United States Patent

Peroni

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[54] PERSONAL UNDERWATER VEHICLE

[72] Inventor: **George J. Peroni,** Miami, Fla.

[73] Assignee: **Seatech Corporation,** Miami, Fla.

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[52] **U.S. Cl.** **115/6.1**

[51] **Int. Cl.** **A63c 11/10**

[58] **Field of Search** ..... 115/6.1, 70; 335/206; 114/16 R, 16 E

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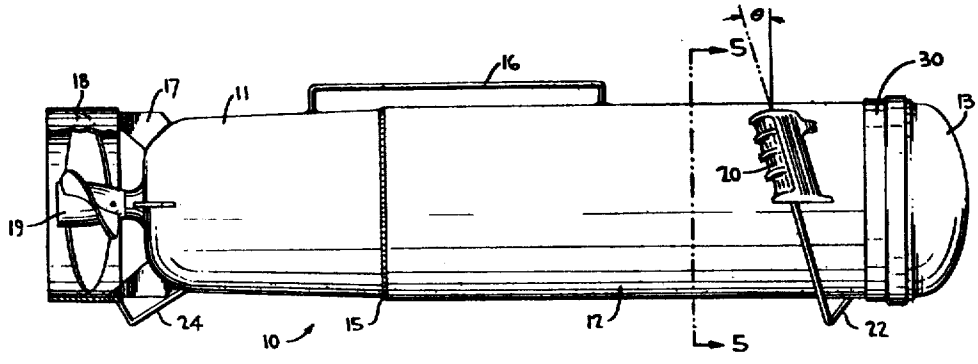
Primary Examiner—Trygve M. Blix

Attorney—Lowe and King

[57] **ABSTRACT**

Heat from the motor of a sealed underwater vehicle is transferred and dissipated through direct heat transfer paths having sufficient heat transfer capacity to permit the continuous operation of the motor at a safe temperature. The direct transfer path includes an annular disc that supports the rear of the motor and also reinforces the interior of the shell-like body of the vehicle; further reinforcement being provided by the fit of the battery in the vehicle. The nose cone is welded to a standard pipe and a rear dome is removably mounted and sealed to the other end of the pipe by a stretchable elastic band. A spring clip is utilized to retain the internal operating assembly together for ease of assembly and disassembly. Control grips for the vehicle provide an open grip by the diver and distribute the bulk of the pulling force across the length of the second and third sections of the diver's fingers and by friction to the full length and width of the palm.

21 Claims, 6 Drawing Figures



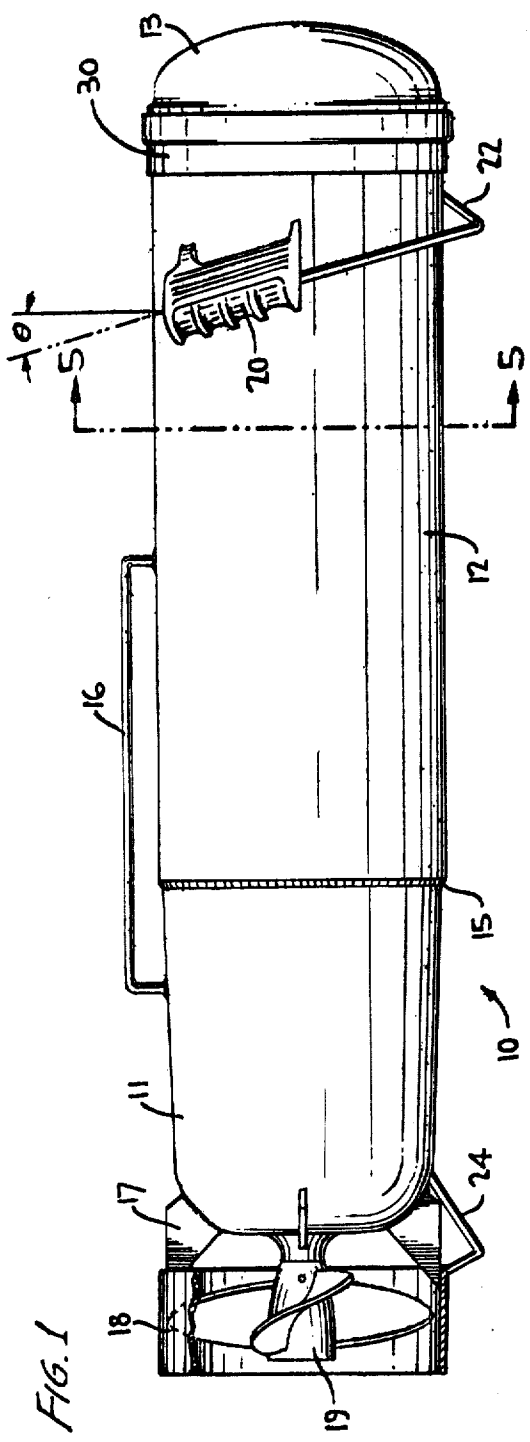

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22
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19

FIG. 1

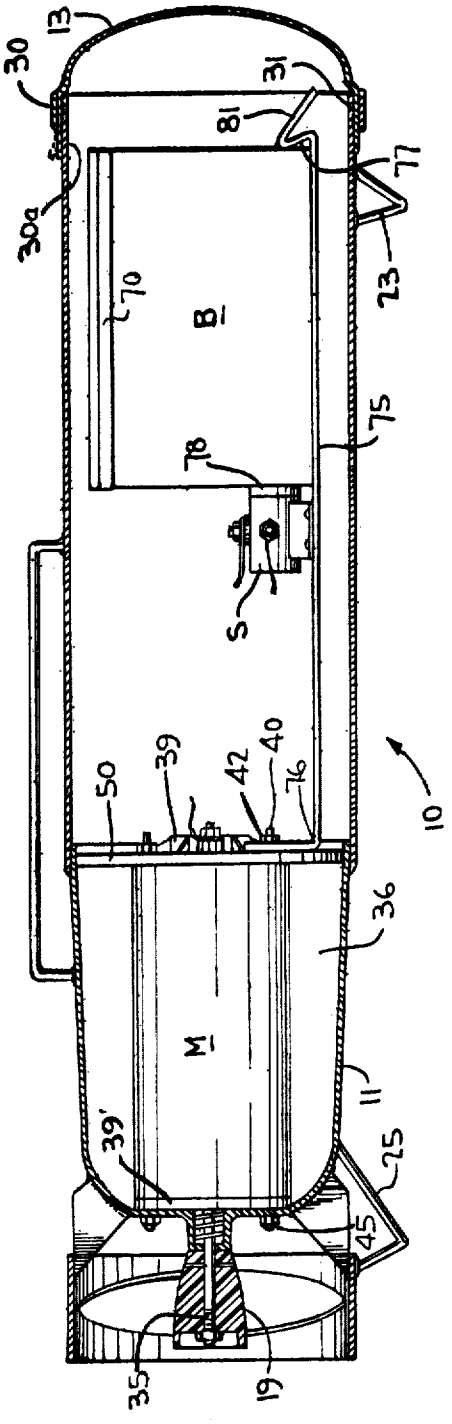

13
30
31
81
77
30a
70
B
23
75
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40
76
10
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M
11
39'
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45
35
19

FIG. 2

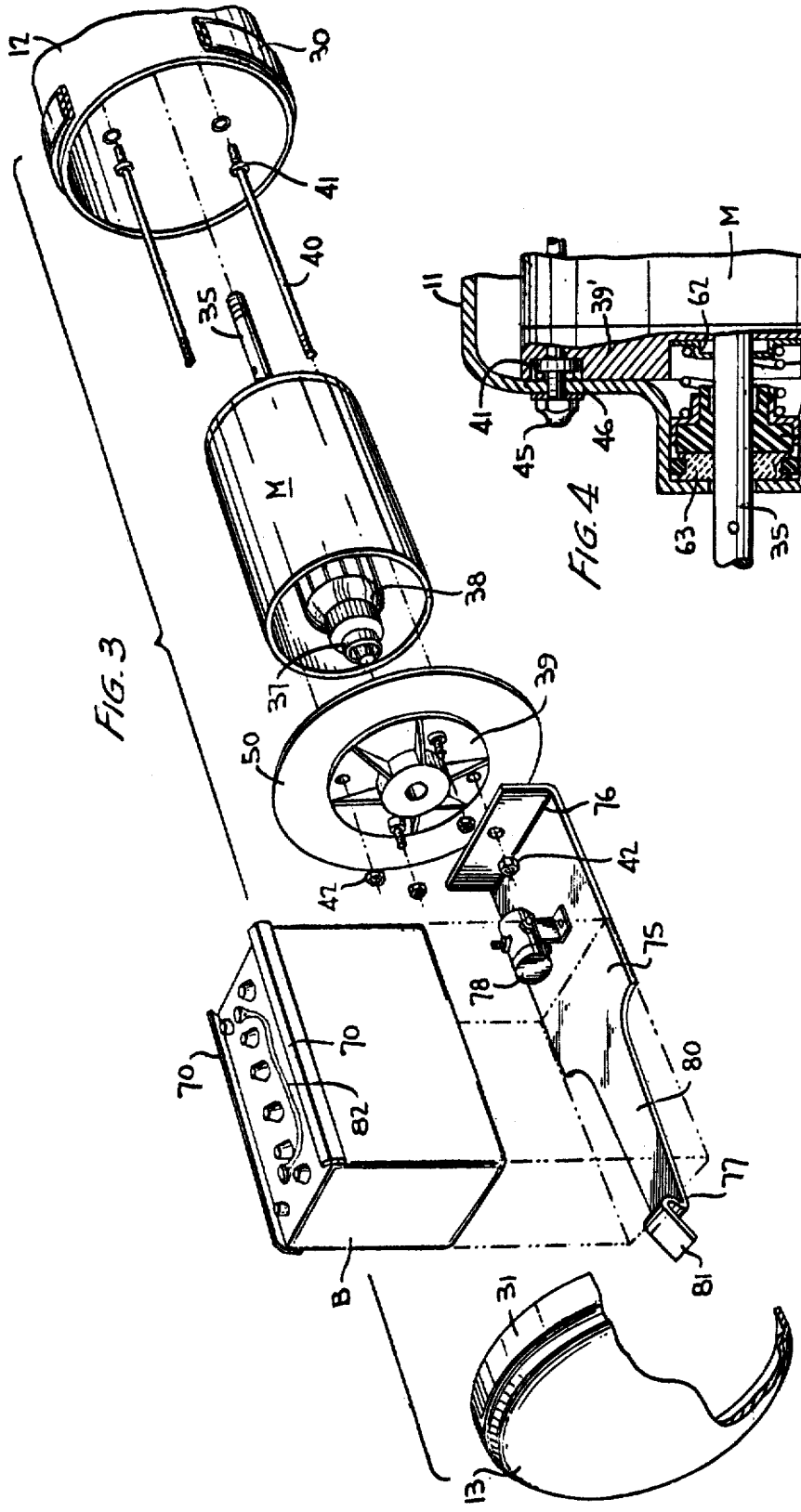

12
30
41
40
35
M
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50
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80
77
81
B
31
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FIG. 3

11
M
39'
62
61
41
45
46
60
44
64
63
35

FIG. 4

FIG. 5

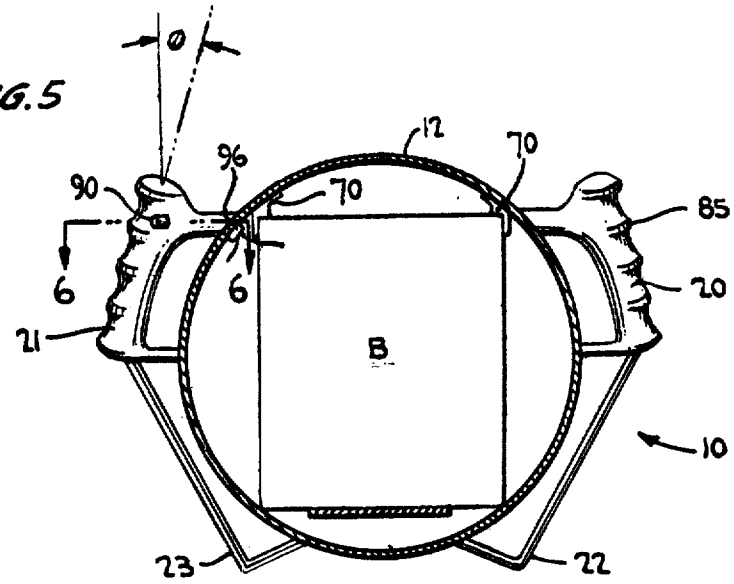
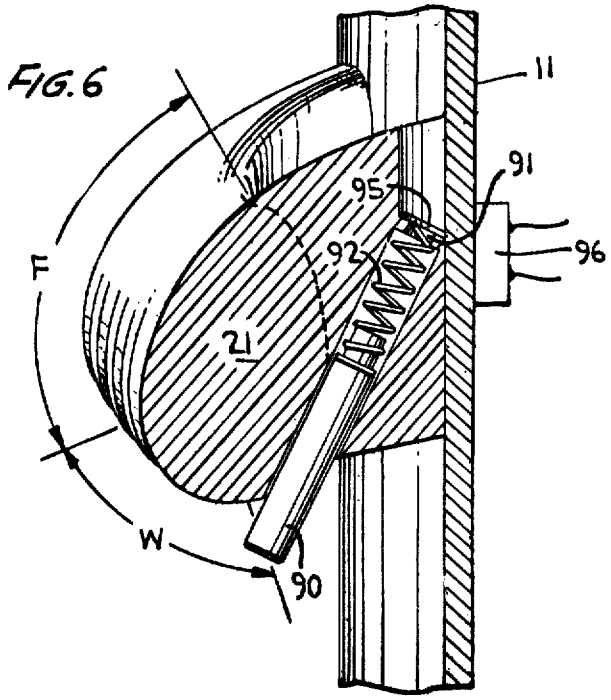


FIG. 6



PERSONAL UNDERWATER VEHICLE

The present invention relates to motorized devices for working submerged in a fluid environment, and more particularly, to an improved vehicle for operation under water to give a diver increased mobility.

BACKGROUND OF THE INVENTION

Exploration of the sea by sport enthusiasts, as well as scientists, is becoming more and more sophisticated. The diver is being provided with new equipment to permit longer, and thus more productive dives into the underwater world. The diver's breathing apparatus has been developed to the point where extended dives of at least a full hour of submerged time is commonplace. Underwater houses where the diver can retreat for obtaining a new air supply, resting and eating have been developed in recent years to further increase the efficiency of the diver. The final link in improving the diver's efficiency is to provide him with an improved vehicle to assist him in increasing his range of movement and to conserve his energy for useful work by removing the burden of having to propel himself through the water.

Such diver assisting vehicles have been proposed in the past; however, due to many limitations, these vehicles have left much to be desired in terms of allowing the diver to reach the full potential of his work efficiency. To explain, a vehicle for use in free diving and exploration must enclose and protect the motor and power source from the ambient water. The motor, which is most commonly an electric motor produces a substantial amount of power loss heat which must be dissipated during use. In the past, as one solution, many elaborate hydraulic and pneumatic cooling systems have been devised for underwater vehicles; however, each of these systems adds greatly to the cost and maintenance of a vehicle, shortens the range of the vehicle due to the power drain imposed by the associated pumps or fans, and increases the weight of the vehicle necessitating a corresponding increase in size to gain the necessary displacement volume to reach the desired neutral buoyancy. Thus, it has generally been agreed that it would be desirable to eliminate such cooling systems and rely on the ambient water to supply the necessary cooling through the heat transfer relationship between said water and the skin of the vehicle.

Thus, another solution that has been proposed is to totally or completely enclose the vehicle with no auxiliary cooling arrangement. However, prior to the present invention, the amount of heat generated in such a vehicle has far exceeded the amount of heat that can be transferred from the motor and dissipated through the skin when the motor is continuously driven. Because of this, divers have had to be content with a vehicle of the totally sealed type that allows only intermittent operation with periods in between to allow dissipation of the built up heat. For example, in order to keep the temperature of the motor and other operating components at a safe operating level, prior vehicles of which I am aware could operate substantially continuously for only a few minutes, at which time it would become necessary for the diver to delay his travelling or exploration to allow the vehicle to remain idle for several minutes and let the operating temperature fall back within the allowable range. If a diver should happen to disregard this pre-set time operating limitation, the temperature of the motor would continue to climb during continuous operation and after reaching a threshold temperature of approximately 125° C, permanent damage to the motor would result and eventually the motor would burn out.

OBJECTIVES OF THE INVENTION

Accordingly, it is one object of the present invention to provide a device, and more particularly a personal underwater vehicle, for use in a fluid environment, specifically under water, that is capable of dissipation of sufficient power loss heat without auxiliary cooling means to permit continuous operation.

It is another object of the present invention to provide an underwater vehicle having novel means for dissipation of the power loss heat, both I^2R and friction heat, so that the maximum temperature during continuous operation is maintained well within the safe range.

It is another object of the present invention to provide an underwater vehicle that is simple in construction for low cost manufacture and easy maintenance while still attaining the above objectives.

BRIEF SUMMARY OF THE INVENTION

To attain these and other objectives of the invention, the present invention makes use of direct heat transfer paths from the motor to the outer shell-like body or skin of the vehicle. These heat transfer paths are effectively gained through direct interconnection between the motor and the body with the heat transfer capacity of the transfer means and said body being sufficient to dissipate the power loss heat generated by said motor and thereby allow continuous operation. Preferably, the structure forming the heat transfer paths is also utilized to support the motor within the body or skin and to reinforce said body against collapse due to the external static pressure of the water. According to the present invention, the main heat transfer path of the vehicle is provided at the rear or interior end of the motor and includes an annular disc having its inner periphery in heat transfer engagement with the motor and its outer periphery in heat transfer engagement with the interior of the body. Heat is transferred radially outwardly and then both forward and rearward in a circumferential path along said body to be quickly cooled by the surrounding water.

Also, in the preferred embodiment, the heat transfer path is augmented by essentially the same type of direct heat transfer engagement of the opposite end of the motor with the forward face or nose of the body. As thus mounted, the motor has two efficient heat transfer paths without any interior hydraulic or pneumatic cooling system, as heretofore has been necessary for continuous operation. The heat transfer paths are preferably located at the end bells of the motor so that the friction heat from the bearings is transferred immediately radially outward to the shell-like body for rapid dissipation.

Other features of the invention include making of the shell-like body in three sections—namely, a nose cone, a standard size pipe for the middle and rear sections and a removable rear dome for covering the end of said pipe for access to the interior. The removable rear

dome is held in position by an elastic band which extends around the girth of the body and covers the exterior side of the interconnection between the dome and the pipe. At least one portion of the longitudinal extent of the band is not permanently attached to the corresponding part so that the same may be rolled back on the other portion to release the rear dome. The band is under sufficient tension to cause a watertight seal at sea level with the seal becoming more efficient as the depth increases.

The battery or power source is positioned within the body so as to engage the interior surface to strengthen the body. A spring clip is provided to releasably hold the battery in position along the longitudinal axis of the vehicle while being capable of release or removal of the battery for recharging and servicing. The spring clip also serves as a convenient arm for withdrawing the motor from its mounted position within the confines of the nose cone through the rear opening.

Further, the control grips or handles for the personal underwater vehicle of the present invention are specially designed to give improved distribution of the pulling force on the driver's hands. According to this aspect of the invention, the grips are sufficiently wide to engage across the length of the second and third sections of the fingers and length and width of the palm of the diver and to limit the hand of the diver to a generally open grip. This configuration, along with a preferred (but not essential) inward and forward tilt of approximately 15° of the handles, has been found to give the diver maximum control with minimum fatigue to the hands and also to the forearms. A plunger having a magnetic element is positioned within one of the handles for operation by the index finger of the diver. This activates the motor or drive means of the vehicle when depressed by bringing the magnetic element into the operating range of a magnetic-proximity switch mounted within the shell-like body.

Still other objects and advantages of the present invention will become readily apparent to those skilled in this art from the following detailed description, wherein I have shown and described only the preferred embodiment of the invention, simply by way of illustration of the best mode contemplated by me of carrying out my invention. As will be realized, the invention is capable of other and different embodiments, and its several details are capable of modification in various obvious respects, all without departing from the invention.

Accordingly, the drawings and description are to be regarded as illustrative in nature, and not as restrictive.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates a side view of a personal underwater vehicle constructed in accordance with the principles of the present invention;

FIG. **2** is a cross-sectional view taken along the longitudinal axis of the vehicle of the invention;

FIG. **3** is an exploded view showing the internal working parts as removed through the rear of the vehicle;

FIG. **4** is a detailed cross-sectional view of the forward most portion of the vehicle;

FIG. **5** is a cross-sectional view taken along line **5**—**5** of FIG. **1**; and

FIG. **6** is a detailed cross-sectional view of the control handle of the vehicle.

DETAILED DESCRIPTION OF THE INVENTION

With reference now to FIG. **1**, the preferred embodiment of the invention may be described with more detail in order to permit one skilled in the art to understand and practice said invention. There is illustrated a personal underwater vehicle having an outer shell-like body or skin, generally designated by the reference numeral **10**, and forming a watertight enclosure. The body **10** is divided into three sections; namely a nose cone **11** forming the forward section, a standard size pipe or tube **12** forming the middle and rear sections and a rear dome **13** covering the rear end of the pipe **12** and completing the enclosure. The body **10** may be fabricated of any suitable material that is lightweight and resistive to corrosion; the most obvious selections in this case being metal, such as aluminum, or thermal conductive plastic. The nose cone **11** and the rear dome **13** are fabricated, such as by casting and a subsequent turning operation so as to mate with the standard size pipe **12** in the manner shown, which greatly contributes to the economy of manufacture of the vehicle.

The nose cone **11** is attached to the pipe **12** by an overlaping joint sealed by a circumferential weld bead **15**. An inverted U-shaped bar **16** is welded to the top of the body **10** to form a convenient means for handling the vehicle out of the water. A plurality of fins **17** are positioned at the forward end of the nose cone **11** to support a nozzle **18** around propeller **19**. The nozzle **18** limits the flow of water radially outward from the tips of the propeller **19** thereby forcing the stream rearwardly and producing maximum reaction force to move the vehicle forward.

Also, the nozzle **18** serves to protect the propeller against hitting foreign objects, such as on the sea floor. As will be described more in detail later, a pair of operating handles or grips **20**, **21** (see FIGS. **1** and **5**) are mounted at the rear of the vehicle. Bent bar elements extend downwardly from the handles to form a pair of rear support feet **22**, **23** (see FIGS. **1** and **2**). Similar forward support feet **24**, **25** are provided at the front of the vehicle, thereby completing a stable four-point support when the vehicle is not in use.

In accordance with one feature of the present invention, the rear dome **13** is held in position and sealed with respect to the pipe **12** by an annular elastic band extending around the girth of the body **10** and spanning the interconnection at this point. The band, which may be of rubber, is positioned in place in a sufficiently stretched condition so as to frictionally hold the dome in place and to self seal the joint.

The forward portion of the width of the band **30** is preferably cemented in position on the pipe **12**. The dome **13** includes a peripherical flange **31** that overlays the end of the pipe **12** and extends up to the point of attachment. In this manner, the band **30** when in sealing position has sufficient engagement with the flange **31** to hold the dome **13** in position (see FIG. **2**). In use, when the vehicle is submerged in water, the static pressure acting on the exterior of the band **30** and on the dome **13** inherently increases the holding force of this novel seal and attaching means to thereby make it even more

effective. Also, when the vehicle is moving through the water, the band **30** presents a joint that is resistive to disturbance by the slip stream since the forward portion of the width of said band **30** is permanently attached. However for a very important reason, a small section of this forward portion is not cemented and overlies a breathing aperture **30***a* in the pipe **12**. Thus, as the vehicle operates, pressurized gas generated by battery B is harmlessly released by intermittent raising of the band **30**, as shown by the dotted line outline in FIG. **2**. The effective differential or gauge pressure in the vehicle **10** may be selectively varied by changing the size of the hole **30***a*, the tension of the band **30** and the positioning of the hole **30***a* back from the edge of said band **30**, as desired. A cooperative selection of these parameters to give a 5 p.s.i. level has been found to be desirable. This pressure allows release of gas bubbles without significant retrograde movement of the water back into the interior of the vehicle **10**; the band **30** being effective to immediately return to the full line, sealed position of FIG. **2**.

When it is desired to remove the rear dome **13** for access to the interior of the body **10**, the rear edge of the band is grasped; pulled forwardly until the rear portion of the width of the band overlays the forward portion, as is illustrated in FIG. **3**. To reapply the dome **13**, and at the same time to effect a self resealing of the body **10**, the dome **13** is merely reapplied and the free edge of the band **30** grasped and pulled back into position overlying the flange **31** of said dome **13**, as in FIGS. **1** and **2**.

Positioned on the interior of the body **10** substantially within the confines of the nose cone **11** is an electric motor M which supplies the driving force to the propeller **19** through a suitable drive shaft **35**. In accordance with the preferred embodiment of the invention illustrated, this motor M is electric and operable on d.c. current obtained from a conventional power source, such as wet cell battery B. Because of their ready availability, the motor M is or may be of the type conventionally utilized for starter motors of internal combustion engines and the battery B is or may be a twelve volt lead-acid battery, also conventional.

As in all types of motors, the electric motor M sustains a power loss of two types during operation that is given off in the form of heat. The first type is determined by the formula I^2R, wherein I is the current flow through the system and R is the resistance of the windings in the motor M. The second type of loss is from friction in the end bearings that support the shaft **35** and rotor **38** of the motor M (only one bearing **37** being shown in FIG. **3**). Since the body **10** is completely sealed to protect the working parts from the water, the annular space **36** is dead air space which is, in effect, an insulator that prevents the effective dissipation of this heat. The ends of the motor M are formed by end bells **39**, **39'** within which the bearings **37** fit. Elongated bolts **40** extend through the housing of the motor M and are effective to hold the end bells **39** into position by collars **41** at the forward end (see FIGS. **3** and **4**) and suitable nuts **42** at the rear end.

In accordance with one important feature of the present invention, an annular disc **50** is fixed to the rear bell **39** in a suitable manner, such as by a force fit around the perimeter thereof. The disc **50** is made of heat transfer material, capable of transferring heat from the motor M radially outward to its outer perimeter. A suitable material having high heat conductivity is aluminum, although other metals such as steel or the like could be used. The outer periphery of the disc **50**, in turn, engages the interior of the body **10** just inside the rear lip of the nose cone **11**. The fit of these two parts is snug so as to provide an efficient transfer path to the outer shell-like body **10**. If desired for maximum heat transfer efficiency, a thermal conductive compound, such as a silicone grease sold under the trade name INSULGREASE, can be used between these mating parts and others at heat transfer points. After the heat is transferred to the body **10** it travels forward and rearward along the nose cone **11** and the pipe **12**, respectively, around the full perimeter thereof to dissipate quickly to the surrounding water.

The thickness of the disc **50** is important in order to provide a path that has a capacity of heat transfer equal to the heat generated by the motor during continuous operation. As an example, if the motor M is a d.c. current motor having a ½ horsepower rating, and a path is to be provided at each end of said motor, then the disc **50** is made, in accordance with the invention, approximately one-fourth inch thick and positioned at the end bell **39** whereupon efficient cooling of the motor to prevent overheating will occur. On the upper end of the scale where the underwater vehicle might include an enclosed compartment for two or more divers, a 20 horsepower motor would require discs of approximately 1 inch thickness to dissipate the heat.

Approximately 80 percent of the heat generated in a d.c. current motor results from the friction loss in the bearings, the second type of heat loss mentioned above, so that the heat transfer by the disc **50** contacting this area is the most efficient. Related to efficiency, there is a way to determine the required or most effective size of the disc **50** in the practice of the invention. First, the motor M is assumed to have bearings **37** sized to accommodate the design load of said motor M. Then the area of the outer periphery of the bearing **37**, as thus determined by the load capacity rating, is checked and must be found to be sufficient to accommodate the friction heat loss plus the part of the I^2R loss for the rotor **38** of the motor M. Finally, I have discovered that to dissipate the necessary heat under normal conditions of the underwater applications of the device of the present invention, the area of the outer periphery of the disc **50** should be at least **2** times the corresponding peripheral area of the bearing **37** and the cross section of the disc **50** is thereby determined. Of course, if desired or found to be necessary, greater heat transfer capability may be attained by utilizing a higher ratio, such as about 3 to 1, which is in fact the case involving the design for the one-half horsepower motor example cited above. With this arrangement, the motor can be maintained within the range of allowable temperatures during continuous operation; i.e., operation wherein the diver is continually on the move in search type operations and disregarding irregular, short interruptions to control the speed of the vehicle **10** or to allow brief inspection of the surroundings. This improvement thus, in short, enables a diver to work substantially continuously for one hour or more without the need to periodically stop to allow dissipation of excess heat, as

has heretofore been necessary. With the positive and direct heat transfer radially outward through the disc **50**, the motor M remains at a substantially constant temperature which is approximately 10°–20°F above the ambient water temperature.

Advantageously, the disc **50** being mounted on the end bell **39** directs the friction loss heat along the shortest possible path to the body **10** for dissipation. The I^1R loss that occurs in the stator windings of the motor M is transferred mainly along the cylindrical housing of said motor M also to the end bell and then along the same path radially outward.

The heat transfer for the front of the motor M can be effected through the end bell **39'** by positioning the same in snug or heat transfer engagement with the forwardmost interior surface of the nose cone **11**, as best shown in FIGS. **2** and **4**. The surface area contact between the nose cone **11** and the end bell **39'** is annular and in accordance with the prescribed ratio for efficient transfer of I^2R and friction heat from the motor M with only nose portion **44** not being in direct contact with the forward face of the motor M. Suitable cap nuts **45** are fastened to the forward end of the bolts **40** to gain this face to face heat transfer engagement; suitable O-rings **46** being provided for sealing around the opening to prevent the entry of water (see FIG. **4**).

The disc **50** and the bolts **40**, in addition to holding the motor M in relation to the body **10** for the heat transfer, obviously also serve the necessary function of holding or supporting said motor M in place. In addition, these parts serve to reinforce the nose cone **11** against collapse due to the static pressure of the water.

To seal the interior of the body **10** from entry of water around the drive shaft **35**, there is provided a rotating shaft seal **60** that is urged forwardly by a spring **61** seated in a washer **62**. The seal **60** prevents the entry of water around the shaft **35** due to the engagement of the conventional lip. A ceramic member **63** is positioned just in front of the seal **60** to cooperate with the front face of the seal **60**; an annular rubber shoe **64** serving to give the member **63** a resilient characteristic. The shoe **64** also provides for a seal against entry of water between the outer perimeter of these members and the nose portion **44**.

As viewed in FIG. **5**, the battery B is preferably and in accordance with one feature of the present invention selected to have an exterior size that approximates the interior of the pipe **12**. That is, the lower corners (taken along a transverse or end view) are adapted to engage the bottom of interior of the pipe **12**. Positioned at the upper corners are a pair of sizing runners **70** that fit along the upper longitudinal edges with a snug fit against the upper portion of the interior of pipe **12**. These runners **70** serve the purpose of holding the battery B in position against movement in the sidewise direction, but most importantly, serve to allow reinforcement of the pipe **12** by the structure of battery B itself. With the battery B being of a conventional molded hard rubber or plastic construction, a substantial amount of reinforcement and rigidity is added to the pipe **12** due to this arrangement. This reinforcement coupled with the reinforcement by the annular disc **50** and the bolts **40** allows the body **10** to be constructed of material substantially thinner than would otherwise be required, and advantageously eliminates any need for internal reinforcing beams or columns.

To properly position the battery B within the body **10** and to prevent any lengthwise movement of the same, a spring clip **75** is positioned underneath, as best shown in FIGS. **2** and **3**. The clip **75** is L-shaped and supported in the front by the lower motor bolt **40** attached by the corresponding nut **42**. The clip **75** is fabricated from metal which is resilient along its length and at forward angle **76** so that said clip **75** is biased upwardly into snug engagement against the bottom of the battery B, as shown in FIG. **2**.

The rear stop for the battery B on the clip **75** is formed by an upward and rearwardly directed stop **77**. The forward stop is conveniently formed by positioning of solenoid S in front of the stop **77** spaced a distance substantially equal to the length of said battery B. To assure a tight fit of the battery B between the stops, a resilient pad **78** is placed on the rearward face of the solenoid S. Since the front of the motor M is attached to the nose cone **11** by nuts **45**, the entire internal operating assembly is thereby interconnected in a secure manner. Also, this arrangement lends itself for the ease of servicing, as will now be described.

First, to merely remove the battery B for checking of the fluid level and for recharging, the rear portion **80** of the clip **75** may be pushed downwardly to free the bottom of battery B. A rearwardly directed tab **81** is provided for engagement by one hand to facilitate this action. Because the portion **80** is reduced in cross section (see FIG. **3**), it is more easily bent to the release position with the one hand engagement. When the stop **77** is depressed sufficiently to allow the bottom of the battery B to slip over it, said battery B can be easily removed through the rear opening by merely engaging the sides and pulling the same rearwardly.

When it is desired to remove the entire internal operating assembly, the spring clip **75** again plays a unique role. The nuts **45** are first removed from the front of the nose cone **11** releasing the assembly. By engaging underneath the tab **81**, the assembly, including the motor M and the spring clip **75** may be simply withdrawn through the rear opening of the pipe **12**. When reassembly is desire, the clip **75** again serves as an arm so that the motor M can be replaced in position within the nose cone **11** by sliding the disc **50** along the interior of the body **10**. After the shaft **35** of the motor M passes through the opening in the nose portion **44**, it can be used to assist in bringing the disc **50** into snug engagement with the rear lip of the nose cone **11**, as shown in FIG. **2**. This arrangement completely eliminates the need for a separable joint in the center of the body **10** where the stress is the greatest during running and maneuvering of the vehicle. Adjacent the rear dome **13**, there is virtually no operating stresses thus permitting the use of the self-sealing elastic band **30** in accordance with the invention.

As previously mentioned, the grips **20**, **21** have been designed with an increased size girth to limit the hand of the diver to a generally open grip to allow maximum control of the vehicle **10** and to reduce the fatigue in the hands and forearm of the diver. Furthermore, by providing said handles **20**, **21** with an average leading face width W (FIG. **5**) of substantially the same as the length as the second and third sections of the fingers of the hand, as the vehicle **10** pulls the diver forward through the water, the maximum area of this strongest portion of the fingers is utilized to transmit the bulk of

the pulling force. However, the palm of the hand assists in transmission of the pulling force by frictional engagement along substantially the full length and width thereof with the outwardly curved face F of the handles **20, 21**. The diver insures this frictional engagement by exerting an inward pressure on the handles, which is a natural reaction in grasping. Furthermore, since the shoulders of the diver are wider than the distance between the handles, the dynamic pressure of the slipstream acting against the leading face of the arms assists in maintaining the palms of the hand in the proper contact with the handles **20, 21**.

These features insure against fatigue since the force is not concentrated in a small area of the hand as with previously designed handles. Furthermore, maximum control is gained since the turning and shifting up and down of the rear of the vehicle **10** to steer the same is now controlled with the open grip permitting freer wrist action. The grips **20, 21** are welded to the pipe **12** at spaced supports defining an opening therebetween to allow the free passage of the water slipstream and thereby negating any tendency for the hand to be lifted up by water pressure from the grip.

A plurality of finger dividing ridges **85** are provided on the handles **20** around the outside facing, substantially 90° of the girth. This facilitates the placement of the fingers and prevents slipping as the rear of the vehicle **10** is positioned during maneuvers. Angles of forward and inward inclination of the grips **20, 21** (see angle θ in FIG. **1** and angle ϕ in FIG. **5**, respectively) are approximately 15° and can be incorporated to give improved control capability. The forward angle allows the diver to follow slightly above the vehicle in which position maximum forward visibility is to be gained. The inward angle best approximates the natural holding on position of the hands. The grips **20, 21** are preferably cast of aluminum and may be made for convenience in one piece and welded into place along with the rear feet **22, 23** as shown; this construction further also adding to the reinforcement of the body **10**.

With the open grip design of the handles **20, 21**, the index finger is free to operate a control magnet plunger **90** in the handle **21** to turn the motor M on and off as desired. As shown in FIG. **6**, the plunger **90** is positioned in a mounting chamber having a bottom **91** to confine a return spring **92**. The lower end of the plunger **90** is securely held by the upper turns of the spring **92**. Drain hole **95** is provided to prevent dashpot effect when the plunger **90** is operated. The terminal end of the spring **92** extends through the hole **95** so that the final turn forms a hook to hold the magnet and spring assembly in position. When the plunger **90** is depressed it is brought into proximity with a magnetically responsive switch **96** effective through conventional wiring connections and the solenoid S to start the motor M. The switch **95** is effective to turn off the motor M anytime the plunger **90** is released since the spring **92** immediately moves the magnet out of the critical operating range.

In view of the foregoing description and explanation of the details of the vehicle of the present invention, the advance over the prior art of the several features can readily be seen. First, due to the provision for direct transfer of heat from the motor M, continuous operation of said motor M at a maximum temperature well within the allowable temperature range is now permitted. The provision of the annular disc **50** to perform this essential function while at the same time serving to (1) support said motor M and (2) reinforce the body **10**, is of particular interest. The battery B with runners **70** and the handles **20, 21** serve further to strengthen and rigidify the body **10**. The novel spring clip **75** serves to position the battery B and allows combined ease of assembly and disassembly of the internal operating assembly. A simplified combined seal, breather and attaching means in the form of an elastic band **30** has been provided. The band makes the rear dome **13** easily removable to afford access to the interior. The handles **20, 21** are made so as to open up the grip of the diver to reduce fatigue and substantially increase the control precision by the diver.

In this disclosure, there is shown and described only the preferred embodiment of the invention, but, as aforementioned, it is to be understood that the invention is capable of various changes or modifications within the scope of the inventive concept as expressed herein.

I claim:

1. In a motorized device for work in a fluid environment, the combination of a motor, a shell-like body forming a sealed enclosure to substantially surround and protect the motor from the environment, at least a portion of the outer surface of said body being capable of transferring heat to said environment, and means for directly transferring substantially the total heat from said motor to said portion of said body, said heat transfer means being at least partially located adjacent one end of said motor, the heat transfer capacity of said means and said body being sufficient to dissipate the power loss heat generated by said motor to permit substantially high output and continuous operation of said motor at a substantially constant maximum temperature within the allowable temperature range of said motor while said body is in said environment, said shell-like body comprising a section of tubular metal pipe, a cone attached to one end of said pipe in sealed relationship, said motor being mounted within the confines of said cone, and a removable dome fitting on the end opposite said one end of said pipe and means for attaching and sealing said dome to said pipe.

2. The combination of claim **1** wherein said means for attaching and sealing said dome comprises an elastic band stretchably spanning the interconnection between said pipe and said rear dome, at least one portion of the width of said band being sufficiently resilient to be separable from the corresponding part of said body by pulling said band back onto the other portion thereof to allow removal of said dome and access to the interior of said body, the sealing efficiency of the band seal being increased as the exterior pressure of said fluid environment is increased.

3. The combination of claim **2** wherein is further provided a breather passageway underlying and sealed by said elastic band, said passageway allowing release of fluid pressure by bubbling from the interior of said device to said environment.

4. An underwater vehicle for personal use comprising an outer shell-like body forming a watertight enclosure, a motor having a housing substantially surrounded by said shell, propulsion means connected to

said motor for moving said vehicle through the water, an annular disc close fitting around said housing for supporting said motor within said body, said disc forming a heat transfer path whereby heat generated in the motor is transferred radially outward through said disc, the outer periphery of said disc close fitting in heat transfer relationship with the interior of said body and spaced from the end walls of the shell, said body being capable of transferring heat to the water and the heat transfer capacity of said disc and said body being sufficient to dissipate the power loss heat generated by said motor to permit the substantially high output and continuous operation of said motor at a substantially constant maximum temperature within the allowable temperature range of said motor while said body is under water.

5. The combination of claim 4 wherein the annular disc is mounted on said motor housing substantially in the plane of one bearing of said motor to directly transfer friction heat therefrom radially outwardly to said body.

6. The combination of claim 4 wherein said body includes a nose cone, said motor being mounted substantially within said nose cone, the housing of said motor adjacent the other bearing of said motor being mounted in face-to-face contact with the forward portion of said nose cone to effect further support of said motor and direct friction heat transfer from said other bearing.

7. An underwater vehicle for personal use comprising an electric motor, a battery for energizing said motor, a shell-like body forming a watertight and substantially surrounding enclosure to protect the motor and battery from the ambient water, propulsion means connected to said motor for moving said vehicle through the water, said body being capable of transferring heat to said ambient water and annular means spaced from the endwalls of the body for supporting said motor within the interior of said body, said annular means forming a heat transfer path for directly transferring the power loss heat from said motor to said body, the heat transfer capacity of said annular means and said body being sufficient to dissipate said heat from said motor so as to permit the substantially high output and continuous operation of said motor at a substantially constant maximum temperature within the allowable temperature range of said motor while said body is under water.

8. The combination of claim 7 wherein said body and said motor are cylindrical in shape and coaxial, said motor being spaced from said body by an insulator along the longitudinal axis substantially the full length of said motor, said annular means including a disc coaxially mounted at one end of said motor.

9. The combination of claim 8 wherein is provided a retainer clip for said battery, said clip being attached to said one end of said motor and said disc for support and extending under said battery, stop means on said clip for preventing shifting of said battery along said body.

10. The combination of claim 9 wherein said clip is spring metal biased upwardly so as to fit snugly against the bottom of said battery, said stop means including an upwardly extending projection on said clip positioned behind said battery, a removable rear dome for presenting an open end of said body adjacent said projection, said clip being adapted for release of said battery for removal past said projection upon being sprung downwardly.

11. The combination of claim 10 wherein said projection forms a handle to facilitate removal of said motor from said body by pulling and withdrawal through said open end.

12. The combination of claim 7 wherein said battery has exterior dimensions approximating the interior of said body to permit a snug fit therein, said battery being sufficiently rigid to reinforce said body.

13. The combination of claim 12 wherein is provided a pair of runners for positioning along the longitudinal edges of said battery to adapt said battery for said snug fit.

14. An underwater vehicle to pull a diver through the water comprising a shell-like body, drive means in said body for propelling said vehicle, a handle means on said body for grasping by said diver, said handle having a girth such as to limit the hand of said diver to a generally open grip, the forward face dimension of said handle transverse to the movement through the water being sufficiently wide to distribute the pulling force across substantially the full length of the second and third sections of the fingers of the diver whereby maximum control and minimum fatigue of said hand is gained, said handle means includes an outwardly curved surface to fit the palm of the hand of the diver to permit transmission of pulling force through frictional engagement, said curved surface merging smoothly with the forward face of said handle, the cross section said handle including said curved surface being substantially tear-shaped and means for mounting said handle means on said body but spaced therefrom to permit ease of flow of water therebetween.

15. The combination of claim 14 wherein said handle means includes spaced parallel ridges extending at least partially around the girth of said handle in at least a 90° arc to separate the fingers and prevent slipping along the same.

16. The combination of claim 14 wherein is provided plunger means reciprocally mounted in said handle to activate said drive means, said plunger means being exposed for engagement by the hand of the diver.

17. The combination of claim 16 wherein said plunger means includes a magnet adjacent the lower end thereof and wherein is provided a magnetically responsive switch on the inside of said body adjacent said handle for activation of said drive means upon depressing said plunger to bring said magnet into proximity to said switch.

18. The combination of claim 14 wherein said handle means is tilted forward for ease of control by the diver when positioned behind and slightly above said vehicle.

19. The combination of claim 14 wherein said handle means is tilted inwardly to approximate the natural holding on position of the hands.

20. In a motorized device for work in a fluid environment, the combination of a motor, a shell-like body forming a sealed enclosure to substantially surround and protect the motor from the environment, at least a portion of the outer surface of said body being capable of transferring heat to said environment, and means for directly transferring substantially the total heat from said motor to said portion of said body, said heat

transfer means being at least partially located adjacent one end of said motor, the heat transfer capacity of said means and said body being sufficient to dissipate the power loss heat generated by said motor to permit substantially high output and continuous operation of said motor at a substantially constant maximum temperature within the allowable temperature range of said motor while said body is in said environment, said motor including a cylindrical housing and said heat transfer means comprising an annular disc, said disc fitting in heat transfer relationship around the outer periphery of said housing and the inner periphery of said body, said housing including and end bell to form the end of said motor, said disc being mounted substantially in the plane of said bell.

21. In a motorized device for work in a fluid environment, the combination of a motor, a shell-like body forming a sealed enclosure to substantially surround and protect the motor from the environment, at least a portion of the outer surface of said body being capable of transferring heat to said environment, and means for directly transferring substantially the total heat from said motor to said portion of said body, said heat transfer means being at least partially located adjacent one end of said motor, the heat transfer capacity of said means and said body being sufficient to dissipate the power loss heat generated by said motor to permit substantially high output and continuous operation of said motor at a substantially constant maximum temperature within the allowable temperature range of said motor while said body is in said environment, said heat transfer means including an end bell of one end of said motor mounted in contact with one end of said shell-like body so as to be in heat transfer relationship therewith whereby to directly transfer heat to said body to aid in dissipation of the heat from said motor.

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