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(54) Title: SHALLOW WATER WET-DRY VEHICLE AND A LITTORAL FIGHTING VEHICLE

(57) Abstract: Seagoing swimmer delivery vehicle operable as a combustion powered surface vessel or an electrically powered underwater vessel. The vehicle includes an outer pressure hull and an inner pressure hull disposed within the outer pressure hull, the inner pressure hull configured to carry at least one swimmer in wet or dry mode. The inner pressure hull is capable of receiving water from the outer pressure hull while air is transferred from the inner pressure hull to the outer pressure hull, and vice-versa. Fuel is stored in flexible bladders in ballast compartments, so bladder shrinkage due to fuel consumption is compensated for by adding water to the ballast compartment.



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SHALLOW WATER WET-DRY VEHICLE AND A LITTORAL FIGHTING VEHICLE

BACKGROUND OF THE INVENTION

5 [0001] The benefit is claimed of Provisional Patent Application No. 60/937,210 filed June 26, 2007.

[0002] This relates to a shallow water vehicle (e.g., a littoral vehicle) such as a wet-dry submersible vehicle, especially of the type for transporting swimmers, i.e., swimmer delivery vehicles and/or ordnance carrying platform in a littoral fighting
10 configuration.

[0003] Swimmer delivery vehicles (SDV's) are generally of two conventional types:

1. Wet-Type SDVs, where the swimmers are surrounded by water at all times and are using individual breathing apparatus (e.g., U.S. Navy Mark 8), and
- 15 2. Dry SDV's, where the swimmers are surrounded by air, and need to swim out of the SDV via an egress-ingress process (i.e., U.S. Navy ASDS).

[0004] It would be desirable to provide an SDV which combines the wet and dry types. This vehicle, may be referred also as littoral fighting vehicle, when its mission is more of ordnance delivering and target engaging rather than, or in
20 addition to, swimmer delivering.

[0005] It would also be desirable for the SDV to be selectively operable as a fully submerged craft, a partially submerged craft, or a surface craft.

[0006] It would be further desirable to enable such an SDV to maintain the trim and balance of the vehicle intact as fuel is depleted, when converting between wet
25 and dry types of operation, and when swimmers swim in and out of the vehicle..

BRIEF SUMMARY

[0007] One aspect of the invention involves a seagoing littoral vehicle comprising an elongated slender hull configured generally symmetrically about its longitudinal
30 front-to-rear centerline. The hull includes upper and lower portions interconnected along a substantially horizontal chine. The hull upper portion includes front and rear

sections including substantially flat sidewalls converging generally upwardly to form a generally inverted V shape. The forward portion of the vehicle includes a generally horizontal top deck spaced below an uppermost portion of the rear portion of the vehicle. A ballast mechanism operates the vehicle selectively as a surface
5 craft or a fully submerged craft or a reduced freeboard low signature craft. An air intake mechanism provides fresh air into the vehicle and is selectively closed from the surrounding water environment when the vehicle is operated as a fully submerged craft.

[0008] Another aspect involves a seagoing swimmer delivery vehicle capable of
10 selectively operating as a combustion powered surface vessel and an electrically powered underwater vessel, the vehicle comprising an inner volume including pressurized compartments capable of sustaining ambient water pressure and maintaining approximately one atmospheric pressure when the vehicle is fully submerged. One of the pressurized compartments is a housing compartment
15 configured to carry a swimmer selectively in a dry mode or a wet mode, wherein in the dry mode the swimmer is surrounded by air at approximately one atmosphere, and in the wet mode, the swimmer is surrounded by water at an ambient external pressure.

[0009] Yet another aspect involves a seagoing swimming delivery vehicle capable
20 of selectively operating as a combustion powered surface vessel and an electrically powered underwater vessel. The vehicle comprises an outer pressure hull and an inner pressure hull being spaced inwardly from the outer pressure hull. The inner pressure hull is configured to carry at least one swimmer in wet or dry mode, wherein the inner pressure hull is capable of being fully flooded with water (wet
25 mode) while the outer pressure hull contains air, and the outer pressure hull is capable of being fully flooded with water while the inner pressure hull contains air (dry mode).

[0010] Water is transferred from the outer pressure hull (more specifically, from the space between the inner and outer pressure hulls) to the inner pressure hull while
30 air is transferred from the inner pressure hull to the outer pressure hull, thereby maintaining the trim and balance of the vessel generally intact throughout the transfer process and afterward.

[0011] Fuel is stored in a flexible bladder surrounded by water in a ballast compartment, so water can be added to the ballast compartment as fuel is consumed, in order to compensate for the fuel consumption and thereby maintain trim and balance of the vehicle.

5

BRIEF DESCRIPTION OF THE DRAWING

[0012] The objects and advantages of the invention will become apparent from the following detailed description of preferred embodiments thereof in connection with the accompanying drawings in which like numerals designate like elements and in which:

10

[0013] Fig. 1 is a side elevational view of a shallow water swimmer delivery vehicle or littoral fighting vehicle depicting various levels thereof waterlines.

[0014] Fig. 2 is a top plan view of Fig. 1.

[0015] Fig. 3 is a front end view of Fig. 1.

15

[0016] Fig. 4 is a rear end view of Fig. 1.

[0017] Fig. 5 is a longitudinal sectional view of the vehicle depicting operating personnel and swimmers.

[0018] Fig. 5A is a cross-sectional view taken along line 5A-5A in Fig. 5.

[0019] Fig. 5B is a cross-sectional view taken along line 5B-5B in Fig. 5.

20

[0020] Fig. 6 is a cross-sectional view through a housing compartment in dry mode, containing a swimmer wherein the vehicle is underwater.

[0021] Fig. 7 is a view similar to Fig. 6 in which the vehicle is underwater and the housing compartment is in wet mode, showing the swimmer exiting the compartment.

25

[0022] Fig. 8 is a view similar to Fig. 6 showing the housing compartment in dry mode and the vehicle in a partially submerged mode.

[0023] Fig. 9 is a view similar to Fig. 6 wherein the vehicle is operating in surface mode and the housing compartment is in dry mode.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0024] Depicted in Figs. 1, 2 and 5 is a shallow water swimmer delivery vehicle (SDV) or a littoral fighting vehicle which is capable of operating selectively as a fully submerged craft, or a partially submerged craft (i.e., a reduced free board low signature craft), or a surface craft. Furthermore, the SDV can transport swimmers selectively in a wet or dry state as desired, as will be explained.

[0025] The SDV includes a hull 10 which includes upper and lower hull portions 12, 14 divided by a generally horizontal chine 16. Front and rear sections 20, 22 of the hull are at different elevations, i.e., they include respective horizontal top decks 24, 26 that are at different vertical levels. That is, the front top deck 24 is lower than the rear top deck 26, resulting in the presence of a vertical step at which a window 28 is disposed. The window 28 includes a pair of transparent window portions 28a, 28b which converge forwardly and upwardly on opposite sides of a longitudinal centerline L of the vehicle to form a wedge like forwardly projected backwardly inclined surfaces and intersect at an upwardly/rearwardly inclined edge 30. The window could be provided with an electrically conductive coating or with an embedded conductive substance, for absorbing or reflecting electro-magnetic radiation, as is known in military aircraft windows technology.

[0026] The top front 24 and rear 26 decks are generally flat and horizontal and provided with hatches 40, 42, 44 to permit ingress and egress of swimmers, operators operating weapon and/or delivering ordnance.

[0027] Extending rearwardly and downwardly inclined from the rear edge of the top rear deck 26 is an inclined surface 48 which terminates at a stern edge of the vehicle. That surface 48 extends along a rear portion 50 of the upper hull portion 12 which projects rearwardly past the lower hull portion 14 to form a tail which overlies and shields at least one rudder 52 and at least one propulsion means 54 of the vehicle, such as a propeller. The rudder 52 enables the vehicle to be steered in a horizontal plane. Steering in a vertical plane can be achieved by conventional front and/or rear lifting surfaces 56, 58 that are hinged to provide proper vertical maneuvering capabilities. The lifting surfaces could also be made retractable into the vessel hull, if desired. An alternative configuration of propulsion and

maneuvering means could relay on vectoring the propulsion mean (i.e. Waterjet or Arneson drive).

5 **[0028]** The bow 60 of the hull is sharply pointed as can be seen in Fig. 2. The bow is formed by surfaces 62, 64 which are inclined upwardly and forwardly on opposite sides of the centerline L and intersect at an upwardly/rearwardly inclined front edge 66.

10 **[0029]** The vehicle is powered by one or more internal combustion engines 68 disposed in an engine compartment 70 (see Fig. 5). Engine exhaust is conducted through an exhaust duct 72 which includes at least one open/closed valve 94, and passes through a muffler 76 before exiting the vessel. Also provided for driving the propeller(s) or other propulsion means if applicable is an electric motor (68a) driven by batteries which may be recharged by the engine when the vehicle is surfaced. Thus, the vehicle can be selectively operated as a combustion powered surface vessel or as an electrically powered submerged vessel.

15 **[0030]** Air intake to the vehicle, when the vehicle is not submerged, is accomplished by an internal inlet 80 located in an air management chamber 82 that is covered by perforated plate 84 disposed on the top rear deck 26. While the engine compartment 70 is kept dry at all times, the air management chamber 82 is wet when the vehicle is submerged, so the air inlet 80 is provided with an at least one open-closed valve 88 which is kept closed when the vehicle is submerged.

20 **[0031]** The hull 10 comprises a pressure hull structure 90, shown in dark lines in Fig. 5, and an outer skin 92 (see also Figs. 5A and 5B). The outer skin includes a pair of flat walls 94, 96 disposed on opposite sides of the centerline L, and converging upwardly toward the top decks 24, 26 and toward the rear tail 48. The outer skin also comprises flat walls 98, 100 disposed on opposite sides of the centerline L and converging downwardly toward the hull lower portion 14 from outer edges of the walls 94, 96. At their rear edges, the walls 98, 100 converge rearwardly toward the centerline to merge into the vehicle's stern.

25 **[0032]** The interior of the vehicle is composed of pressurized compartments and non-pressurized compartments, as will be explained. The pressurized hull structure 90 includes an outer pressurized hull 110, and an inner pressurized hulls 114, where 114 disposed within the outer pressurized hull 110. At its rear region, the outer

pressurized hull 110 surrounds the engine compartment 70 and a multi-level workstation 120 for human operators, including an operator's tower 122. Like the engine compartment 70, the workstation 120 is kept dry and under approximately one atmospheric pressure at all times.

5 **[0033]** The outer pressurized hull 110 extends forwardly from the workstation 120, and contains one or two inner pressurized hulls 112, 114 which define a swimmer ingress-egress chamber 134 and a housing compartment 136, respectively. Spaces 138 formed between the skin 94, 96, 98, 100 of the hull on the one hand, and the outer pressurized hull 110 (Fig. 5B) on the other hand, are not pressurized and serve
10 as ballast compartments for containing ballast water. By evacuating water from the ballast compartments 138, the vehicle will be positively buoyant for surface mode of operation, and by admitting water into the ballast compartments 138, the vehicle will tend to become neutrally buoyant for underwater operation. Suitable pumping capability is provided for accomplishing this evacuating and admitting water, as is
15 conventional.

[0034] The housing compartment 136 is able to house swimmers, weapons and/or equipment in a wet mode and/or a dry mode. A space 140 formed between the outer pressurized hull 110 and the inner pressurized hull 114 constitutes a transfer compartment for controlling the state (dry or wet state) of the housing compartment
20 136. That is, the transfer compartment 140 is substantially filled with water when the housing compartment 136 is substantially dry, and the transfer compartment is substantially dry when the housing compartment is substantially flooded. The term substantially is used here to suggest that some water (or some air) may still occupy the 140 and 136 spaces even though they are in a dry (or wet) condition,
25 respectively. Thus, when water is transferred via a suitable water transfer means from the transfer compartment 140 to the housing compartment 136, air is simultaneously transferred from the housing compartment to the transfer compartment 140, and vice-versa. As a result, the overall trim and balance of the vehicle are maintained while the housing compartment is being converted between
30 wet and dry operation modes.

[0035] It will thus be appreciated that the housing compartment 136 constitutes a wet/dry compartment which when dry can be pressurized at atmospheric pressure to

house swimmers and/or equipment (see Fig. 6). When the submerged vehicle reaches a swimmers' destination or a weaponry deployment location, the housing compartment 136 may be flooded by water transferred from the transfer compartment 140. Once the housing compartment 136 is substantially flooded and reaches the ambient external water pressure, swimmers can leave or enter the housing compartment through the trunk 39 and the hatch 40.

[0036] The ingress/egress chamber 134 communicates with both the workstation 120 and the housing compartment 136 via respective hatches 150, 152 (and respective trunks) to enable personnel to leave or enter the vehicle through the upper hatch 42 when the vehicle is on the surface or only slightly semi-submerged. Also, swimmers may enter or leave the vehicle via the ingress/egress chamber 134 when the vehicle is submerged. That is, by pressurizing the air in the ingress/egress chamber 134 to equal the ambient external water pressure, swimmers may exit the ingress/egress chamber 134 through the bottom hatch 154. The ingress/egress chamber 134 can also be flooded with water from the transfer chamber 140 (while transferring air to the chamber 140) to enable swimmers to enter or leave through the upper hatch 42, so in this case the ingress/egress chamber 134 becomes a wet/dry compartment in a similar manner described above for the housing compartment 136.

[0037] Fuel for the vehicle may be contained within flexible bladders 160 located in the ballast compartments 138. The bladders are surrounded by water, so as fuel is consumed and the bladders shrink, water can be added to the ballast compartments to enable space formerly occupied by fuel to become occupied by water. Thus, the trim and balance of the vehicle are maintained substantially intact while fuel is consumed.

[0038] Figure 8 depicts a condition when the vehicle is in a semi-submerged mode, i.e., the transport compartment contains enough water to cause the vehicle to partially submerge.

[0039] Fig. 9 depicts a condition when the vehicle is a surface craft, i.e., most of the water has been evacuated from the transfer compartment 140 and the ballast compartments 138.

[0040] It will be appreciated that by evacuating water from the ballast compartments 138 and the transfer compartment, the vehicle can be operated as a surface vessel, with the water level at W1 in Fig. 1. When the ballast and transfer compartments 138, 140 are flooded with water, the vehicle can be operated as a fully submerged vessel, with the water level at W2 in Fig. 1. By providing either, or both, of the ballast and transfer compartments 138, 140 with some water, the vessel can be operated in partially submerged states, i.e., variable freeboard operation, with the water level at W3 or W4, for example, as shown in Fig. 1.

[0041] Swimmers can enter or leave the vehicle while in fully or partially submerged states by means of the wet/dry housing chamber 136, or the ingress/egress chamber 134, which can be converted between wet and dry operation without adversely affecting the trim or balance of the vehicle.

[0042] The consumption of fuel is compensated for by adding water around the flexible fuel bladder 160 to compensate for the loss of fuel volume, thereby maintaining trim and balance.

[0043] It will be appreciated that the vehicle may serve as a littoral fighting vehicle and conduct numerous types of missions in addition or as alternative to swimmer delivering, such as:

- carrying and operating surface-to-surface ordnance while operating as a surface craft, or as a reduced freeboard low signature craft,
- carrying and operating underwater ordnance,
- carrying and operating electro-optical targeting systems,
- carrying and operating underwater acoustic targeting systems,
- carrying and operating obstacle avoidance sonar (OAS),
- carrying and operating Doppler Navigation Sonar (DNS), and
- carrying and operating Electro Optical periscope(s).

[0044] Although the present invention has been described in connection with preferred embodiments thereof, it will be appreciated by those skilled in the art that additions, deletions, modifications, and substitutions not specifically described may be made without departing from the spirit and scope of the invention as defined in the appended claims.

WHAT IS CLAIMED IS:

1. A seagoing littoral vehicle comprising:

5 an elongated slender hull configured generally symmetrically about its longitudinal front-to-rear centerline, said hull including upper and lower portions interconnected along a substantially horizontal chine, said hull upper portion including front and rear sections including substantially flat sidewalls converging generally upwardly on opposite sides of the longitudinal centerline to form a
10 generally inverted V shape, said front section including a generally horizontal top deck spaced below an uppermost portion of said rear section;

 a ballast mechanism for operating the vehicle selectively as a surface craft or a fully submerged craft or a reduced freeboard low signature craft; and

15 an air intake mechanism for providing fresh air into the vehicle and being selectively closed from the surrounding water environment when the vehicle is operated as a fully submerged craft.

20 2. The seagoing vehicle according to claim 1 wherein a front end of the front section is defined by two substantially flat surfaces converging forwardly on opposite sides of said centerline to form a wedge-like shaped bow.

 3. The seagoing vehicle according to claim 1, wherein upper ends of said
25 substantially flat sidewalls are truncated to form a substantially horizontal top deck along said rear section, and a tail which declines rearwardly from a rear end of said top deck.

 4. The seagoing vehicle according to claim 3, further including a propeller
30 and a rudder arranged at the stern of the vehicle and shielded from above by the tail.

5. The seagoing vehicle according to claim 1 wherein upper ends of said substantially flat sidewalls are truncated along the front section to form a generally horizontal lower deck, and are truncated along the rear section to form a generally horizontal top deck, wherein said lower deck is at a lower elevation than said top deck to form a step in the hull upper portion, wherein the front end of said rear section includes a transparent window.

6. The seagoing vehicle according to claim 5 wherein said window includes an electrically conductive layer in the form of a coating or an embedded layer for reflecting electro-magnetic radiation.

7. The seagoing vehicle according to claim 1 wherein an interior volume of said vehicle includes a pressurized compartment for maintaining approximately atmospheric pressure at all mode of operation therein and a non-pressurized compartment selectively filled with air, water or a combination thereof.

8. The seagoing vehicle according to claim 7 wherein a flexible fuel bladder is disposed within said non-pressurized compartment, and surrounded by water, wherein water added to said non-pressurized compartment as the bladder shrinks during fuel consumption, maintains the trim and balance of the vehicle intact.

9. The seagoing vehicle according to claim 1 wherein the interior of the vehicle includes first and second pressurized compartments defining, respectively, a housing compartment and a transfer compartment; said housing compartment being usable in a wet or dry condition for transporting swimmers, the transfer compartment being operable to receive water from, or transfer water to, the housing compartment, wherein a transfer of water between such compartments is performed simultaneously with a transfer of air between such compartments, to maintain overall trim and balance of the vehicle.

10. The seagoing vehicle according to claim 9 wherein said pressurized compartment further includes a dry area for containing an engine and a human operator and maintained substantially dry at all times.

5 11. The seagoing vehicle according to claim 9 wherein the housing compartment is disposed inside of the transfer compartment.

12. The seagoing vehicle according to claim 1 wherein a perforated plate is mounted on said upper portion of said hull to allow the passage of air into the
10 vehicle, said plate having at least one hundred holes of diameter less than .5 inches.

13. The seagoing vehicle according to claim 9 said housing compartment includes a hatch allowing a swimmer to swim into or out of said housing compartment when said housing compartment is flooded in a wet condition.

15

14. The seagoing vehicle according to claim 1 further including a flexible fuel bladder disposed within an inner volume of the vehicle and surrounded by water, and means for adding water to the surrounding water as said bladder shrinks during fuel consumption, to maintain the trim and balance of the vehicle.

20

15. The seagoing vehicle according to claim 9, wherein one of said pressurized compartments includes a downwardly openable hatch allowing ingress or egress of a swimmer, while air in such compartment is pressurized to the surrounding ambient water pressure.

25

16. A seagoing swimmer delivery vehicle capable of selectively operating as a combustion powered surface vessel and an electrically powered underwater vessel, the vehicle comprising an inner volume including pressurized compartments capable of sustaining ambient water pressure and maintaining approximately one
30 atmospheric pressure when the vehicle is fully submerged, one of said pressurized compartments being a housing compartment configured to carry a swimmer selectively in a dry mode or a wet mode, wherein in said dry mode the swimmer is

surrounded by air at approximately one atmosphere, and in said wet mode, the swimmer is surrounded by water at ambient pressure.

17. The seagoing vehicle according to claim 16 wherein one of said
5 pressurized compartments is configured to selectively carry water or air or a combination thereof and is connected to the housing compartment for exchanging water and air therewith in a manner maintaining the trim and balance of the vehicle.

18. The seagoing vessel according to claim 17 wherein the housing
10 compartment is disposed inside of, and spaced from, the transfer compartment.

19. The seagoing vehicle according to claim 16 further including a flexible fuel bladder disposed within said inner volume and surrounded by water, so that the addition of water as said bladder shrinks during fuel consumption, maintains the
15 trim and balance of the vehicle.

20. A seagoing swimmer delivery vehicle capable of selectively operating as a combustion powered surface vessel and an electrically powered underwater vessel, the vehicle comprising an outer pressure hull in which an inner pressure hull is disposed, the inner pressure hull spaced inwardly from, the outer pressure hull, the
20 inner pressure hull configured to carry at least one swimmer in wet or dry mode, wherein said inner pressure hull is capable of being flooded with water while said outer pressure hull contains air, and said outer pressure hull is capable of being flooded with water while said inner pressure hull contains air.
25

21. The seagoing vehicle according to claim 20 wherein said inner pressure hull includes a top side connected to a top side of the outer pressure hull by a trunk large enough to allow a swimmer to enter or leave the inner pressure hull.

22. The seagoing vehicle according to claim 21 wherein said trunk is
30 covered by a water-tight hatch to prevent water from flooding the inner pressure hull.

23. The seagoing vehicle according to claim 20 wherein said inner and outer pressure hulls are interconnected to transfer water and air between one another to maintain the trim and balance of the vehicle.

5

24. The seagoing vehicle according to claim 20, further including a non-pressurized ballast compartment, said vehicle operable in varying states of freeboard by inserting selected amounts of water to the ballast compartment and the transfer compartment.

10

25. The seagoing vehicle according to claim 20 wherein said inner pressure hull has a trunk connected to the lower portion of the vehicle, large enough to allow a swimmer to enter or leave the inner pressure hull in a dry mode, while the air within the inner pressure hull is equalized to surrounding external ambient pressure.

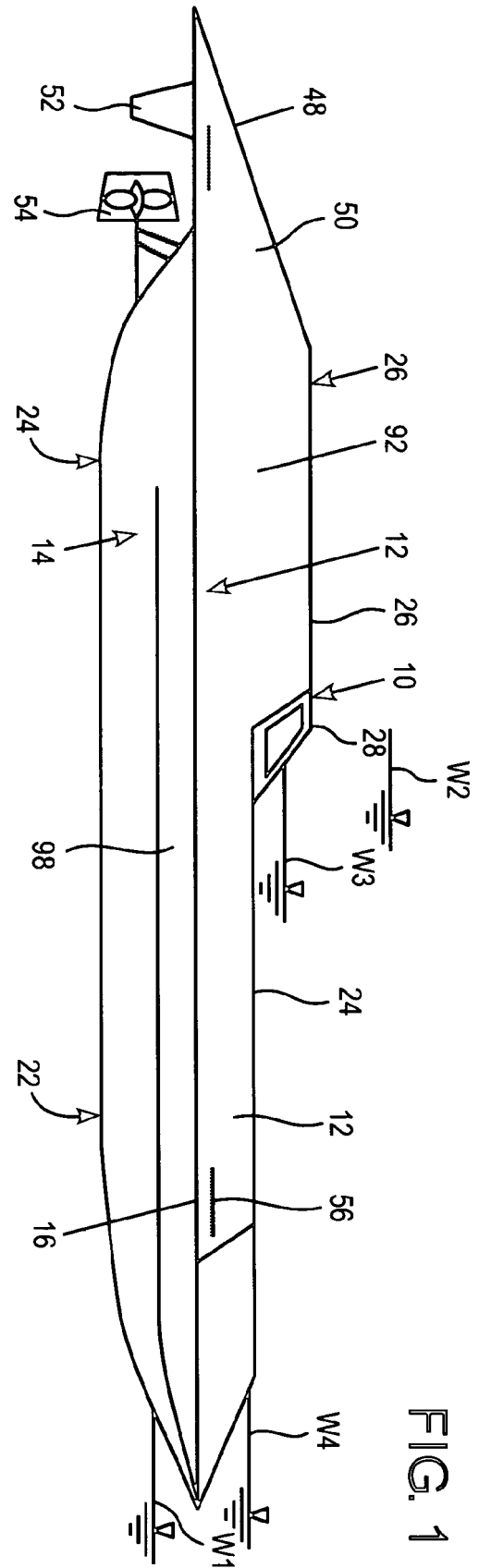


FIG. 1

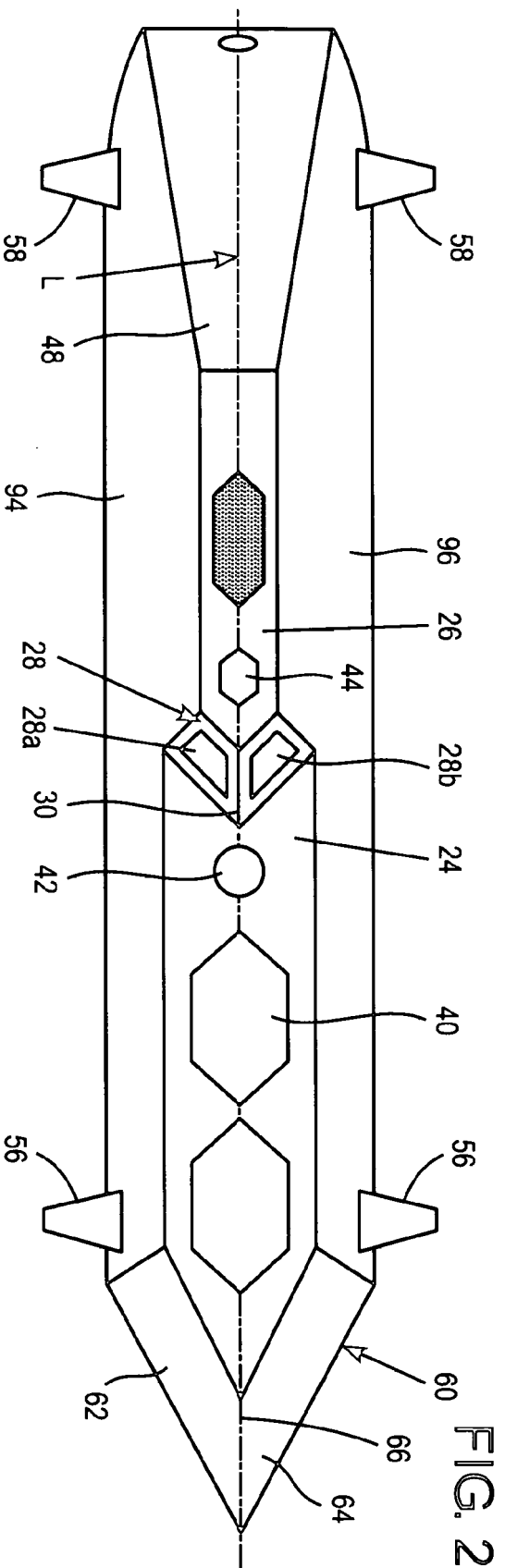


FIG. 2

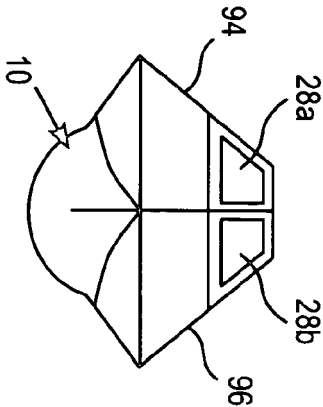


FIG. 3

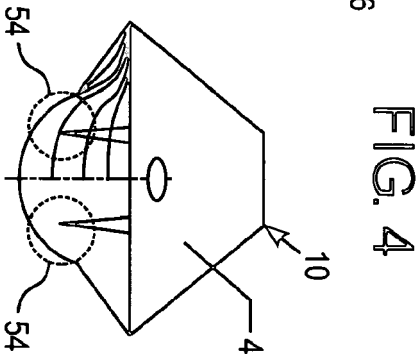


FIG. 4

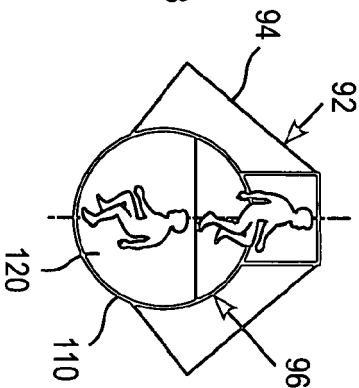


FIG. 5A

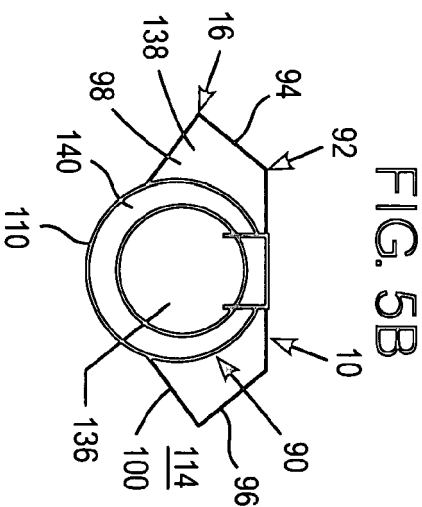


FIG. 5B

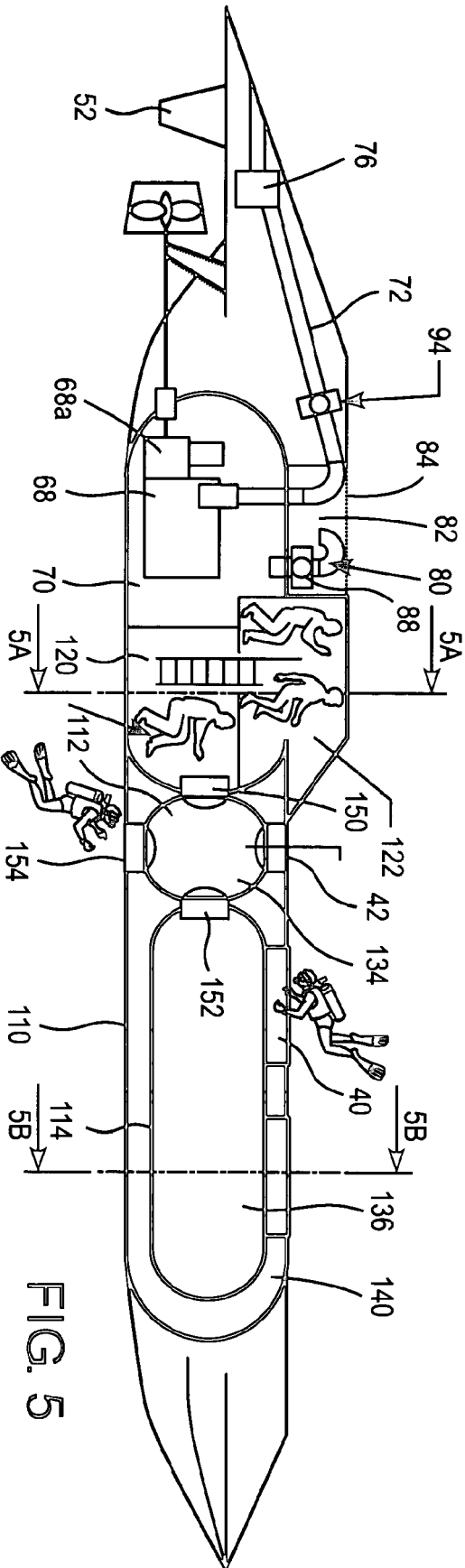


FIG. 5

