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(54) **A PROPULSION MODULE, PROPULSION SYSTEM, WATERCRAFT AND RELATED METHODS**

(57) A propulsion module, a propulsion system, a watercraft, an assembly method for a propulsion module, an assembly method for a propulsion system and an assembly method for a watercraft are provided. The propulsion module includes a waterjet. The propulsion module also includes an electric motor configured to channel seawater through the waterjet, wherein in use, the electric motor is configured to be externally passively cooled by surrounding seawater. Further, the propulsion module includes an electronic speed controller (ESC) connected to the electric motor and configured to control the electric motor, wherein in use, the ESC is configured to be externally passively cooled by the surrounding seawater.

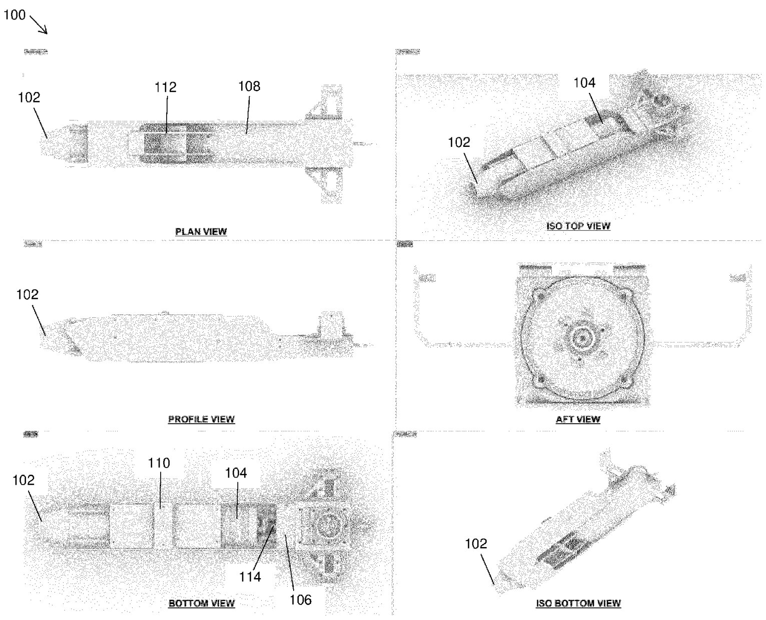

FIG. 1

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Description

TECHNICAL FIELD

[0001] The present invention relates broadly, but not exclusively, to a propulsion module for a watercraft, a propulsion system for the watercraft, the watercraft, and assembly methods thereof.

BACKGROUND OF THE DISCLOSURE

[0002] Electric motorized watercrafts including personal watercrafts such as jetboards, and specialized marine crafts can be used in recreational, commercial and military applications. A typical electric motorized watercraft comprises a hull, a power system for propelling the electric motorized watercraft on seawater and a controller system for controlling the power system.

[0003] In the typical electric motorized watercraft, a pin-socket type connection between the power system and the controller system may be used. While the pin-socket type connection may be designed to be watertight, due to high and variable currents through the pins and the sockets during a typical use of the electric motorized watercraft, there can be thermal expansion and contraction of the metal pins and the metal sockets. This can lead to creeping of moisture, in particular seawater, in between the contact surfaces of the pins and the sockets, resulting in a build-up of salts over time, which can corrode the pins and/or the sockets. Corrosion of the pins and/or the sockets can cause substantial water ingress into the connections, thereby leading to an electrical short circuit.

[0004] Further, high heat may be generated in wires connecting the power system and the controller system. The high heat can affect rubber seals used in cable glands for the wires. Specifically, the high heat may cause the rubber seals to harden and crack over time due to varying temperatures between the high heat and the seawater temperature, especially when the electric motorized watercraft is used in colder waters. The hardened and cracked rubber seals can lead to water ingress through the cable glands over time, thereby resulting in an electrical short circuit.

[0005] In addition, the power system and the controller system of the electric motorized watercraft can generate a large amount of heat that needs to be quickly dissipated. A conventional method of cooling requires seawater to be internally circulated in the power system and the controller system. The conventional cooling method may be prone to blockage due to debris and salt deposits, leading to overheating of the power system and the controller system, which may in turn result in failure of the power system and the controller system.

[0006] Also, a battery of the power system needs to be waterproof and safe to users when it is detached from the electric motorized watercraft. A conventional battery has battery power terminals which can be switched on live via a push button even when the battery is detached from the electric motorized watercraft. This can expose the users to electric shocks. Further, the detached battery can short circuit if the battery power terminals are accidentally electrically connected, for example when there is water across the battery power terminals or accidental contact of both terminals.

[0007] A need therefore exists to provide an electric motorized watercraft that seeks to address at least some of the above problems. Furthermore, other desirable features and characteristics will become apparent from the subsequent detailed description and the appended claims, taken in conjunction with the accompanying drawings and this background of the disclosure.

SUMMARY

[0008] According to a first aspect, there is provided a propulsion module for a watercraft, comprising: a waterjet; an electric motor configured to channel seawater through the waterjet, wherein in use, the electric motor is configured to be externally passively cooled by surrounding seawater; and an electronic speed controller (ESC) connected to the electric motor and configured to control the electric motor, wherein in use, the ESC is configured to be externally passively cooled by the surrounding seawater.

[0009] According to a second aspect, there is provided a propulsion system for a watercraft, comprising: a propulsion module, wherein the propulsion module comprises:

a waterjet; an electric motor configured to channel seawater through the waterjet, wherein in use, the electric motor is configured to be externally passively cooled by surrounding seawater; and an electronic speed controller (ESC) connected to the electric motor and configured to control the electric motor, wherein in use, the ESC is configured to be externally passively cooled by the surrounding seawater; and a power module detachably attachable to the propulsion module, wherein the power module is configured to provide electricity to the propulsion module.

[0010] According to a third aspect, there is provided a watercraft, comprising: a hull module; a propulsion module detachably attachable to the hull module, wherein the propulsion module comprises: a waterjet; an electric motor configured to channel seawater through the waterjet, wherein in use, the electric motor is configured to be externally passively cooled by surrounding seawater; and an electronic speed controller (ESC) connected to the electric motor and configured to control the electric motor, wherein in use, the ESC is configured to be externally passively cooled by the surrounding seawater; and a power module detachably attachable to the propulsion module, wherein the power module is configured to provide electricity to the propulsion module.

[0011] According to a fourth aspect, there is provided an assembly method for a propulsion module for a watercraft, comprising: providing a waterjet; providing an electric motor configured to channel seawater through the waterjet, wherein in use, the electric motor is configured to be externally passively cooled by surrounding seawater; attaching the electric motor to the waterjet; providing an electronic speed controller (ESC) configured to control the electric motor, wherein in use, the ESC is configured to be externally passively cooled by the surrounding seawater; and connecting the ESC to the electric motor.

[0012] According to a fifth aspect, there is provided an assembly method for a propulsion system for a watercraft, comprising: providing a propulsion module, wherein the propulsion module comprises: a waterjet; an electric motor configured to channel seawater through the waterjet, wherein in use, the electric motor is configured to be externally passively cooled by surrounding seawater; and an electronic speed controller (ESC) connected to the electric motor and configured to control the electric motor, wherein in use, the ESC is configured to be externally passively cooled by the surrounding seawater; and attaching a power module to the propulsion module, wherein the power module is configured to provide electricity to the propulsion module.

[0013] According to a sixth aspect, there is provided an assembly method for a watercraft, comprising: providing a hull module; attaching a propulsion module to the hull module, wherein the propulsion module comprises: a waterjet; an electric motor configured to channel seawater through the waterjet, wherein in use, the electric motor is configured to be externally passively cooled by surrounding seawater; and an electronic speed controller (ESC) connected to the electric motor and configured to control the electric motor, wherein in use, the ESC is configured to be externally passively cooled by the surrounding seawater; and attaching a power module to the propulsion module, wherein the power module is configured to provide electricity to the propulsion module.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Embodiments and implementations are provided by way of example only, and will be better understood and readily apparent to one of ordinary skill in the art from the following written description, read in conjunction with the drawings, in which:

FIG. 1 is a schematic representation of a propulsion module for a watercraft, according to an example embodiment.

FIG. 2 is a schematic representation of a power module, according to an example embodiment.

FIG. 3 is a schematic representation of a hull module, according to an example embodiment.

FIG. 4 is a schematic representation of a watercraft, according to an example embodiment.

FIG. 5 is a schematic representation of a front binder, according to an example embodiment.

FIG. 6 is a flowchart illustrating an assembly method for a propulsion module for a watercraft, according to an example embodiment.

FIG. 7 is a flowchart illustrating an assembly method for a propulsion system for a watercraft, according to an example embodiment.

FIG. 8 is a flowchart illustrating an assembly method for a watercraft, according to an example embodiment.

[0015] Skilled artisans will appreciate that elements in the figures are illustrated for simplicity and clarity and have not necessarily been depicted to scale.

DETAILED DESCRIPTION

[0016] Embodiments will be described, by way of example only, with reference to the drawings. Like reference numerals and characters in the drawings refer to like elements or equivalents.

[0017] Embodiments of the invention provide a propulsion module for a watercraft, a propulsion system for the watercraft and the watercraft. Advantageously, the watercraft allows a user to move over water surface under the watercraft's power, without external power assistance such as from wind, waves or the user. As would be appreciated, the watercraft can be an electric motorized watercraft including a personal watercraft such as a jetboard, and a specialized marine craft. The watercraft can be used in various applications such as recreational, commercial and military applications. As non-limiting examples, embodiments of the invention can be used in an inflatable monohull, a twin-hull boat, and/or a submerged underwater diver delivery vehicle.

[0018] FIG. 1 is a schematic representation of a propulsion module 100 for a watercraft, according to an example embodiment. The propulsion module 100 comprises a waterjet 102. Further, the propulsion module 100 comprises an electric motor 104 configured to channel seawater through the waterjet 102. In use, the electric motor 104 is configured to be externally passively cooled by surrounding seawater. The propulsion module 100 also comprises an electronic speed controller (ESC) connected to the electric motor 104 and configured to control the electric motor 104. In use, the ESC is configured to be externally passively cooled by the surrounding seawater. Beneficially, with the electric motor 104 and ESC configured to be externally passively cooled by the surrounding seawater, the need for internal circulation of seawater for cooling and its associated problems are eliminated. Further, no modification to the propulsion module 100 is required to divert a small amount of seawater for cooling purposes. In contrast to a need to maintain a typical cooling system such as flushing with freshwater after use or replacing cooling tubes, maintenance of the external passive cooling system is not required.

[0019] According to one embodiment, the electric motor 104 may be a brushless direct current (BLDC) sensored motor. In some implementations, the electric motor 104 may be a BLDC sensored motor with field-weakening. The electric motor 104 may comprise a hollow member disposed along a rotational axis of a rotor of the electric motor 104. In use, the electric motor 104 may be configured to be further passively cooled by the surrounding seawater channeled through the hollow member by a centrifugal force created by the electric motor 104. The hollow member may be a hollow shaft.

[0020] Further, the ESC may comprise electrical components housed in an ESC casing 106. The electrical components may be in thermal contact with an inner surface of the ESC casing 106. The ESC casing 106 may be made of a metallic material such as aluminium. The ESC casing 106 may also be configured to be fully watertight. The external surfaces of the ESC casing 106 can be exposed to the surrounding seawater and the bottom of the ESC casing 106 may be in direct contact with seawater flowing under the bottom of the watercraft. In some implementations, the bottom of the ESC casing 106 may form part of the bottom of the watercraft. Beneficially, the arrangement allows the ESC casing 106 to be exposed to a relatively high flow of seawater to rapidly dissipate heat generated by the electrical components in the ESC. One or more external surfaces of the ESC casing 106 may be roughened to optimize a boundary layer behaviour to allow maximum inflow into a water intake member 108 and the waterjet 102. An intake to the waterjet 102 may be part of a monocoque design that integrates the structure of the propulsion module 100 into a single water intake member 108. The water intake member 108 can be made of carbon fibre. The water intake member 108 can be moulded to a predefined shape based on requirements to ensure optimum water inflow into the waterjet 102 for improved performance.

[0021] The assembly of the electric motor 104 and the waterjet 102 into the propulsion module 100 can be done using non-metallic materials such as Acrylonitrile Butadiene Styrene (ABS) plastic. Beneficially, possible galvanic corrosion between stainless steel screws, carbon fibre and threaded aluminium plates in a typical watercraft can be prevented. As a result, life of mechanical connections is improved because corrosion in threads holding the stainless steel screws is eliminated. Similarly, a mounting interface 110 of the propulsion module 100 can also be made of ABS plastic so as to isolate stainless steel fasteners from other metallic material. Beneficially, galvanic corrosion is prevented. The mounting interface 110 can have a dovetail design. Beneficially, the dovetail design allows for a quick slide-and-screw installation of the propulsion module 100 to the watercraft, while allowing high transfer of thrust from the propulsion module 100 into the watercraft.

[0022] Further, the propulsion module 100 may comprise a water intake grating 112 configured to restrict floating debris from entering the propulsion module 100 and also protect the user from accidental contact with moving parts of the waterjet 102. The water intake grating 112 may have a streamlined profile and may be configured to withstand impact from the floating debris. The water intake grating 112 may also have a winged profile for improving water inflow into the waterjet 102 at high speeds in both strong waves and calm water conditions, with minimal additional drag.

[0023] According to some implementations, the propulsion module 100 may further comprise a connecting member 114 attached to the ESC and the electric motor 104. The connecting member 114 may be watertight and may house wires connecting the ESC and the electric motor 104. The connecting member 114 may be a rigid structure and may be made of a metallic material such as aluminium. Further, the connecting member 114 may be threaded at both ends and may form a watertight seal when fixed to the electric motor 104 and the ESC with a high temperature-resistant silicon gasket. The wires connecting the ESC and the electric motor 104 may comprise electric motor power wires and sensor wires. Beneficially, the wires connecting the ESC and the electric motor 104 are protected from possible damage and are not in contact with the seawater, thereby reduces the possibility of a short circuit. In some implementations, the propulsion module 100 may comprise a plurality of connecting members 114 attached to the ESC and the electric motor 104. Each motor phase wire may pass through a separate connecting member 114. Advantageously, the arrangement allows improved dissipation of heat generated by the wires, without significant expansion or contraction of the connecting members 114. The possibility of water ingress into the electric motor 104 and/or the ESC is eliminated, thus preventing a short circuit due to water ingress. Further, the connecting members 114 also enhances ease and speed of assembling the propulsion module 100 as the electric motor 104 can be preassembled with the ESC into a single unit.

[0024] According to an example embodiment, a propulsion system for a watercraft comprises a propulsion module 100. The propulsion module 100 comprises a waterjet 102. The propulsion module 100 also comprises an electric motor 104 configured to channel seawater through the waterjet 102. In use, the electric motor 104 is configured to be externally passively cooled by surrounding seawater. Further, the propulsion module 100 comprises an electronic speed controller (ESC) connected to the electric motor 104 and configured to control the electric motor 104. In use, the ESC is configured to be externally passively cooled by the surrounding seawater. The propulsion system also comprises a power module detachably attachable to the propulsion module 100. The power module is configured to provide electricity to the propulsion module 100.

[0025] FIG. 2 is a schematic representation of a power module 200, according to an example embodiment. The power module 200 can comprise any source of electric power. As a non-limiting example, the power module 200 can comprise a battery. The power module may comprise an ultra-lightweight carbon structure which can be configured to provide a light yet strong watertight case for the source of electric power and other components of the power module 200. The power module 200 may comprise one or more corrugated surfaces 202 configured to, in use, increase a contact surface area between the power module 200 and the surrounding seawater. For example, bottom and side surfaces of the power module 200 may be corrugated. Beneficially, the one or more corrugated surfaces 202 also allows high flow of seawater all around the bottom and side surfaces of the power module 200 when the watercraft is in the water. The ultra-lightweight carbon structure can be open at both ends, and can be closed and made watertight by a first endcap 203 and a second endcap 203'. The second endcap 203' can comprise dual gas pressure testing ports for testing watertightness of the propulsion module 200.

[0026] The power module 200 may comprise a first sensor 204 configured to detect that the power module 200 is attached to the propulsion module 100. The power module 200 may further comprise a second sensor 206 configured to detect that an external kill switch is attached to the power module 200. The first sensor 204 and the second sensor 206 may be hall sensors. According to one embodiment, a main power switch on a power management system may be closed and the power module 200 may only be live to deliver electrical power to the ESC only when the first sensor 204 detects that the power module 200 is attached to the propulsion module 100, and the second sensor 206 detects that an external kill switch is attached to the power module 200. Beneficially, safety of using the watercraft is enhanced. For example, once the user falls off a moving watercraft, electrical power to the watercraft would automatically be cut off.

[0027] In some implementations, the second sensor 206 may be disposed at the first endcap 203. Further, the power module 200 may comprise a plurality of first sensors 204 and/or second sensors 206. The power module 200 may also comprise a power level indicator 207 and a safety control board.

[0028] As mentioned above, the power module 200 can comprise a battery. The battery can be a Li-NMC cylindrical cell pack configured to withstand high operating temperatures. Further, a battery management system (BMS) can be provided for additional safety with multiple alarms and shut off levels.

[0029] When the power module 200 is locked in place in the watercraft, a socket of the power module 200 is fully engaged with power and/or communications pins of the watercraft. Removal of the power module 200 may require lifting the power module 200 while overcoming a frictional force between the pins and the socket. The removal of the power module 200 may be relatively easy to perform when the watercraft is new and the pins are clean. However, over time, exposure of the pins to marine environments, for example seawater, can cause surfaces of the pins to develop a layer of oxide. The layer of oxide can increase a frictional force between the pins and the socket, resulting in a need for a relatively greater force to remove the power module 200 from the watercraft.

[0030] The power module 200 may comprise a cam 208 attached to a handle 210 of the power module 200. In use, the cam 208 can push the power module 200 in a direction away from the propulsion module 100. Beneficially, the cam 208 provides improved ease when disengaging and detaching the power module 200 from the propulsion module 100 and removing the power module 200 from the watercraft. Safety of the user is also enhanced as the need to fit fingertips into small gaps to pry the power module 200 out of the watercraft is eliminated, hence preventing risk of the fingers being pinched.

[0031] FIG. 3 is a schematic representation of a hull module 300, according to an example embodiment. FIG. 4 is a schematic representation of a watercraft 400, according to an example embodiment. The watercraft 400 comprises the hull module 300. The watercraft 400 also comprises a propulsion module 100 detachably attachable to the hull module 300. The propulsion module 100 comprises a waterjet 102. The propulsion module 100 also comprises an electric motor 104 configured to channel seawater through the waterjet 102. In use, the electric motor 104 is configured to be externally passively cooled by surrounding seawater. Further, the propulsion module 100 comprises an electronic speed controller (ESC) connected to the electric motor 104 and configured to control the electric motor 104. In use, the ESC is configured to be externally passively cooled by the surrounding seawater. The watercraft 400 also comprises a power module 200 detachably attachable to the propulsion module 100. The power module 200 is configured to provide electricity to the propulsion module 100.

[0032] The hull module 300 may be designed to be hydrodynamically stable and agile for different user weights and different speeds of the watercraft 400. Bottom and sides of the hull module 300 may be shaped based on Computational Fluid Dynamics (CFD) analysis of computer models and/or full-scale real-life testing of prototypes. Beneficially, good balance and minimal roll at low speeds, and excellent manoeuvring at high speeds is achieved. The hull module 300 may be constructed by precision moulding layers of glass and carbon fibres over a moulded Expanded Polystyrene (EPS) foam core and thermoformed shapes that resemble shapes of the propulsion module 100 and the power module 200 to form cavities therein.

[0033] As shown in FIG. 3, the hull module 300 has a first cavity 302 formed therein, the first cavity 302 configured to receive the propulsion module 100, and wherein the hull module 300 has a second cavity 304 formed therein, the second cavity 304 configured to receive the power module 200. The first cavity 302 and the second cavity 304 can be on opposite sides of the hull module 300. As would be appreciated, in some implementations, the first cavity 302 and the second cavity 304 can be on the same side of the hull module 300.

[0034] A structure formed in the hull module 300 that defines the second cavity 304 may include wedges along its edges. Beneficially, the wedges act as a guide for the power module 200 such that the power module 200 can be self-centered while being inserted into the second cavity 304 and locked in place.

[0035] The propulsion module 100 can be designed for relatively simple installation of its components such as the electric motor 104 and allows waterflow to be directed to required parts of the propulsion module 100 and the power module 200 to ensure adequate external passive cooling of the propulsion module 100 and power module 200 by the seawater. The watercraft 400 may have gaps between the hull module 300 and the propulsion module 100. Advantageously, the gaps permit adequate amount of seawater to circulate past the electric motor 104 and the power module 200 to remove heat generated during operation. The gaps can also draw air bubbles trapped under the bottom of the watercraft 400, away from the waterjet 102, thereby increasing efficiency of the waterjet 102.

[0036] Referring to FIG. 3, the hull module 300 may have a front binder slot 306 formed therein. FIG. 5 is a schematic representation of a front binder 500, according to an example embodiment. Referring to FIG. 3 and FIG. 4, the front binder slot 306 may be configured to secure the front binder 500. The front binder 500 can have multiple functions. The front binder 500 may be configured to contain and conceal a receiver 502, such as a radio receiver. The receiver 502 may be configured to receive signals from a wireless controller. Beneficially, the receiver 502 is not exposed, thus the probability of the receiver 502 being damaged is reduced. The front binder 500 may also serve as a retaining tongue to hold the power module 200 in place when the power module 200 is installed in the hull module 300. The front binder 500 may comprise a power module securing interface 504. Advantageously, the front binder 500 prevents excessive movement of the power module 200 when the watercraft 400 is in motion. Further, the front binder 500 may serve as a base for a handle configured for operation and handling of the watercraft 400. The front binder 500 may comprise one or more handle securing points 506 that allow for concealed securing of the handle, while allowing the handle to be replaced when required by the user, without having to remove the front binder 500. The front binder 500 may comprise one or more hull module mounting points 508 for securing the front binder 500 to the hull module 300. The front binder 500 may be configured such that all screws that secure the front binder 500 in place can be accessed without the need for special tools. Beneficially, the front binder 500 can be easily removed and replaced by the user when required.

[0037] Referring to FIG. 3 and FIG. 4, the hull module 300 may comprise a deck pad 308 configured to provide traction when wet and also absorb impact from the user when in use. The hull module 300 may further comprise a traction pad disposed on the deck pad 308 to improve the user's barefoot grip on the deck pad 308. In some implementations, the traction pad may be disposed on an adjustable plate to form an assembled traction pad. The assembled traction pad can be fixed above the deck pad 308. Beneficially, the assembled traction pad is adjustable and can be swiveled and fixed in position according to a user's preference, thereby providing the user with additional support and control when riding the watercraft 400 barefooted.

[0038] Further, the hull module 300 may have one or more foot binding inserts formed in the deck pad 308. The power module 200 may also have one or more foot binding inserts formed therein. Foot bindings can be fixed to the foot binding inserts using screws or any other fixing means. The user can slip each foot into a respective foot binding to maintain full contact with the watercraft while riding. Beneficially, enhanced control is provided to the user. In addition, the one or more foot binding inserts of the power module 200 may be disposed at the handle 210 of the power module 200 (see FIG. 2). Advantageously, one or more foot bindings can be securely fitted over the handle 210 of the power module 200 so that users of all heights and weights can be accommodated on the watercraft 400.

[0039] Referring to FIG. 4, the watercraft 400 may further comprise a board endcap 406. The board endcap 406 can have multiple functions. The board endcap 406 can be fixed to one end of the propulsion module 100 and also fixed to a corresponding end of the hull module 300. As a non-limiting example, the board endcap 406 can be fixed to the propulsion module 100 and the hull module 300 using screws. Beneficially, the board endcap 406 improves securement of the propulsion module 100 to the hull module 300. Further, the board endcap 406 can act as a bumper when the user handles the watercraft 400 out of the water, particularly when the user stands the watercraft 400 vertically on the board endcap 406. Advantageously, the board endcap 406 protects the waterjet 102 and the hull module 300 from being damaged due to contact with hard surfaces such as rough floors or impact from being dropped on end. In addition, the board endcap 406 can extend the watercraft length to improve hydrodynamic performance and efficiency. Also, the board endcap 406 allows the user to quickly and easily replace the board endcap 406 when necessary. The board endcap 406 may comprise a sloped profile which advantageously protects the user from potential hard contact with relatively sharper edges of the hull module 300 when the user learns to ride the watercraft 400. In some implementations, the board endcap 406 may be made of high impact Acrylonitrile Butadiene Styrene (ABS). Advantageously, the board endcap 406 is resistant to UV and seawater exposure.

[0040] As shown in FIG. 3 and FIG. 4, the hull module 300 may comprise a plurality of fins 310 disposed at a bottom surface of the hull module 300 that faces the surrounding seawater. The plurality of fins 310 may be configured to provide traction when changing a direction of the watercraft 400 and/or when maintaining course stability of the watercraft 400 in a straight line. As would be appreciated, the plurality of fins 310 may comprise any number of fins 310 depending on the application for optimizing performance. For example, a pair of the fins 310 may be used. In some implementations, two pairs of the fins 310 may be used. The forward pair of the fins 310 may be positioned differently from the aft pair of the fins 310, to provide the user with a different riding experience. The positions of the fins 310 can be determined using CFD analysis and full-scale testing.

[0041] The watercraft 400 may further comprise a controller module. The controller module may comprise a wireless controller configured to transmit a signal to the ESC based on a user preference. As a non-limiting example, the user preference can comprise a speed level. In some implementations, the controller module may be configured to indicate a connection status between the controller module and the power module 200. Further, the controller module may indicate a remaining battery level of the wireless controller and/or the power module 200. The controller module may also comprise a wired receiver connected to the ESC. In some implementations, the controller module may be disposed in the propulsion system.

[0042] As mentioned above, the receiver 502 can be embedded in the front binder 500. The receiver 502 can be radiolucent. In some implementations, the receiver 502 can be disposed at a distance away from the propulsion module 100 and power module 200 to minimize electromagnetic interference (EMI), which may interfere with radio signals. The receiver 502 may have amplified sensors to maintain radio link with the wireless controller even when the watercraft 400 is momentarily underwater and also to overcome any stray EMI.

[0043] A receiver cable may pass through a receiver cable tunnel that can be disposed adjacent to the power module 200. Beneficially, the receiver cable tunnel provides separation of the receiver 502 from potential EMI from the power module 200. A watertight receiver connector may be disposed at the ESC. Advantageously, the receiver connector allows for easy replacement of the front binder 500 and/or the propulsion module 100.

[0044] The wireless controller can be configured to provide the user of any skill level an ability to control a power level of the watercraft 400 precisely to match his/her skill level, while incorporating necessary safety features. The wireless controller may be waterproof. Further, the wireless controller may comprise a built-in battery which can be charged via a watertight magnetic connector. The wireless controller can be used to control a throttle via a finger trigger, and can comprise two thumb buttons for increasing and/or decreasing the power level of the watercraft 400. The user can increase and/or decrease the power level of the watercraft 400 in small fixed increments, while on the move, without a need for mobile applications to change watercraft power settings. The graduated sensitivity of the throttle beneficially allows the user to finely adjust a throttle between power levels of the watercraft 400.

[0045] The wireless controller can also display a remaining power in the battery via a LED indicator. The LED indicator may change lights according to a remaining power in the battery. For example, green may indicate full battery level, orange may indicate medium battery level, and red may indicate low battery level. An LCD display may be provided to show the battery levels of the wireless controller and/or the watercraft 400 in clear and simple bars. The LCD display may also show the power level of the watercraft 400 and locked and/or unlocked status of the power module 200 in the watercraft 400. A solid, non-flashing light indicated on the wireless controller may show that the wireless controller is connected to the watercraft 400 and is ready for use.

[0046] FIG. 6 is a flowchart 600 illustrating an assembly method for a propulsion module for a watercraft, according to an example embodiment. At step 602, a waterjet is provided. At step 604, an electric motor configured to channel seawater through the waterjet is provided. The electric motor may also be configured to channel the seawater through a water intake grating. In use, the electric motor is configured to be externally passively cooled by surrounding seawater. At step 606, the electric motor is attached to the waterjet. At step 608, an electronic speed controller (ESC) configured to control the electric motor is provided. In use, the ESC is configured to be externally passively cooled by the surrounding seawater. At step 610, the ESC is connected to the electric motor.

[0047] FIG. 7 is a flowchart 700 illustrating an assembly method for a propulsion system for a watercraft, according to an example embodiment. At step 702, a propulsion module is provided. The propulsion module comprises a waterjet. The propulsion module also comprises an electric motor configured to channel seawater through the waterjet. The electric motor may also be configured to channel the seawater through a water intake grating. In use, the electric motor is configured to be externally passively cooled by surrounding seawater. Further, the propulsion module comprises an electronic speed controller (ESC) connected to the electric motor and configured to control the electric motor. In use, the ESC is configured to be externally passively cooled by the surrounding seawater. At step 704, a power module is attached to the propulsion module. The power module is configured to provide electricity to the propulsion module.

[0048] FIG. 8 is a flowchart 800 illustrating an assembly method for a watercraft, according to an example embodiment. At step 802, a hull module is provided. At step 804, a propulsion module is attached to the hull module. The propulsion module comprises a waterjet. The propulsion module also comprises an electric motor configured to channel seawater through the waterjet. The electric motor may also be configured to channel the seawater through a water intake grating. In use, the electric motor is configured to be externally passively cooled by surrounding seawater. Further, the propulsion module comprises an electronic speed controller (ESC) connected to the electric motor and configured to control the electric motor. In use, the ESC is configured to be externally passively cooled by the surrounding seawater. At step 806, a power module is attached to the propulsion module. The power module is configured to provide electricity to the propulsion module.

[0049] It will be appreciated by a person skilled in the art that numerous variations and/or modifications may be made to the present invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. For example, parameters such as shape of the hull module may vary depending on the application for optimizing performance. The present embodiments are, therefore, to be considered in all respects to be illustrative and not restrictive.

Claims

1. A propulsion module for a watercraft, comprising:

a waterjet;
an electric motor configured to channel seawater through the waterjet, wherein in use, the electric motor is configured to be externally passively cooled by surrounding seawater; and
an electronic speed controller (ESC) connected to the electric motor and configured to control the electric motor, wherein in use, the ESC is configured to be externally passively cooled by the surrounding seawater.

2. The propulsion module of claim 1, wherein the electric motor is a brushless direct current (BLDC) sensored motor.

3. The propulsion module of claim 1 or 2, wherein the electric motor comprises a hollow member disposed along a rotational axis of a rotor of the electric motor, and wherein in use, the electric motor is configured to be further passively cooled by the surrounding seawater channeled through the hollow member by a centrifugal force created by the electric motor.

4. The propulsion module of any one of the preceding claims, wherein the ESC comprises electrical components housed in an ESC casing, and wherein the electrical components are in thermal contact with an inner surface of the ESC casing.

5. The propulsion module of any one of the preceding claims, further comprising a connecting member attached to the ESC and the electric motor, wherein the connecting member is watertight and houses wires connecting the ESC and the electric motor.

6. A propulsion system for a watercraft, comprising:

a propulsion module, wherein the propulsion module comprises:

a waterjet;
an electric motor configured to channel seawater through the waterjet, wherein in use, the electric motor is configured to be externally passively cooled by surrounding seawater; and
an electronic speed controller (ESC) connected to the electric motor and configured to control the electric motor, wherein in use, the ESC is configured to be externally passively cooled by the surrounding seawater; and

a power module detachably attachable to the propulsion module, wherein the power module is configured to provide electricity to the propulsion module.

7. The propulsion system of claim 6, wherein the power module comprises one or more corrugated surfaces configured to, in use, increase a contact surface area between the power module and the surrounding seawater.

8. The propulsion system of claim 6 or 7, wherein the power module comprises a first sensor configured to detect that the power module is attached to the propulsion module.

9. The propulsion system of claim 8, wherein the power module further comprises a second sensor configured to detect that an external kill switch is attached to the power module.

10. The propulsion system of any one of claims 6 to 9, wherein the power module comprises a cam attached to a handle of the power module, and wherein in use, the cam pushes the power module in a direction away from the propulsion module.

11. A watercraft, comprising:

a hull module;
a propulsion module detachably attachable to the hull module, wherein the propulsion module comprises:

a waterjet;

an electric motor configured to channel seawater through the waterjet, wherein in use, the electric motor is configured to be externally passively cooled by surrounding seawater; and
an electronic speed controller (ESC) connected to the electric motor and configured to control the electric motor, wherein in use, the ESC is configured to be externally passively cooled by the surrounding seawater; and

a power module detachably attachable to the propulsion module, wherein the power module is configured to provide electricity to the propulsion module.

12. The watercraft of claim 11, wherein the hull module has a first cavity formed therein, the first cavity configured to receive the propulsion module, and wherein the hull module has a second cavity formed therein, the second cavity configured to receive the power module.

13. The watercraft of claim 12, wherein the first cavity and the second cavity are on opposite sides of the hull module.

14. The watercraft of any one of claims 11 to 13, wherein the hull module comprises a plurality of fins disposed at a bottom surface of the hull module that faces the surrounding seawater, and wherein the plurality of fins is configured to provide traction.

15. The watercraft of any one of claims 11 to 14, further comprising a controller module, wherein the controller module comprises a wireless controller configured to transmit a signal to the ESC based on a user preference.

16. The watercraft of claim 15, wherein the user preference comprises a speed level.

17. The watercraft of claim 15 or 16, wherein the controller module is configured to indicate a connection status between the controller module and the power module.

18. An assembly method for a propulsion module for a watercraft, comprising:

providing a waterjet;
providing an electric motor configured to channel seawater through the waterjet, wherein in use, the electric motor is configured to be externally passively cooled by surrounding seawater;
attaching the electric motor to the waterjet;
providing an electronic speed controller (ESC) configured to control the electric motor, wherein in use, the ESC is configured to be externally passively cooled by the surrounding seawater; and
connecting the ESC to the electric motor.

19. An assembly method for a propulsion system for a watercraft, comprising:

providing a propulsion module, wherein the propulsion module comprises:

a waterjet;
an electric motor configured to channel seawater through the waterjet, wherein in use, the electric motor is configured to be externally passively cooled by surrounding seawater; and
an electronic speed controller (ESC) connected to the electric motor and configured to control the electric motor, wherein in use, the ESC is configured to be externally passively cooled by the surrounding seawater; and

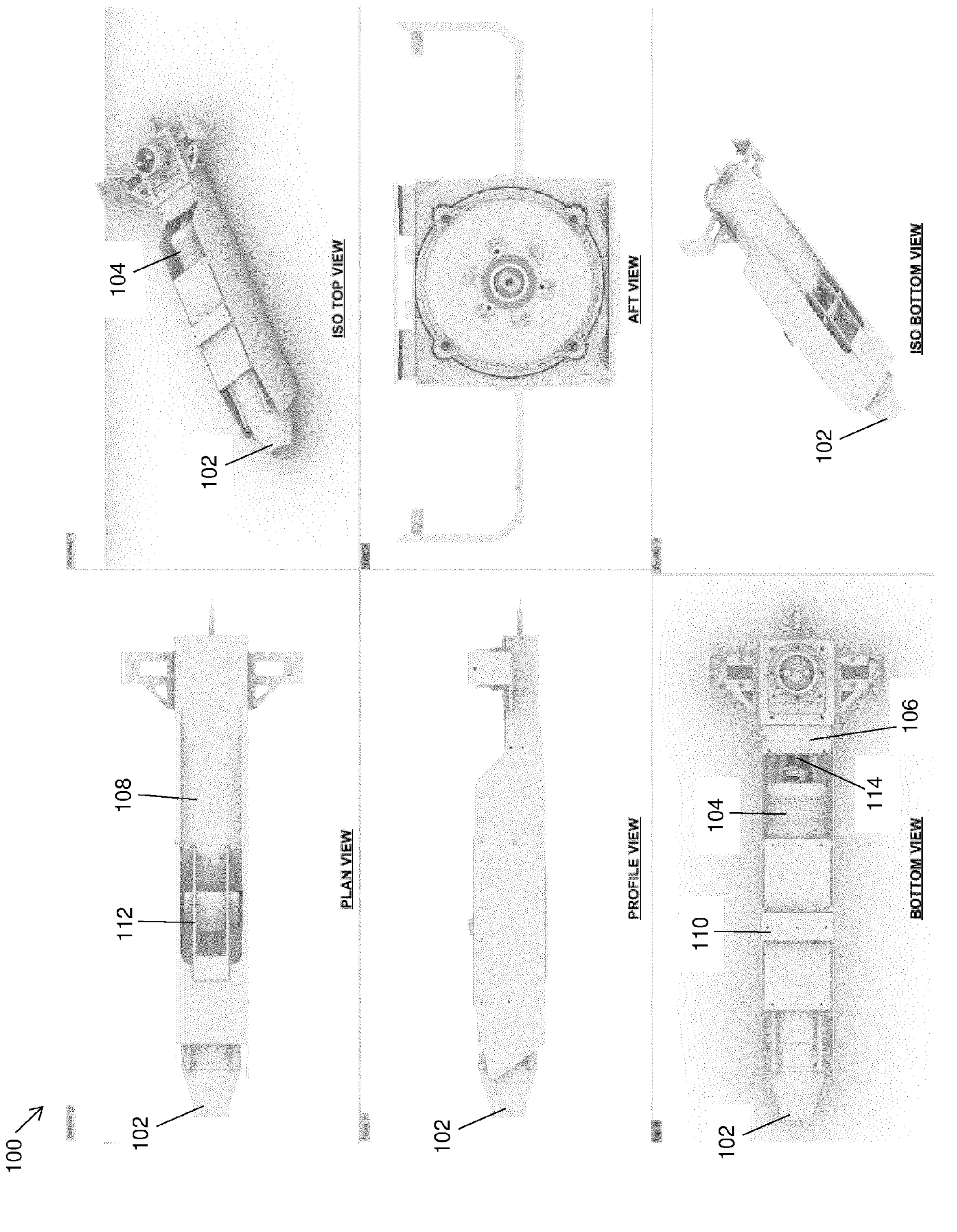
attaching a power module to the propulsion module, wherein the power module is configured to provide electricity to the propulsion module.

20. An assembly method for a watercraft, comprising:

providing a hull module;
attaching a propulsion module to the hull module, wherein the propulsion module comprises:

a waterjet;
an electric motor configured to channel seawater through the waterjet, wherein in use, the electric motor is configured to be externally passively cooled by surrounding seawater; and
an electronic speed controller (ESC) connected to the electric motor and configured to control the electric motor, wherein in use, the ESC is configured to be externally passively cooled by the surrounding seawater; and

attaching a power module to the propulsion module, wherein the power module is configured to provide electricity to the propulsion module.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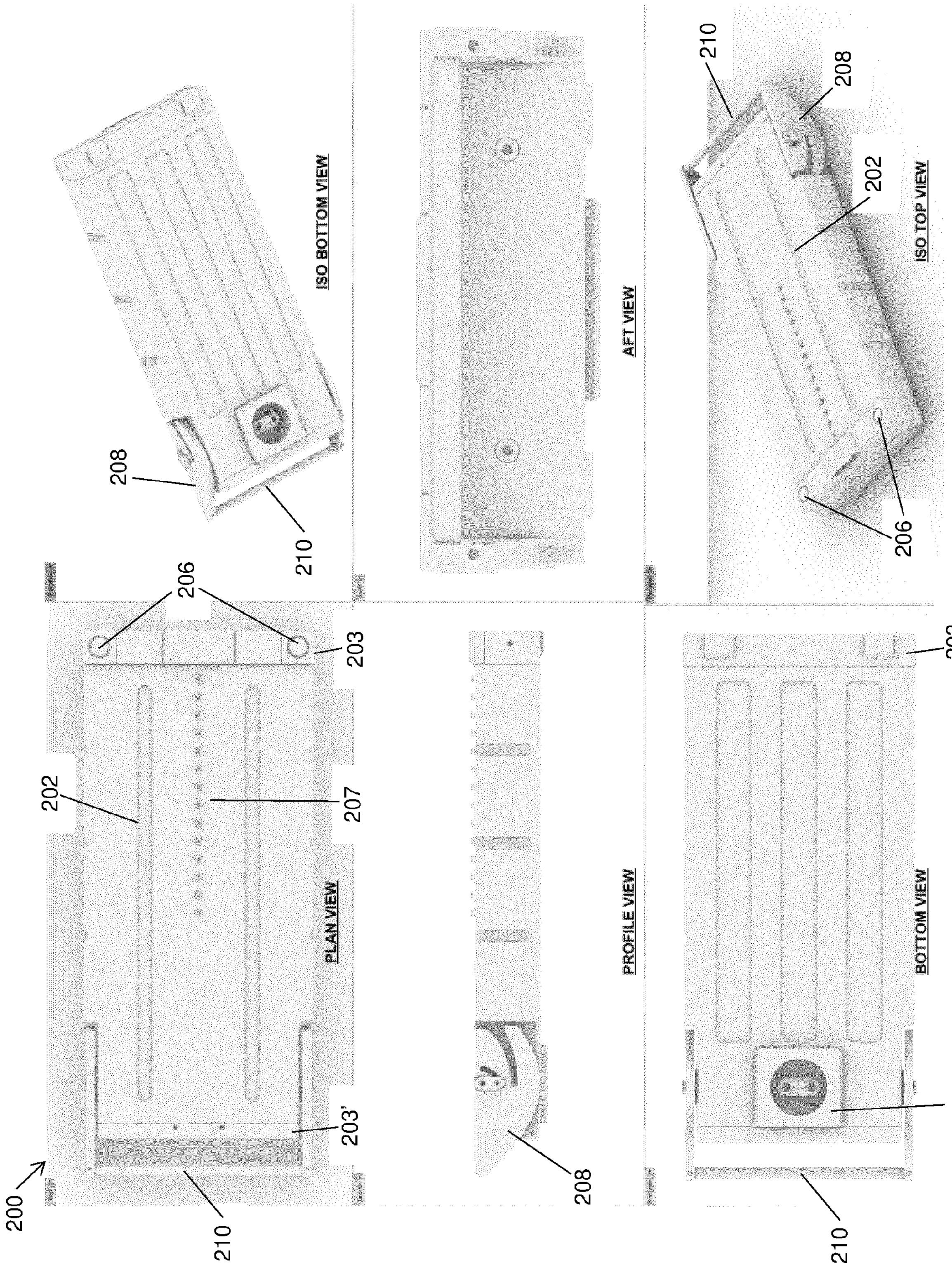
ISO BOTTOM VIEW

FIG. 1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ISO TOP VIEW

FIG. 2

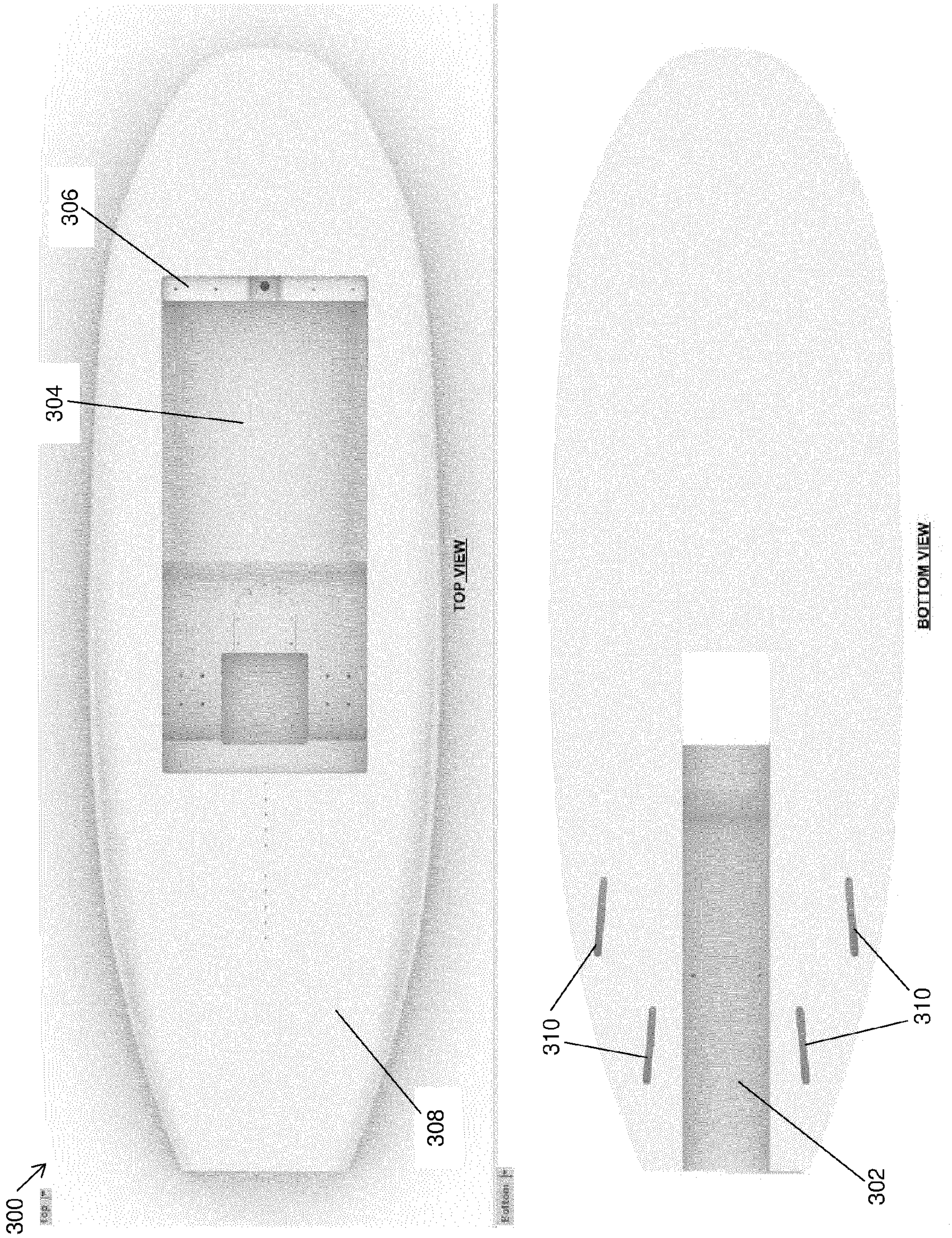

FIG. 3

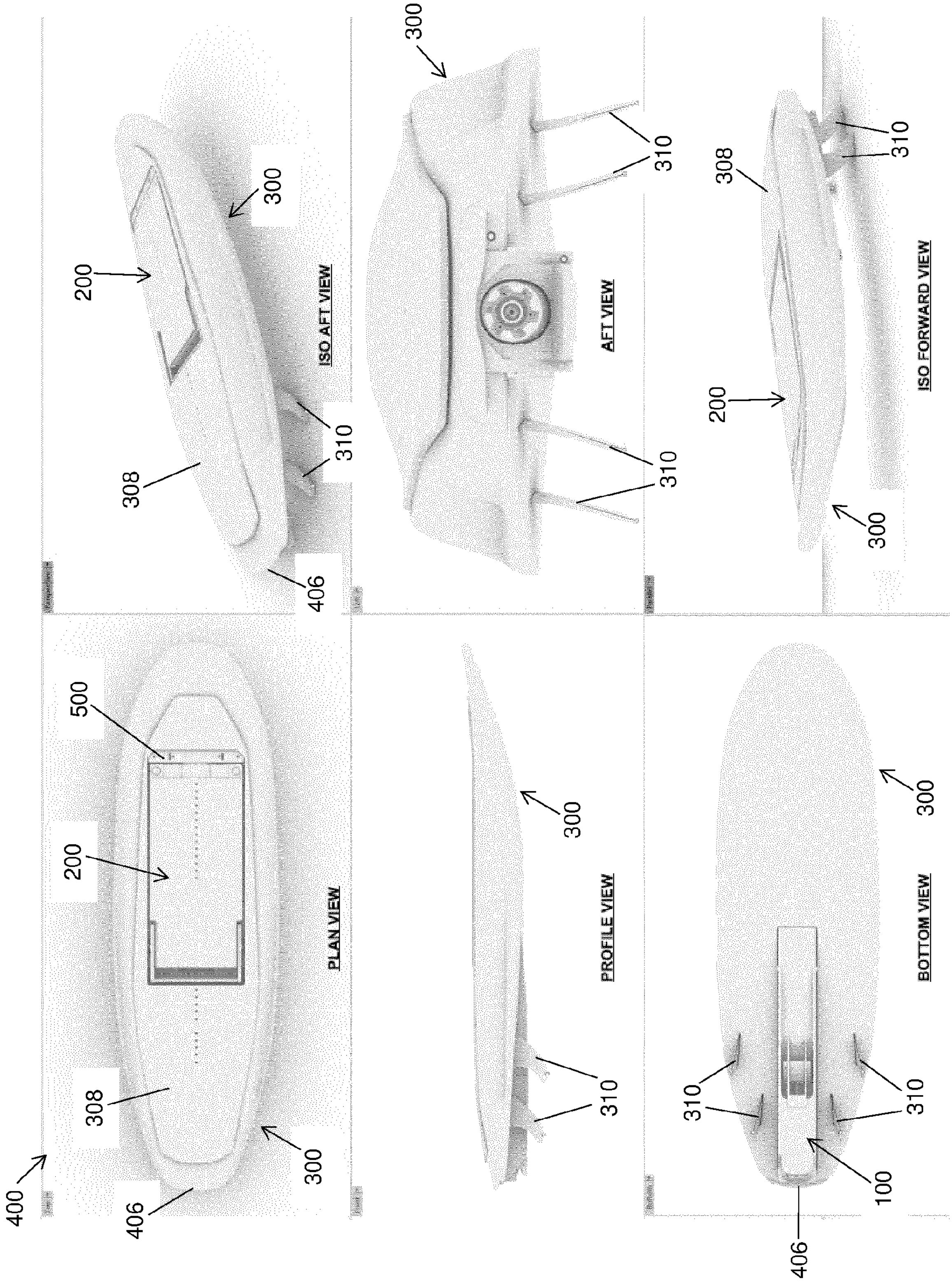
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FIG. 4

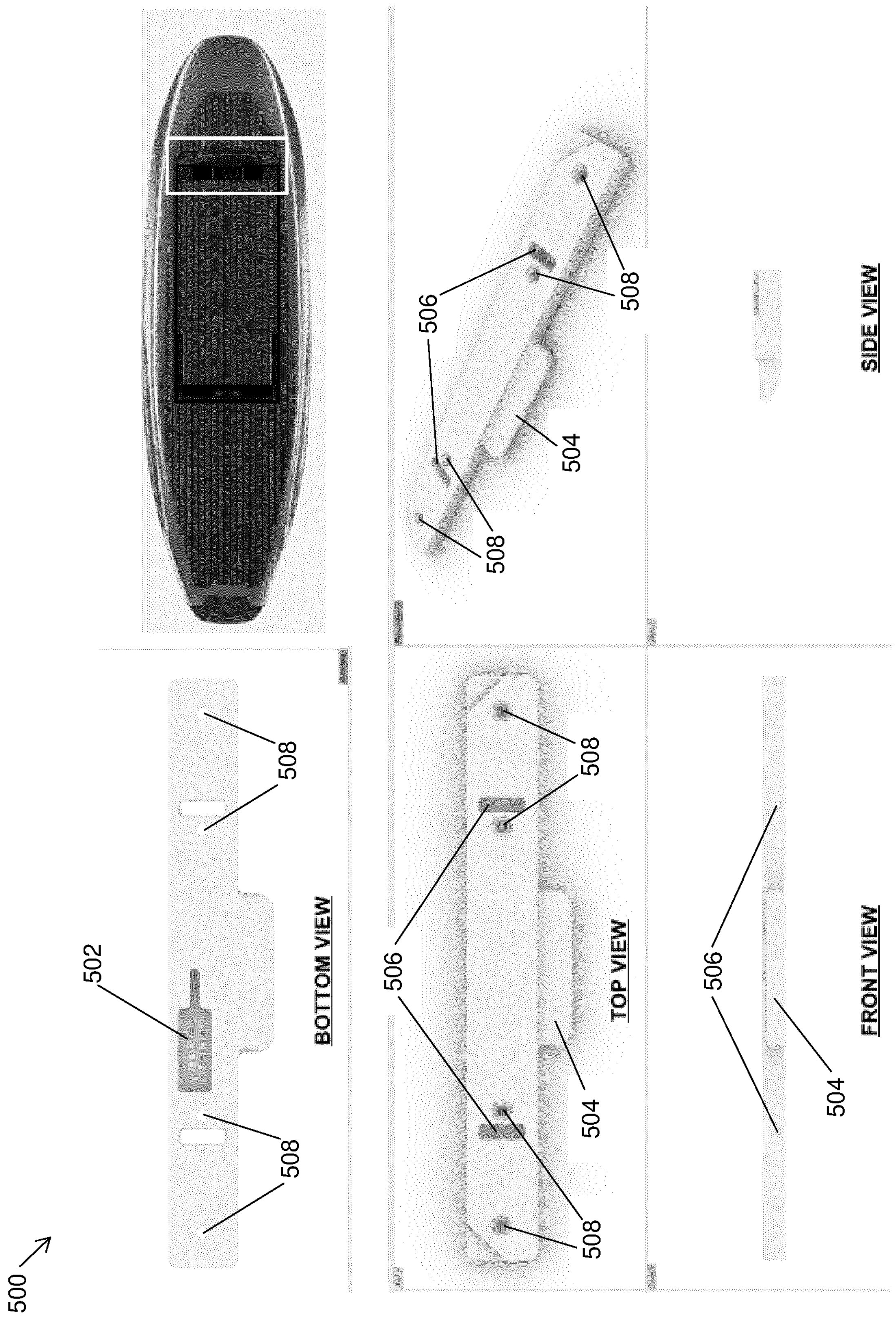

FIG. 5

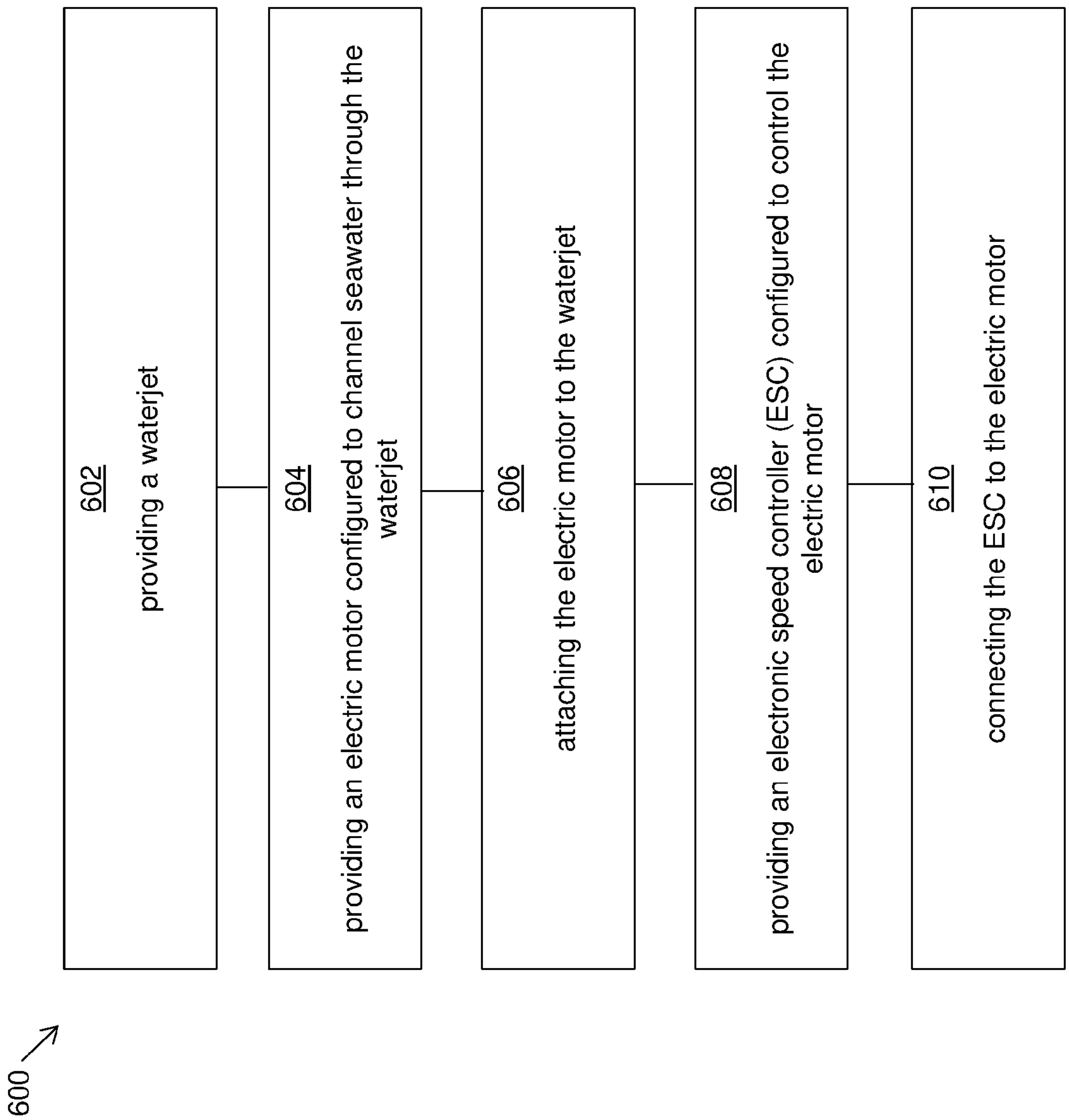
600
602
providing a waterjet
604
providing an electric motor configured to channel seawater through the waterjet
606
attaching the electric motor to the waterjet
608
providing an electronic speed controller (ESC) configured to control the electric motor
610
connecting the ESC to the electric motor

FIG. 6

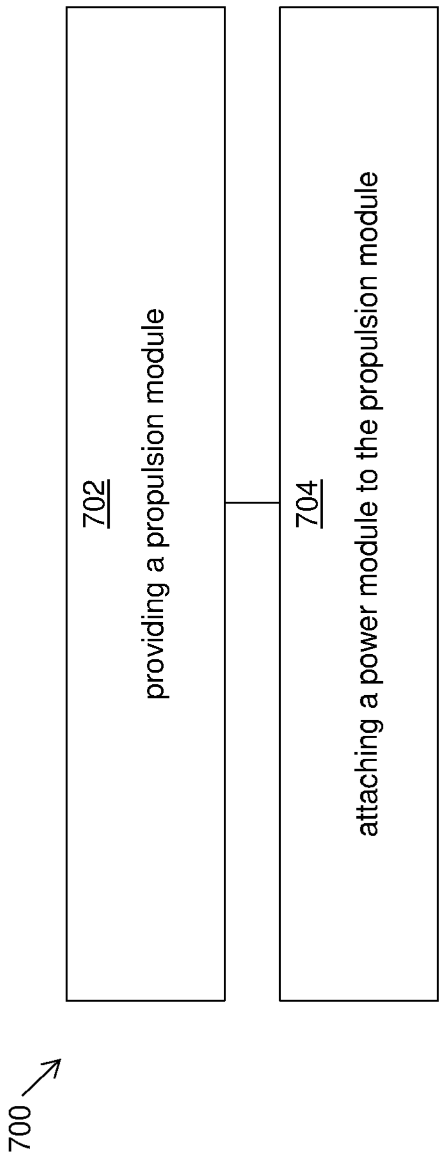
700
702
providing a propulsion module
704
attaching a power module to the propulsion module

FIG. 7

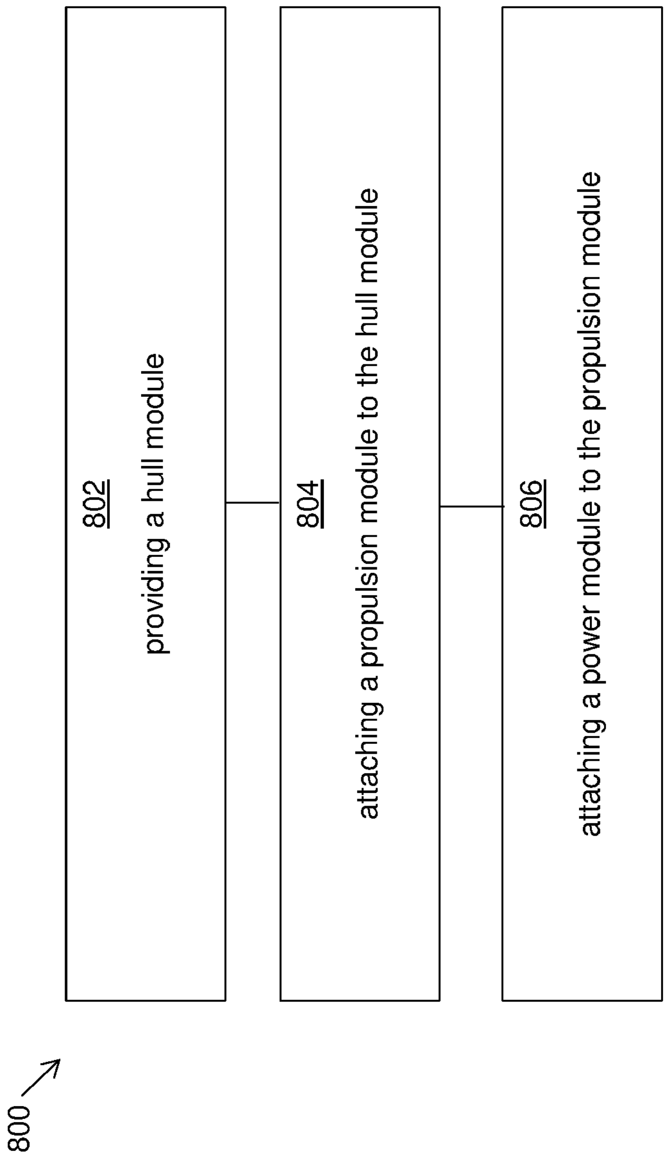
800
802
providing a hull module
804
attaching a propulsion module to the hull module
806
attaching a power module to the propulsion module

FIG. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 24 17 7744

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
The Hague	19 November 2024	Barré, Vincent

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EUROPEAN SEARCH REPORT

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The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
The Hague	19 November 2024	Barré, Vincent

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