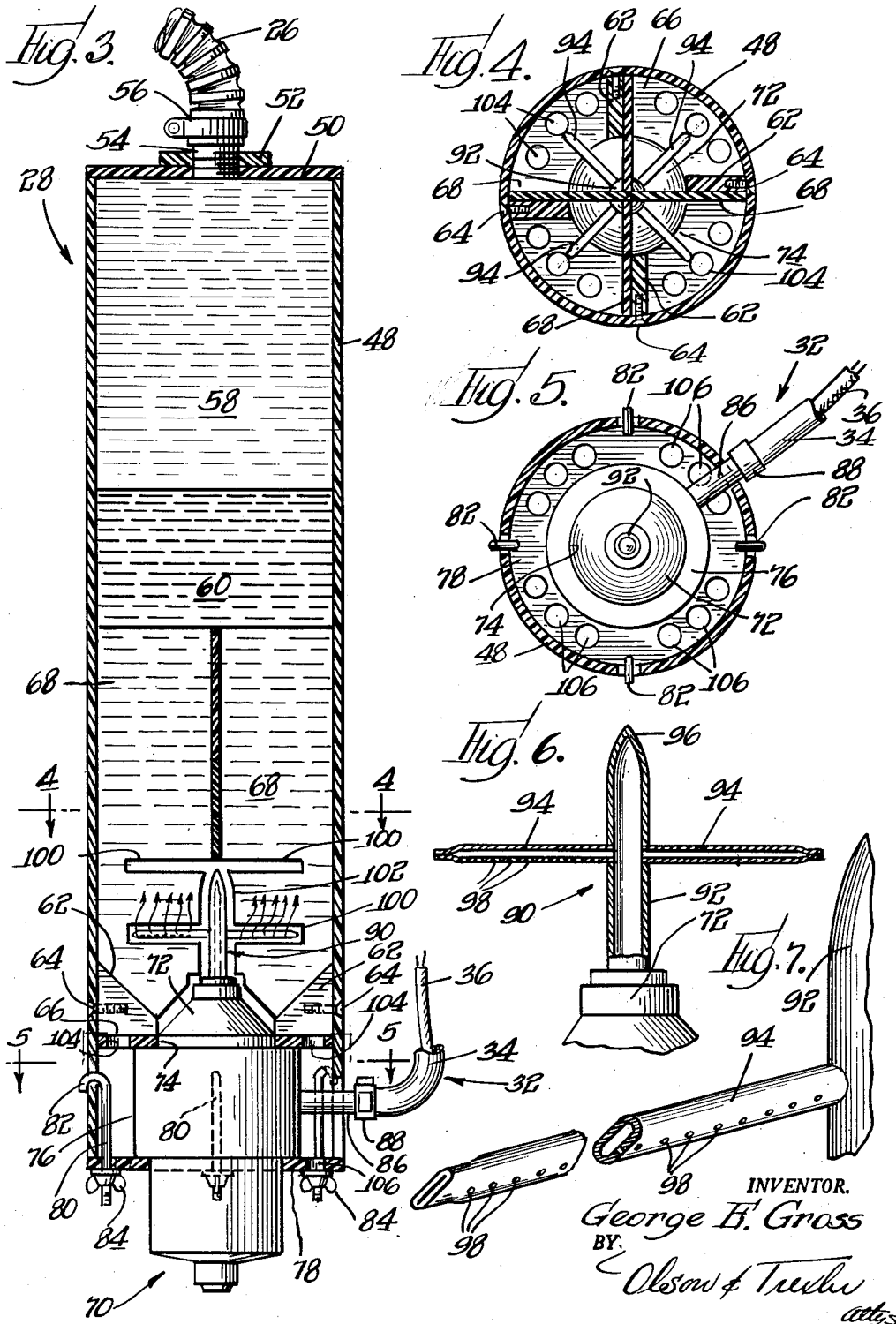
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AIR SOURCE FOR A SKIN DIVER

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3 Sheets-Sheet 2



March 10, 1964

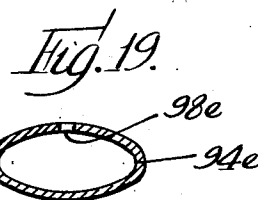
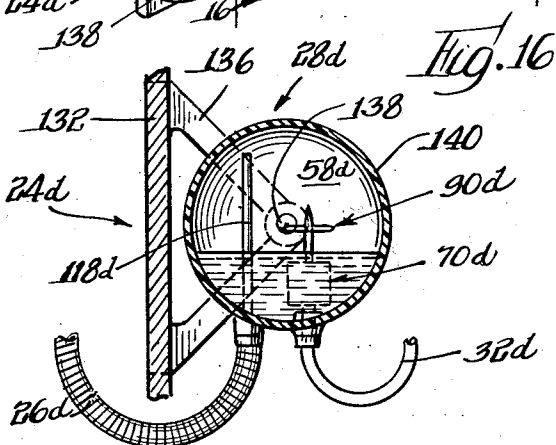
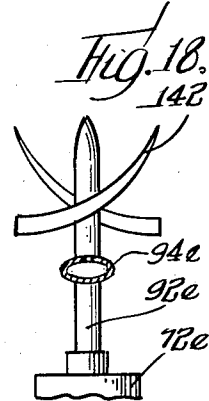
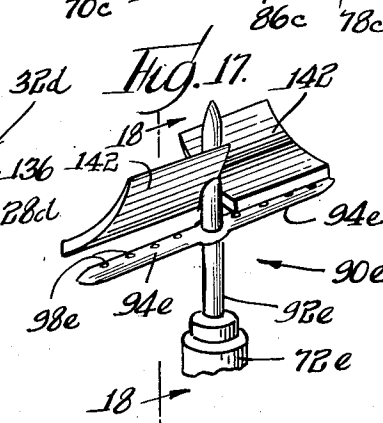
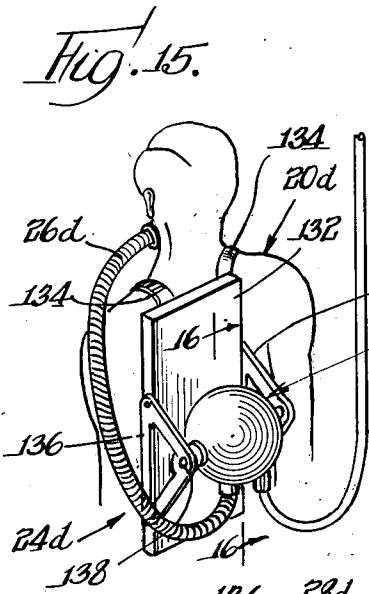
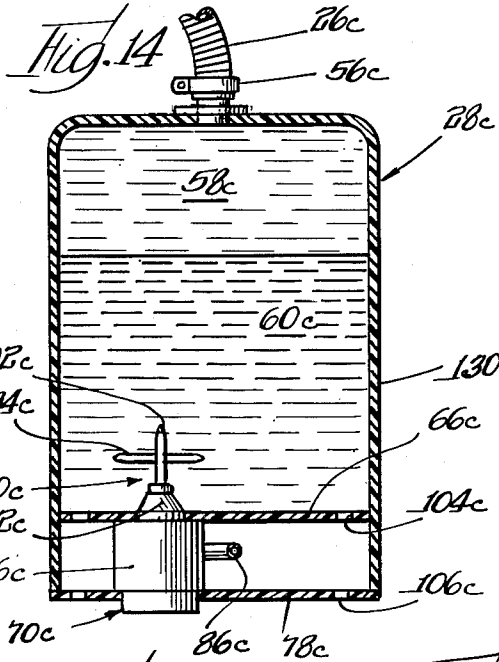
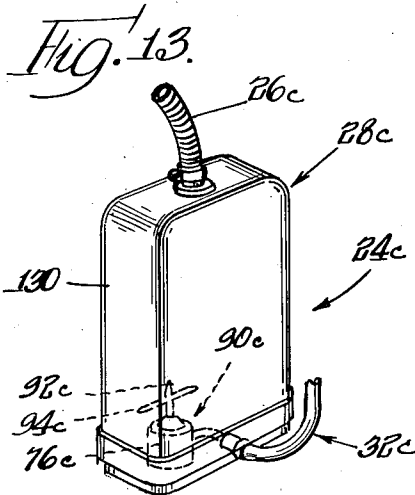
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AIR SOURCE FOR A SKIN DIVER

Filed Sept. 29, 1960

3 Sheets-Sheet 3



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3,124,131

AIR SOURCE FOR A SKIN DIVER

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Filed Sept. 29, 1960, Ser. No. 59,287
13 Claims. (Cl. 128—145)

This invention relates generally to diving apparatus and especially to a source of air for use by a skin diver.

In compliance with customary practice, skin divers intending to work beneath the surface for extended periods of time equip themselves with a source of air for breathing. This air source commonly comprises a thick-walled cylinder filled with highly compressed air and a regulating device for throttling the air from the cylinder pressure down to somewhat in excess of atmospheric pressure for breathing. Air sources so comprised are disadvantageous in a number of respects.

An air cylinder of convenient size for use by a skin diver does not contain sufficient air to enable the diver to remain submerged for periods much in excess of 3/4 of an hour without refilling or replacing the cylinder. Moreover, the highly compressed air in the cylinder poses a safety hazard. For example, accidental fracture of the shutoff valve can convert the cylinder to a jet-propelled missile capable of working substantial mischief. Furthermore, some operating air compressors are known to throw a certain amount of lubricating oil; and this oil frequently becomes entrained in the air being compressed. For breathing purposes, such contaminated air is undesirable. In addition, compressors are not ordinarily available at the diving site; and tanks of compressed air are therefore customarily transported from a remote location.

Therefore, a general object of the present invention is to provide a new and improved air source for a skin diver.

Another object of the invention is to provide a safe and convenient air source for a skin diver.

Yet another object of the invention is to provide an air source of the type described which affords an unlimited supply of air.

Still another object of the invention is to provide a source of filtered air for a skin diver.

A further object of the invention is to provide a continuing source of clean, fresh air for a skin diver.

A still further object of the invention is to provide breathing apparatus for a skin diver which automatically limits the depth to which the diver can go.

And a still further object of the invention is to provide an air source for a skin diver requiring no separate compressor and no handling of highly compressed gases.

A yet further object of the invention is to provide an air source for a skin diver which source is both easy and inexpensive to manufacture.

And a yet further object of the invention is to provide an air source for a skin diver which incorporates the feature of positional locatability as for safety purposes.

Additional objects and features of the invention pertain to the particular structure, materials and arrangements whereby the above objects are attained.

A structure in accord with the invention includes a chamber defining a water space and an air space over the water space; a conduit extending from the air space to the breathing organs of a diver; a rotor in the water space; drive means for the rotor; and a conduit from the earth's atmosphere to the rotor so constructed and arranged that air is pumped by the rotor from the atmosphere to the water in the water space whereupon the air rises to the air space for breathing by the diver.

The invention, both as to its structure and mode of operation, will be better understood by reference to the following disclosure and drawings forming a part thereof, wherein:

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FIG. 1 is a diagrammatic showing of a submerged skin diver employing an air source in accordance with the invention;

FIG. 2 is an enlarged view taken through the section 2—2 of FIG. 1;

FIG. 3 is an enlarged, central sectional view of the chamber portion of the air source illustrated in FIG. 1;

FIG. 4 is a view taken through the section 4—4 of FIG. 3;

FIG. 5 is a view taken through the section 5—5 of FIG. 3;

FIG. 6 is an enlarged view in cross-section of the rotatable element employed in the air source of FIGS. 1—5;

FIG. 7 is a fragmentary, further enlarged view in perspective of the rotatable element shown in FIG. 6;

FIG. 8 is a perspective view of a modified embodiment of the rotatable element;

FIG. 9 is a diagrammatic showing of a skin diver equipped with a modified embodiment of the invention incorporating a submersible power source and a flexible chamber-defining member;

FIG. 10 is an enlarged view of the chamber of the air source illustrated in FIG. 9;

FIG. 11 is a diagrammatic showing of the diver of FIG. 9, illustrating operation of the chamber-defining member when the diver is in a stooping position;

FIG. 12 is a view taken through the section 12—12 of FIG. 10;

FIG. 13 is a perspective view of another modified embodiment of the air source of the invention;

FIG. 14 is an enlarged, central cross-sectional view of the embodiment of FIG. 13;

FIG. 15 is a perspective view of a yet further modified embodiment of the invention wherein the chamber means takes generally spherical shape;

FIG. 16 is an enlarged view taken through the section 16—16 of FIG. 15;

FIG. 17 is a perspective view showing another modified embodiment of the rotatable element;

FIG. 18 is a view taken through the section 18—18 of FIG. 17; and

FIG. 19 is an enlarged, cross-sectional view of one of the hollow arms of the rotatable element of FIG. 17.

Referring now in detail to the drawings, specifically to FIG. 1, a skin diver shown at the numeral 20 will be seen submerged in a body of water 22 and equipped with an air source or breathing apparatus 24. The air source 24 includes a flexible tube or conduit 26, one end of the tube 26 being received in the diver's mouth by means of a conventional, valved mouthpiece, not shown. The other end of tube 26 is affixed to the upper end of a chamber-defining member 28, tube 26 advantageously comprising a corrugated rubber tube.

The chamber-defining member 28 is strapped to the diver's back by means of a belt 30; and adjacent the lower end of member 28 there is affixed a conduit means 32. As will be seen from an inspection of FIG. 2, conduit means 32 comprises a flexible, waterproof tube or hose 34 which freely surrounds a flexible, insulated, electrical cable 36, the spacing of cable 36 from the interior wall of hose 34 allowing free passage of air from the earth's atmosphere to the chamber-defining member 28.

Returning to FIG. 1, the end of conduit 32 which is not attached to chamber-defining member 28 will be seen extending above the surface of the body of water 22, a doughnut-shaped, buoyant element 38 being advantageously employed in this supporting of the surface end of conduit 32. A flag 40 or other marker can be secured to the element 38 for location purposes, if desired.

Continuing with reference to FIG. 1, the cable 36 will be seen extending through the surface end of hose 34 into the vicinity of a pier 42. There, cable 36 makes

electrical connection to an outlet box 44 that is supplied with current from a source, not shown, through the thin-wall conduit 46. This electrical connection enables cable 32 to provide motive power to the drive means contained in air source 24 as will be described hereinafter.

Turning now to FIG. 3, the chamber-defining member 28 will be seen comprised of a hollow cylindrical housing 48 which, in one specific embodiment of the invention, has been usefully fabricated from a transparent, resinous plastic material, such as for example a polymerized methyl methacrylate resin. Other shapes and materials have also been usefully employed. The top end of housing 48 is closed off by a plate 50 advantageously cemented in place. A mounting plate 52 is suitably secured on top of the plate 50 in order to cooperate with a fitting 54 and a hose clamp 56 in securing the flexible tube 26 to the housing 48, fitting 54 communicating with the interior of housing 48 through apertures appropriately provided in the plates 50 and 52.

The housing 48 is arranged to define an air space 58 and a water space 60 beneath the air space, and the tube 26 is arranged to communicate with the air space 58 to permit breathing of the air within space 58 by the diver. Within the water space 60 toward the bottom of chamber 48, a number of brackets 62 are affixed to the interior of the sidewall of housing 48 as by screws 64. The brackets 62 are disposed in a radial relationship and are adapted to mount a floor 66 in the housing 48, the floor 66 being cemented to brackets 62 or fastened thereto by screws or by other suitable means. The brackets 62 are also employed in mounting a number of fixed vanes or baffles 68 generally within the water space 60.

A drive means 70 is assembled to housing 48 beneath the floor 66 extending its output end 72 through a central aperture 74 formed in the floor 66. Advantageously, brackets 62 and baffles 68 are appropriately cutaway to provide clearance for the end 72 of drive means 70. The drive means 70 includes an enlarged mid-portion 76 which is trapped beneath the floor 66 and above a mounting plate 78 which is positioned over the lower end of housing 48 parallel with plate 66, as is shown in FIG. 3. Bolt fasteners 80 are employed in securing plate 78 in place; and the bolt fasteners 80 have hooked ends 82 which pass through appropriate apertures in the wall of housing 48, the opposite end of the bolt fasteners 80 being threaded to receive cooperatively threaded wing nuts 84.

A rigid, stub conduit 86 extends from the midportion 76 of drive means 70 to pass through the wall of housing 48 exposing its free end for attachment to the conduit means 32. The electric cable 36 of conduit means 32 passes through the stub conduit 86 to make electrical connection to the electric drive motor included within the means 70. In affixing the conduit means 32 to the stub conduit 86, the flexible hose 34 is slid over the stub conduit 86, being affixed in place by means of a hose clamp 88. Stub conduit 86 is arranged to be of sufficient internal diameter to afford continuation of the space established between cable 36 and the interior of the walls of hose 34, thus insuring ready passage of air to the rotatable element of the drive means 70.

From the output end 72 of drive means 70, there extends a rotatable element 90 comprising, as is well shown in FIG. 6, a hollow output shaft 92 and a number of hollow, radiating arms 94. Since the element 90 is employed in pumping air from the earth's surface to the space 58, the hollow portion of shaft 92 is arranged to communicate with the space defined between cable 36 and the interior of hose 34 as extended by conduit 86. Moreover, shaft 92 has its tip end 96 closed off. The hollow portions of the arms 94 open into the hollow portion of shaft 92; and it has proved desirable to arrange the cross-sectional area of the hollow portion of shaft 92 to equal the total cross-sectional area of the hollow

portions of the several arms 94. Thus, no constrictions in the air flowpath are incurred.

With particular reference to FIG. 7, the arms 94 will be seen provided with a number of apertures 98 spaced radially along the arms 94 and opening into the hollow portions thereof. The total cross-sectional area of the holes 98 is desirably arranged to equal the total cross-sectional area of the hollow portion of output shaft 92 in compliance with the arrangement for minimizing restriction of the air flowpath.

As will be seen from an inspection of FIG. 3, the rotatable element 90 extends above the output end 72 of drive means 70 into the region occupied by the baffles 68. Accordingly, the baffles 68 are appropriately provided with radial slots 100 and axial slots 102 in order to avoid interference with the rotation of element 90; and since element 90 is intended to be operated when intimately surrounded by water, the floor 66 and the plate 78 are apertured with holes 104 and 106 respectively thereby permitting ingress of water from the diver's surroundings into the water space 60. Other means may be provided for affording a liquid surrounding for the element 90.

The specific embodiment of element 90 illustrated in FIGS. 3-7 includes four arms 94 equally arcuated spaced coplanarly about the shaft 92. Moreover, as is particularly well shown in FIG. 7, the arms 94 are arranged to be of generally ovoid or elliptical cross-section, the major axis of the oval or ellipse being inclined with respect to the longitudinal axis of shaft 92 in order that the arms 94 may constitute impeller blades. In such arrangement, it is advantageous to position the holes 98 on the upstream side of the arms 94. When the arms 94 take the form of impeller blades, rotation of the element 90 tends to create a swirling action of the water within space 60. This action is undesirable for purposes which will be brought out hereinafter; and therefore, the baffles 68 are provided as has been described in order to reduce this swirling motion of the water.

It is to be understood that provision of the arms 94 as has been described immediately hereinabove is not the only suitable arrangement thereof. With reference for the moment to FIG. 8, a modified rotatable element 90a will be seen fashioned in the form of a spider and comprised of a hollow, coaxial shaft 92a from which two pairs of axially spaced-apart, counterrotatable arms 94a radiate. It will be observed that arms 94a are of generally circular cross-section, and it has been found that arms so provided do not tend to create any substantial swirling action of the water in space 60, hence permitting the elimination of baffles. Swirling action of the water in space 60 may also be minimized by providing housing 48 in generally rectangular shape rather than cylindrical as shown and by positioning the rotatable element 90 in off-centered relationship. Furthermore, a separately provided impeller blade may be combined with hollow arms as will be described hereinbelow.

In operation, the diver 20 equipped with air source 24 will submerge himself in the body of water 22, maintaining himself in an upright position. As the diver submerges, water enters the chamber defining element 28 through holes 104 and 106; and assuming that rotatable element 90 is being driven by means 70 when the water level reaches and covers the arms 94, air will begin being pumped from the earth's atmosphere through the conduit means 32 out through the apertures 98 and into the water within the water space 60 of housing 48. As the diver inhales, he will withdraw air from the space 58 through the tube 26. Upon his exhaling, a suitable valve provided in the mouthpiece will close off access to the tube 26; and the diver's exhaled breath will exit directly into the watery surroundings. The air withdrawn from space 58 by the diver inhaling, will be replenished by the element 90 at a rate of approximately 1134 cubic feet per minute.

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In replenishing the air in space 58, the rotatable element 90 utilizes a procedure similar to an aspirator effect. As the arms 94 are driven rapidly through the water within the space 60, movement of the arms relative to their watery environment will draw minute bubbles of air through the apertures 98, the baffles 68 resisting swirling of the water in space 60 in order to insure substantial relative movement between the arms 90 and their watery environment. When the bubbles of air are released from the holes 98, the rotation of the arms 94 will strip the bubbles from the apertures releasing them into the water within space 60. Thereupon, these bubbles will rise through the water in space 60 to replenish the air withdrawn from space 58 by the diver's inhaling.

As air is being withdrawn from the hollow interior of the arms 94 through the holes 98, a slight vacuum is created within the hollow portion of the arms 94 whereby to draw air from the earth's surface through the conduit means 32 into the hollow portion of shaft 92. It is recognized that the particular holes 98 relatively close to the shaft 92 do not move at the same linear speed that those holes 98 spaced further out on the arm 94 experience. Accordingly, it is possible to draw drops of water in through these more centrally disposed holes into the hollow portion of arm 94. However, centrifugal action will tend to drive such drops of water radially outwardly within the arm 94; and such drops of water will tend to act as pistons pumping air out of the holes ahead of them and drawing a vacuum behind.

It will be observed that the small bubbles of air stripped from the arms 94 will be scrubbed by the water in space 60 as they rise to become part of the air in space 58. Thus, a constant, clean source of air is available to the diver. In addition, it will be recognized that any water from the body of water 22 which is splashed into the surface opening in conduit means 32 will not interfere with the operation of the invention since water is necessarily contained in the space 60.

Ordinarily, the water in which the diver 20 submerges himself will be sufficiently clean and free of debris for the purposes of the invention. Nonetheless, under certain circumstances, it will be advisable to place a screen over the inlet holes 106 in plate 78 in order to filter out such things as particles of aquatic vegetation and small aquatic animals. Under certain circumstances, it may also be advantageous to provide a ball valve arrangement in conjunction with the fitting 54 whereby to prevent the diver from inadvertently inhaling water if he fails to maintain a substantially upright position.

In one specific construction of the embodiment illustrated in FIGS. 1-7, the electric motor incorporated in drive means 70 has taken the form of a one-twentieth horsepower motor driving its output shaft at approximately 2900 r.p.m. In the same embodiment, the arms 94 have been arranged to radiate from the shaft 92 approximately 2½ inches while the holes 98 have been provided with a ½ inch drill. This particular construction has also incorporated a conduit means 32 approximately 30 feet in length, this particular length being selected to deliberately limit the depth to which the diver can go. As is well known in the art of skin diving, a diver should not proceed beyond a 30 foot depth without special training.

While a specific embodiment of the invention has been shown and described with reference to FIGS. 1-7, it should be understood, of course, that the invention is not limited thereto since many modifications may be made. For example, turning to FIGS. 9-12 wherein like numerals have been used to designate like elements, the suffix letter "b" being applied to distinguish those elements associated with FIGS. 9-12, a skin diver 20b will be seen equipped with an air source 24b. In the air source 24b, a flexible tube 26b communicates the breathing organs of the diver with the air space in a chamber-defining element 28b, the element 28b being secured to

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the diver's body by means of a belt 30b. A conduit means 32b communicates the element 28b with the surface, the means 32b comprising only a hollow, flexible hose 34b. Motive power is supplied to the air source 24b by means of an insulated, flexible electrical cable 36b electrically connected to batteries 110 strapped to the belt 30b.

With particular reference to FIG. 10, the chamber-defining element 28b will be seen comprised of a base 112 to which a flexible housing 114 is affixed by a clamping element 116. The housing 114 defines an air space 58b and a water space 60b and is desirably fabricated from a rubber-coated fabric, such as canvas, or some other similar, flexible material. Within the housing 114, a flexible standpipe 118 is mounted with its open end extending into air space 58b, the other end of standpipe 118 communicating with the flexible tube 26b by passageway element 120. The open end of standpipe 118 is advantageously maintained within the confines of air space 58b as by means of a chain or stranded cable 122 affixed between the top of housing 114 and the free end of standpipe 118.

Mounted in the base 112 are a pair of electric motors 124 and 126 which are electrically connected to the cable 36b. The motors 124 and 126 are arranged to drive the rotatable elements 90b, the motors 124 and 126 being selected to drive their respective elements 90b in opposite rotational directions whereby to minimize swirling action of water within the space 60b. The elements 90b are otherwise similarly constructed in accordance with the description of element 90 in the embodiment of FIGS. 1-7. It is valuable to observe that a single motor could be employed in place of the motors 124 and 126, suitable gearing being provided therewith for appropriately driving the two elements 90b.

Advantageously, base 112 is perforated with a number of holes 128 which afford ingress of water to the housing 114.

As is illustrated in FIG. 11, the diver 20b is permitted substantial freedom of movement without disrupting the proper operation of air source 24b. The diver may stoop, bend and twist his body in a number of different manners and directions; and regardless of the diver's posture, the flexibility of housing 114 will allow the air space 58b to remain generally above the water space 60b. Moreover, the use of the cable 122 insures that the upper or free end of standpipe 118 is maintained within the air space 58b; and the diver is thus insured of inhaling air.

Turning now to FIGS. 13 and 14, an air source or breathing apparatus 24c will be seen to include a flexible tube or conduit 26c, a chamber-defining member 28c and a conduit means 32c much in the same manner as the apparatus 24 described with reference to FIGS. 1-7. Other similar elements in the embodiment of FIGS. 13 and 14 have been identified by like numerals to which the suffix letter "c" has been affixed. The embodiment of FIGS. 13 and 14 is particularly characterized by the inclusion of a housing 130 provided in the form of a hollow rectangular solid.

Within the housing 130, a drive means 70c is mounted between a floor 66c and a mounting plate 78c, the drive means 70c being situated in off-centered relationship. This off-centered relationship of the drive means 70c when combined with the generally rectangular cross-sectional shape of housing 130 substantially eliminates swirling of water in the water space 60c, thereby permitting elimination of baffles within the water space. In other respects, the arrangement of FIGS. 13 and 14 operates in a manner similar to the operation of the embodiment of FIGS. 1-7.

In order to alleviate the need for maintaining the chamber-defining element in a substantially upright position, the housing may be provided in spherical shape and the system mounted for free rotation on a yoke or in

gimbals. Such an arrangement is illustrated in FIGS. 15 and 16 wherein parts similar to the parts previously described are denoted by similar numerals to which the suffix letter "d" has been affixed. Specifically, a diver 20d will be seen carrying a pack board 132 employing shoulder straps 134. Brackets 136 extend outwardly from pack board 132 at opposite lateral edges thereof; and stub shafts 138 are secured adjacent the extreme ends of brackets 136 for rotatably mounting the chamber-defining member 28d. The member 28d will be seen to include a housing 140 fashioned in a generally spherical shape.

It will be observed that the flexible tube 26d and the conduit means 32d are affixed to the chamber-defining member adjacent the bottom thereof and that the drive means 70d is situated in the lower hemisphere of the housing 140. Accordingly, the weight of the drive means 70d tends to maintain the chamber-defining member in proper spatial relationship wherein the standpipe 118d communicates with the air space 58d. In other important respects, the arrangement of FIGS. 15 and 16 functions similarly to the embodiments previously described.

One modified arrangement of the rotatable element 90 has been hereinabove described with reference to FIG. 8, which arrangement was specifically provided for minimizing the swirling action of the water in the water space within the chamber-defining member. Referring now to FIGS. 17-19, a further modified rotatable element 90e will be seen to include a spider fashioned from radially extending arms 94e, the arms 94e being secured to a shaft 92e rendering the spider rotatable. The holes 98e formed in the arms 94e are arranged to open in a generally downstream direction, as shown; and a propeller element 142 is advantageously mounted to the shaft 92e downstreamwise from the arms 94e in generally axially aligned relationship therewith.

The propeller element 142 urges water in a generally downstream direction; and the space between the arms 94e and the propeller blades has been found to act as a venturi whereby to provide smooth flow of the bubbles emanating from the holes 98e away from the arms 94e. This venturi effect is particularly apparent when the arms 94e are fashioned in generally elliptical cross-section as shown; and while the propeller means 142 have been shown as a straight blade, it is to be recognized that blades have varying degrees of pitch may also be usefully employed.

From the descriptions given, it is apparent that the present invention provides an air source for a skin diver, which source is both safe and convenient to use, the source providing air which has been filtered through water and the source being unlimited as to the quantity or period over which air can be supplied. In addition, it will be recognized that the present invention requires neither the use of a compressor nor the handling of highly compressed gases. Accordingly, the specific examples herein shown and described should be considered as illustrative only. Various changes in structure, other than those set forth, will, no doubt, occur to those skilled in the art; and these changes are to be understood as forming a part of this invention insofar as they fall within the spirit and scope of the appended claims.

The invention is claimed as follows:

1. An air source for a skin diver comprising: chamber means defining a water space having water therein and an air space over said water space having air therein; means for securing said chamber means to the person of a skin diver; conduit means from said air space to the breathing organs of said diver; rotatable means in said water space; drive means for said rotatable means; and conduit means from the earth's atmosphere to said rotatable means, so constructed and arranged that air is aspirated by said rotatable means from said atmosphere to the water in said water space whereupon said air rises

through the water space in said chamber means to said air space for breathing by said diver.

2. An air source according to claim 1 wherein said rotatable means defines an impeller.

3. An air source according to claim 1 wherein said rotatable means is a spider.

4. An air source according to claim 1 wherein said rotatable means includes a spider and a separate impeller blade.

5. An air source for a skin diver as set forth in claim 1 wherein the rotatable means is provided with a pair of opposing surfaces forming a venturi, and wherein at least one of said surfaces is provided with a plurality of apertures communicating with the atmosphere.

6. An air source for a skin diver comprising: chamber means defining a water space having water therein and an air space over said water space having air therein; means for securing said chamber means to the person of a skin diver; conduit means from said air space to the breathing organs of said diver; rotatable means in said water space including a hollow, rotatable shaft and a plurality of hollow arms radiating from said shaft and provided with minute apertures, said apertures being spaced radially from said shaft and disposed on said arms in a direction axially of said shaft, said apertures communicating with the hollow interior of said shaft through the hollow interior of said arms; drive means for said rotatable means; conduit means from the earth's atmosphere to the hollow interior of the shaft of said rotatable means, so constructed and arranged that air is aspirated by said rotatable means from said atmosphere to the water in said water space whereupon said air rises through the water space in said chamber means to said air space for breathing by said diver.

7. An air source according to claim 6 wherein said arms are circular in cross-section.

8. An air source according to claim 6 wherein said arms are elliptical in cross-section and wherein the major axis of the ellipse is inclined with respect to the longitudinal axis of said shaft, said apertures being disposed on the upstream side of said arms.

9. An air source according to claim 6 wherein said rotatable means further includes an impeller blade aligned with said hollow radiating arms, wherein said arms are elliptical in cross-section and wherein said apertures are disposed on the downstream side of said arms.

10. An air source for a skin diver comprising: chamber means defining a water space having water therein and an air space over said water space having air therein; means for securing said chamber means to the person of a skin diver; conduit means from said air space to the breathing organs of said diver; rotatable means in said water space including a hollow, rotatable shaft and a plurality of hollow arms radiating from said shaft and provided with minute apertures spaced radially from said shaft, said apertures communicating with the hollow interior of said shaft through the hollow interior of said arms; drive means for said rotatable means; water in said water space enveloping said rotatable means; baffle means disposed in said water space; and conduit means from the earth's atmosphere to the hollow interior of the shaft of said rotatable means, so constructed and arranged that air is aspirated by said rotatable means from said atmosphere to the water in said water space whereupon said air rises through the water in said chamber to said air space for breathing by said diver.

11. An air source for a skin diver comprising: chamber means defining a water space having water therein and an air space over said water space having air therein; means for securing said chamber means to the person of a skin diver; conduit means from said air space to the breathing organs of said diver; rotatable means in said water space including a hollow, rotatable shaft and a plurality of hollow arms radiating from said shaft and provided with minute apertures spaced radially from said

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shaft, said apertures communicating with the hollow interior of said shaft through the hollow interior of said arms; drive means for said rotatable means; water in said water space enveloping said rotatable means; inlet means communicating the interior of said chamber means with the environmental surroundings thereof; and conduit means from the earth's atmosphere to the hollow interior of the shaft of said rotatable means, so constructed and arranged that air is aspirated by said rotatable means from said atmosphere to the water in said water space whereupon said air rises through the water in said chamber to said air space for breathing by said diver.

12. An air source according to claim 1 wherein said chamber means is defined at least partly by a flexible envelope.

13. An air source for a skin diver comprising: chamber means defining a water space having water therein and an air space over said water space having air therein; means for securing said chamber means to the person of a skin diver; conduit means from said air space to the breathing organs of said diver; rotatable means in said water space including a hollow, rotatable shaft and a plurality of hollow arms radiating from said shaft and provided with minute apertures spaced radially from said

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shaft, said apertures communicating with the hollow interior of said shaft through the hollow interior of said arms; drive means for said rotatable means; water in said water space enveloping said rotatable means; conduit means from the earth's atmosphere to the hollow interior of the shaft of said rotatable means; and a buoyant member at the surface end of said last mentioned conduit means for supporting said surface end in the earth's atmosphere, so constructed and arranged that air is pumped by said rotatable means from said atmosphere to the water in said water space whereupon said air rises to said air space and is filtered for breathing by said diver.

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