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(54) **POWER SYSTEM FOR HYDROFOIL BOARD, AND ELECTRIC HYDROFOIL BOARD**

(57) Disclosed are a power system for a hydrofoil board and an electric hydrofoil board. The system includes: a mast assembly and a power assembly, where a first end of the mast assembly is provided with a first connection portion; the power assembly includes a fuselage, with a front hydrofoil and a rear hydrofoil provided at two ends of the fuselage, and a connection slot is provided on the fuselage; and the connection slot is provided as a through slot, and the first connection portion is configured to be removably inserted into the connection slot in a plug-in manner, with two ends of the first connection portion tightly abutted against two sides of the connection slot. The present application achieves the purpose of providing upward lift force through the front hydrofoil and the rear hydrofoil at the two ends of the fuselage

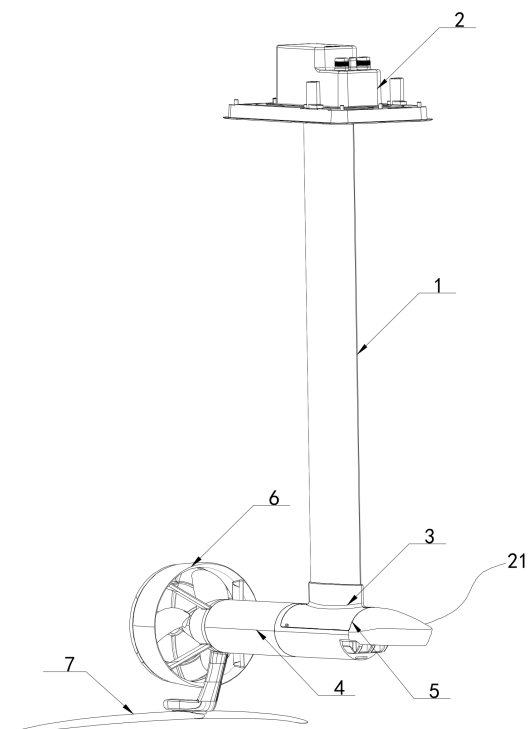


Fig. 1

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## Description

### TECHNICAL FIELD

**[0001]** The present application relates to the technical field of hydrofoil boards, and particularly to a power system for a hydrofoil board.

### BACKGROUND

**[0002]** Currently, for powered hydrofoil boards, power wires and signal wires of a power portion are connected to the main control board of the mast portion through soldering or transfer connections, making assembly and disassembly with the mast portion difficult. To facilitate assembly and disassembly for use, in related technologies, the power portion and the mast portion are provided as separate structures, mounting slots are provided on the power portion or the mast portion to connect the other part, and connectors are arranged in the mounting slots to achieve electrical connection. However, since the power portion needs to operate underwater for long periods and is subject to complex forces, simply using mounting slots to connect the two parts results in insufficient connection stability, so additional locking components (such as screws) are required to increase connection stability, still making assembly and disassembly relatively inconvenient.

### SUMMARY

**[0003]** A main objective of the present application is to provide a power system for a hydrofoil board to solve the problem of being difficult to assemble and disassemble the mast portion and the power portion of the hydrofoil board in related technologies.

**[0004]** To achieve the above objective, the present application provides a power system for a hydrofoil board, which includes: a mast assembly and a power assembly; where

a first end of the mast assembly is provided with a first connection portion;  
the power assembly includes a fuselage, with a front hydrofoil and a rear hydrofoil provided at two ends of the fuselage, and a connection slot is provided on the fuselage;  
the connection slot is provided as a through slot, and the first connection portion is configured to be removably inserted into the connection slot in a plug-in manner, with sidewalls of the connection slot tightly abutted against two ends of the first connection portion, and the connection slot is configured to inwardly squeeze and clamp the first connection portion under the lift force of the front hydrofoil and the rear hydrofoil.

**[0005]** Further, the second electrical connector and the

first electrical connector are configured to be electrically connected in a plug-in manner.

**[0006]** Further, the fuselage is provided therein with an electronic speed controller assembly located at the bottom of the connection slot, and the second electrical connector is electrically connected to the electronic speed controller assembly.

**[0007]** Further, the electronic speed controller assembly includes an electronic speed controller board, which is perpendicular to the mast assembly, and the second electrical connector is vertically fixed on the electronic speed controller board and has an electrical connection to the electronic speed controller board;  
the first electrical connector and the second electrical connector are oppositely arranged.

**[0008]** Further, the first connection portion is further provided with a retention groove, and the connection slot is provided with a retention protrusion removably engaged in the retention groove.

**[0009]** Further, mounting portions located above the electronic speed controller board are provided at two sides of the connection slot; and  
the first connection portion is fixedly connected to the mounting portion by screws.

**[0010]** Further, the first connection portion is provided with a first plastic piece, and the connection slot is provided with a second plastic piece, and the second electrical connector is located in the second plastic piece, and the first electrical connector is located in the first plastic piece;

the first plastic piece is provided with a first plug-in portion, and the second plastic piece is provided with a second plug-in portion, a docking portion of the second electrical connector is located in the second plug-in portion, and a docking portion of the first electrical connector is located in the first plug-in portion, the second plug-in portion and the first plug-in portion are in plug-in cooperation, and the docking portion of the second electrical connector and the docking portion of the first electrical connector are in plug-in cooperation; and

**[0011]** A sealing ring is provided between the second plug-in portion and the first plug-in portion.

**[0012]** Further, end faces of the second plastic piece and the first plastic piece abut against each other, and a sealing gasket is embedded at the abutment, and the sealing gasket is arranged around the second plug-in portion.

**[0013]** Further, the connection slot is provided with a mounting plate, and the mounting plate is provided with a second mounting hole, and the second plastic piece is fixedly installed in the second mounting hole; and  
the second mounting hole is provided with an adhesive injection groove at an end facing the first plastic piece, and the adhesive injection groove is filled with sealing adhesive to seal a connection between the second mounting hole and the second plastic piece.

**[0014]** Further, the first connection portion is provided with a first mounting hole, and the first plastic piece

is provided with a connection hole corresponding to the first mounting hole, and a positioning pin is provided in the connection hole; the diameter of the positioning pin is smaller than the inner diameter of the connection hole, and two ends of the positioning pin pass through the connection hole and are provided with buffer pads, which abut against two sides of the first plastic piece; an end, away from the second plastic piece, of the positioning pin is fixedly connected to the first connection portion.

**[0015]** Further, the power assembly further includes a temperature sensor provided close to the second electrical connector to detect the temperature at a connection between the second electrical connector and the first electrical connector.

**[0016]** Further, the power assembly further includes a current/voltage detection module configured to detect current and voltage of the second electrical connector and the first electrical connector.

**[0017]** Further, the power assembly further includes a position detection sensor provided on the fuselage and/or the mast assembly to detect the relative position between the second electrical connector and the first electrical connector.

**[0018]** Further, the power system further includes a main control system and a power supply system, where the main control system and the power supply system are in electrical connection, and the main control system is electrically connected to the electronic speed controller assembly through the second electrical connector and the first electrical connector.

**[0019]** Further, the power system for a hydrofoil board further includes an attitude detection sensor configured to detect an attitude of the board body, and when the attitude of the board body is in a preset attitude, the attitude detection sensor sends an electrical signal to the main control system, and the main control system controls the power supply system to cut off power after receiving the electrical signal.

**[0020]** Further, the power assembly further includes a position detection sensor provided on the fuselage and/or the mast assembly to detect the relative position between the second electrical connector and the first electrical connector;

when the relative position between the second electrical connector and the first electrical connector is in a preset position, the position detection sensor sends an electrical signal to the main control system, and the main control system controls a power supply system to cut off power after receiving the electrical signal.

**[0021]** According to another aspect of the present application, an electric hydrofoil board is provided, which includes a board body and the above-mentioned power system, and a second end of the mast assembly is removably connected to the board body through a second connection portion.

**[0022]** In the embodiments of the present application, by providing a mast assembly and a power assembly, a first connection portion is provided at a first end of the mast assembly, the power assembly includes a fuselage, with a front hydrofoil and a rear hydrofoil provided at two ends of the fuselage, and a connection slot is provided on the fuselage, the connection slot is provided as a through slot, and the first connection portion is configured to be removably inserted into the connection slot in a plug-in manner; two ends of the first connection portion tightly abutted against two sides of the connection slot, and the connection slot is configured to inwardly squeeze and clamp the first connection portion under the lift force of the front hydrofoil and the rear hydrofoil, achieving an objective that when the mast assembly and the fuselage are engaged in a plug-in manner through the first connection portion and the connection slot, during use, the front hydrofoil and the rear hydrofoil at two ends of the fuselage provide upward lift force, and since the connection slot is a through slot, two sides of the connection slot will squeeze upward against two ends of the first connection portion, so that the first connection portion is stably fixed in the connection slot, thereby realizing the technical effect of facilitating the assembly and disassembly of the mast assembly and the power assembly while ensuring sufficient connection stability, and further solving the problem of being difficult to assemble and disassemble the mast portion and the power portion of the hydrofoil board in related technologies.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0023]** The accompanying drawings, which are included to provide a further understanding of the present application and are incorporated in and constitute a part of the present application, illustrate embodiments of the present application and together with the description explain the principles of the present application. The drawings and their description illustrate exemplary embodiments of the present application, and are not to be construed as limiting the present application. In the drawings:

Fig. 1 is a schematic diagram of an assembly structure according to an embodiment of the present application;

Fig. 2 is a schematic diagram of an exploded structure according to an embodiment of the present application;

Fig. 3 is a schematic diagram of a partially enlarged structure of a fuselage according to an embodiment of the present application;

Fig. 4 is a schematic diagram of a partially sectional structure according to an embodiment of the present application; and

Fig. 5 is a schematic diagram of a partially enlarged structure according to Fig. 4;

where 1 mast assembly, 2 main control system, 3 first connection portion, 4 fuselage, 5 connection slot, 6 propeller, 7 rear hydrofoil, 8 first plastic piece, 81 first plug-in portion, 9 positioning pin, 10 buffer pad, 11 mounting plate, 12 second plastic piece, 121 second plug-in portion, 1211 sealing groove, 14 mounting portion, 15 second electrical connector, 16 adhesive injection groove, 17 sealing gasket, 18 first electrical connector, 19 sealing ring, 20 electronic speed controller board, 21 power assembly, 22 second connection portion, 23 second mounting hole.

## DETAILED DESCRIPTION OF THE EMBODIMENTS

[0024] To enable a person skilled in the art to better understand the solutions of the present application, the technical solutions in the embodiments of the present application will be clearly and completely described below with reference to the accompanying drawings in the embodiments of the present application. Apparently, the described embodiments are merely some rather than all of the embodiments of the present application. All other embodiments obtained by a person skilled in the art based on the embodiments of the present application without creative efforts shall fall within the scope of protection of the present application.

[0025] It should be noted that the terms "first", "second" and the like in the specification and claims of the present application and the aforesaid accompanying drawings are used to distinguish similar objects, and are not necessarily used to describe a specific order or sequence. It should be understood that the data used in such a manner are interchangeable under appropriate circumstances to implement the embodiments of the present application described herein.

[0026] In the present application, the terms "upper", "lower", "inner" and the like indicate an orientation or positional relationship based on the orientation or positional relationship shown in the accompanying drawings. These terms are mainly intended to facilitate better description of the present application and its embodiments, and are not intended to limit that the indicated devices, elements or components must be constructed or operated in a specific orientation.

[0027] In addition to indicating an orientation or positional relationship, some of the aforesaid terms may also have other meanings. For example, the term "upper" may indicate a certain dependency or connection relationship in some cases. For a person skilled in the art, the specific meanings of these terms in the present application can be understood according to specific circumstances.

[0028] Furthermore, the terms "arrange", "be provided with", "connect" and "fix" shall be understood in a broad sense. For example, "connect" may refer to a fixed connection, a detachable connection or an integral structure; it may refer to a mechanical connection or an electrical connection; it may refer to a direct connection, an indirect connection through an intermediate medium, or internal

communication between two devices, elements or components. For a person skilled in the art, the specific meanings of the above terms in the present application can be understood according to specific circumstances.

[0029] In addition, the term "plurality" as used herein shall mean two or more.

[0030] It should be noted that the embodiments of the present application and the features thereof may be combined with each other without conflict. The present application will be described in detail below with reference to the accompanying drawings and in conjunction with the embodiments.

[0031] To facilitate assembly and disassembly for use, in related technologies, the power portion and the mast portion are provided as separate structures, mounting slots are provided on the power portion or the mast portion to connect the other part, and connectors are arranged in the mounting slots to achieve electrical connection. However, since the power portion needs to operate underwater for long periods and is subject to complex forces, simply using mounting slots to connect the two parts results in insufficient connection stability, so additional locking components (such as screws) are required to increase connection stability, still making assembly and disassembly relatively inconvenient.

[0032] To solve the above technical problem, as shown in FIGS. 1 to 5, an embodiment of the present application provides a power system for a hydrofoil board, which includes: a mast assembly 1 and a power assembly 21; where

a first connection portion 3 is provided at a first end of the mast assembly 1, and the first connection portion 3 is provided with a first electrical connector 18; the power assembly 21 includes a fuselage 4, with a front hydrofoil (not shown in the drawings) and rear hydrofoil 7 provided at two ends of the fuselage 4, and a connection slot 5 is provided on the fuselage 4, and the connection slot 5 is provided therein with a second electrical connector 15; the connection slot 5 is provided as a through slot, and the first connection portion 3 is configured to be removably inserted into the connection slot in a plug-in manner; two ends of the first connection portion 18 tightly abutted against two sides of the connection slot 15; two ends of the first connection portion 3 tightly abutted against two sides of the connection slot 5.

[0033] In the present embodiment, the power system cooperates with a board body to form an electric hydrofoil board. The power system mainly includes a mast assembly 1 and a power assembly 21. The mast assembly 1 is approximately of a vertical bar structure, with its upper end connected to the board body and its lower end connected to the power assembly 21. The main structure of the power assembly 21 is the fuselage 4, with a front hydrofoil and a rear hydrofoil 7 arranged at two ends of

the fuselage 4. When used as an electric hydrofoil board, the fuselage 4 is provided with a motor and a propeller 6, and the propeller 6 is located close to the rear hydrofoil 7. The motor drives the propeller 6 to rotate to provide thrust, so that the front hydrofoil and the rear hydrofoil 7 generate lift under the action of water flow.

**[0034]** To facilitate carrying and use, in the present embodiment, the mast assembly 1 and the power assembly 21 are removably connected. Specifically, as shown in FIGS. 2 and 3, by providing a connection slot 5 on the fuselage 4 and providing a first connection portion 3 at a lower end of the mast assembly 1, and cooperating the first connection portion 3 with the connection slot 5 in a plug-in manner. During mounting, the first connection portion 3 is inserted into the connection slot 5. To enable the mast assembly 1 and the fuselage 4 to have sufficient connection stability after connection while reducing the mounting of additional locking components, in the present embodiment, the connection slot 5 is provided as a through slot, and the front hydrofoil and the rear hydrofoil 7 are arranged at two ends of the fuselage 4. It should be noted that the connection slot 5 being a through slot in the present embodiment means that the connection slot 5 is of an open structure in the width direction and has sidewalls that cooperate with two ends of the first connection portion 3 in the length direction.

**[0035]** The purpose of arranging the front hydrofoil and the rear hydrofoil 7 at two ends of the fuselage 4 is to enable the fuselage 4 to generate a certain deformation upward by using the lift force provided by the front hydrofoil and the rear hydrofoil 7, and this deformation will act on two sides of the connection slot 5, so that two sides of the connection slot 5 squeeze inward against two ends of the first connection portion 3. The purpose of setting the connection slot 5 as a through slot is to make it easier for the connection slot 5 to squeeze the first connection portion 3 inward under the action of the lift force. If the connection slot 5 is a recessed groove enclosed on all sides, it is not conducive to the deformation of the connection slot 5. Moreover, even if deformation occurs, during the deformation process, two sides of the connection slot 5 in the length direction will squeeze inward against the first connection portion 3, but two sides in the width direction will separate from the first connection portion 3 due to the squeezing force, and it will be difficult for two sides in the width direction to recover after deformation, resulting in a decrease in the connection strength between the first connection portion 3 and the connection slot 5.

**[0036]** Therefore, in the present embodiment, the connection slot 5 is provided as a through slot, and the lift force generated by the front hydrofoil and the rear hydrofoil 7 arranged at two ends of the fuselage 4 is utilized to press the first connection portion 3, thereby improving the connection strength between the mast assembly 1 and the fuselage 4. Due to the improved connection strength, it is possible to consider not using additional locking

components or reducing the number of locking components used after mounting, facilitating assembly and disassembly.

**[0037]** Generally, in addition to the motor, an electronic speed controller portion for controlling the motor operation is also arranged inside the fuselage 4, and the power supply portion and the main control portion for the motor are installed inside the mast assembly 1 or the board body. Since the board body has a relatively large area, the power supply portion is preferably installed inside the board body to ensure endurance, while the main control portion can be installed at a location selected according to actual design.

**[0038]** Since the mast assembly 1 and the fuselage 4 are removably connected, it is necessary to simultaneously achieve the electrical connection between the electronic devices inside the mast assembly 1 and those inside the fuselage 4 during connection and disconnection. For this purpose, as shown in FIGS. 2 to 4, in the present embodiment, a first electrical connector 18 is provided inside the first connection portion 3, and correspondingly, a second electrical connector 15 is provided inside the connection slot 5. The first electrical connector 18 is electrically connected to the electronic devices inside the mast assembly 1, specifically through cable connection or welding, and the second electrical connector 15 is electrically connected with the electronic devices inside the fuselage 4, specifically through cable connection or welding. The first electrical connector 18 and the second electrical connector 15 can be connected in a male-female terminal plug-in manner or using contact connection. Since the first connection portion 3 and the connection slot 5 are connected in a plug-in manner, both male-female terminal plug-in and contact connection can be used to simultaneously achieve electrical connection between the first electrical connector 18 and the second electrical connector 15. To further improve the connection stability between the mast assembly 1 and the fuselage 4, as well as the connection stability between the first electrical connector 18 and the second electrical connector 15, a plug-in method is preferred between the two electrical connectors.

**[0039]** In one implementation, three first electrical connectors 18 and three second electrical connectors 15 are provided, where two of the first electrical connectors 18 serve as the positive or negative power terminals, and two of the second electrical connectors 15 serve as the negative or positive power terminals, while another first electrical connector 18 serves as a communication terminal, and correspondingly, another second electrical connector 15 also serves as a communication terminal. Among the above-mentioned terminals, the positive and negative power terminals can be connected in a male-female terminal plug-in manner, and the two communication terminals can also be connected in a male-female terminal plug-in manner. Of course, other non-wired connection methods, such as wireless Bluetooth connection, can also be used.

**[0040]** In the present embodiment, an objective is achieved that when the mast assembly 1 and the fuselage 4 are engaged in a plug-in manner through the first connection portion 3 and the connection slot 5, during use, the front hydrofoil and the rear hydrofoil 7 at two ends of the fuselage 4 provide upward lift force, and since the connection slot 5 is a through slot, two sides of the connection slot 5 will squeeze upward against two ends of the first connection portion 3, so that the first connection portion 3 is stably fixed in the connection slot 5, thereby realizing the technical effect of facilitating the assembly and disassembly of the mast assembly 1 and the power assembly 21 while ensuring sufficient connection stability, and further solving the problem of being difficult to assemble and disassemble the mast portion and the power portion of the hydrofoil board in related technologies.

**[0041]** To facilitate the control of the motor operation in the fuselage 4, an electronic speed controller assembly is disposed inside the fuselage 4 in the present embodiment. The electronic speed controller assembly is located at the bottom of the connection slot 5, and the second electrical connector 15 is electrically connected to the electronic speed controller assembly. In the present embodiment, since the second electrical connector 15 needs to be plugged-in the first electrical connector 18, the second electrical connector 15 needs to be arranged on a bottom surface of the connection slot 5. Since the electronic speed controller assembly needs to be electrically connected to the second electrical connector 15, to facilitate the connection between the electronic speed controller assembly and the second electrical connector 15 and reduce the connection path, the electronic speed controller assembly is arranged at the bottom of the connection slot 5 in the present embodiment, making it relatively close to the second electrical connector 15.

**[0042]** As shown in Fig. 5, the electronic speed controller assembly includes an electronic speed controller board 20, which is perpendicular to the mast assembly 1. The second electrical connector 15 is vertically fixed on the electronic speed controller board 20 and is electrically connected therewith, and the first electrical connector 18 and the second electrical connector 15 are oppositely arranged.

**[0043]** Specifically, it should be noted that the electronic speed controller board 20 is a PCB board for controlling the motor operation inside the fuselage 4, and positive and negative electrode and signal wire solder pads are arranged on the electronic speed controller board 20. To facilitate the connection of the second electrical connector 15 arranged along the plug-in direction to the electronic speed controller board 20, the electronic speed controller board 20 is arranged perpendicular to the mast assembly 1, so that the electronic speed controller board 20 is also perpendicular to the second electrical connector 15, and the second electrical connector 15 can be soldered onto the positive and negative

electrode and signal wire solder pads. Correspondingly, the first electrical connector 18 can be soldered and fixed at the corresponding position on the first connection portion 3, and the first electrical connector 18 can be connected to the main control board installed inside the mast assembly 1 through wires. In the present embodiment, the first electrical connector 18 can be a copper post male terminal or a copper post female terminal, and the second electrical connector 15 can be a copper post female terminal or a copper post male terminal.

**[0044]** Based on the plug-in between the first connection portion 3 and the connection slot 5, to further improve the connection stability with the lift force of the front hydrofoil and the rear hydrofoil 7, a retention groove (not shown in the drawings) is also provided on the first connection portion 3 in the present embodiment, and a retention protrusion (not shown in the drawings) is provided inside the connection slot 5. The retention protrusion is removably engaged in the retention groove. During the plug-in process of the first connection portion 3 and the connection slot 5, the first electrical connector 18 and the second electrical connector 15 are engaged, and at the same time, the retention protrusion is engaged in the retention groove. The squeezing force exerted by two sides of the connection slot 5 towards the middle of the connection slot 5 due to the upward lift force of the front hydrofoil and the rear hydrofoil 7 presses the retention protrusion tightly into the retention groove, thereby further improving the connection strength between the mast assembly 1 and the fuselage 4. Since a snap-fit method is used, no additional components are required for assembly and disassembly, making assembly and disassembly more convenient.

**[0045]** Based on the plug-in cooperation between the first connection portion 3 and the connection slot 5 and the engagement connection between the retention groove and the retention protrusion, to further enhance the connection strength between the mast assembly 1 and the fuselage 4, the mast assembly 1 and the fuselage 4 are connected by screws in the present embodiment. To reduce the number of screws used and balance the force at the connection, the screws are vertically installed into the first connection portion 3 and located in the middle of the first connection portion 3. Since the electronic speed controller board 20 is located at the bottom of the connection slot 5, the screws need to avoid occupying the mounting space of the electronic speed controller board 20 when vertically inserted.

**[0046]** For this purpose, as shown in FIGS. 3 and 4, mounting portions 14 are provided on two sides of the connection slot 5 in the present embodiment. The mounting portions 14 are located above the electronic speed controller board 20, and the first connection portion 3 is fixedly connected to the mounting portions 14 by screws. The mounting portions 14 located above the electronic speed controller board 20 provide mounting positions for the screws, so that when the screws are vertically screwed into the mounting portions 14, the lower ends

of the screws can still maintain sufficient connection strength without extending deep into the electronic speed controller board 20.

**[0047]** In one embodiment, the mounting portion 14 near the front hydrofoil can be a part of the fuselage 4, while the mounting portion 14 near the rear hydrofoil 7 can be an additional mounting platform installed inside the connection slot 5. The mounting platform can be connected to a sidewall of the connection slot 5 by screws.

**[0048]** In the present embodiment, a mounting platform is only additionally arranged near the rear hydrofoil 7 to form the mounting portion 14 on this side, since the fuselage 4 is provided with a propeller 6 near the rear hydrofoil 7, and the corresponding motor driving the propeller 6 is also installed near the rear hydrofoil 7. Therefore, the electronic speed controller board 20 electrically connected to the motor will also be relatively close to the rear hydrofoil 7. As a result, there is a lack of mounting space for the screws on the side of the connection slot 5 near the rear hydrofoil 7. Therefore, to avoid the electronic speed controller board 20 while providing sufficient connection strength, an additional mounting platform is installed on this side to install the screws in the present embodiment. At the same time, since there is a certain cavity between the first connection portion 3 and the connection slot 5 at this position, a mounting platform is arranged in this cavity to install the screws to improve space utilization.

**[0049]** To facilitate the mounting of the first electrical connector 18 and the second electrical connector 15, as shown in FIGS. 2 to 5, in the present embodiment, a first plastic piece 8 is provided inside the first connection portion 3, and a second plastic piece 12 is provided inside the connection slot 5. The second electrical connector 15 is located inside the second plastic piece 12, and the first electrical connector 18 is located inside the first plastic piece 8;

a first plug-in portion 81 is provided on the first plastic piece 8, a second plug-in portion 121 is provided on the second plastic piece 12, a docking portion of the second electrical connector 15 is located in the second plug-in portion 121, the docking portion of the first electrical connector 18 is located in the first plug-in portion 81, the second plug-in portion 121 and the first plug-in portion 81 are in plug-in cooperation, and the docking portion of the second electrical connector 15 and the docking portion of the first electrical connector 18 are in plug-in cooperation.

**[0050]** A sealing ring 19 is provided between the second plug-in portion 121 and the first plug-in portion 81.

**[0051]** Specifically, it should be noted that the first connection portion 3 has a mounting position for fixedly installing the first plastic piece 8, and the connection slot 5 also has a mounting position for installing the second plastic piece 12. A connection between the first plastic piece 8 and the first connection portion 3 as well as a connection between the second plastic piece 12 and the

connection slot 5 need to be performed sealing treatment. The first electrical connector 18 is installed inside the first plastic piece 8. Since the first electrical connector 18 needs to be connected to other electronic devices inside the mast assembly 1 through wires, the first connection portion 3 has a hole corresponding to the first electrical connector 18. Similarly, the first plastic piece 8 also needs to have a hole corresponding to the first electrical connector 18. The number of holes here is determined by the number of plugs on the first electrical connector 18.

**[0052]** To improve the connection sealing between the first electrical connector 18 and the second electrical connector 15 after plug-in, a lower end of the first plastic piece 8 in the present embodiment has a first docking portion 81, and the docking portion of the first electrical connector 18 for docking with the second electrical connector 15 is located inside the first plug-in portion 81. Similarly, an upper end of the first plastic piece 8 has a second plug-in portion 121, and the docking portion of the second electrical connector 15 for docking with the first electrical connector 18 is located inside the second plug-in portion 121. When the mast assembly 1 and the fuselage 4 are connected, the first plug-in portion 81 is plugged-in the second plug-in portion 121, and at the same time, the docking portion of the first electrical connector 18 is plugged-in the docking portion of the second electrical connector 15. At this time, the docking portions of the two connection ports are surrounded by the first plug-in portion 81 and the second plug-in portion 121. Since the first plug-in portion 81 and the second plug-in portion 121 are in an inner-outer sleeving manner, the docking portions of two connection ports can also be sealed after sealing the two docking portions. For this purpose, a sealing ring 19 is provided between the second plug-in portion 121 and the first plug-in portion 81 in the present embodiment, as shown in Fig. 5.

**[0053]** In one embodiment, as shown in Fig. 3, the first plug-in portion 81 is sleeved on the outside of the second plug-in portion 121. To facilitate the mounting of the sealing ring 19, several sealing grooves 1211 are arranged on the outside of the second plug-in portion 121 in the present embodiment. The sealing grooves 1211 are sequentially arranged along the axial direction of the second plug-in portion 121, and the sealing ring 19 can be sleeved on each sealing groove 1211. When the first plug-in portion 81 is plugged-in the second plug-in portion 121, the sealing ring 19 is squeezed against an inner side of the first plug-in portion 81 to seal the connection between the first plug-in portion 81 and the second plug-in portion 121. At the same time, the several sealing rings 19 distributed along the axial direction can form multi-stage sealing to improve the sealing performance, and the arrangement of the sealing rings 19 can increase friction force after the first plug-in portion 81 and the second plug-in portion 121 are connected, which can improve the connection stability.

**[0054]** To further improve a waterproof sealing effect,

in the present embodiment, end faces of the second plastic piece 12 and the first plastic piece 8 abut against each other, and a sealing gasket 17 is embedded at the abutment. The sealing gasket 17 is arranged around the second plug-in portion 121. Specifically, it should be noted that in the present embodiment, the sealing gasket 17 can be pre-embedded on the upper end face of the second plastic piece 12. After the mast assembly 1 and the fuselage 4 are connected, the first plastic piece 8 will squeeze the sealing gasket 17, thereby using the deformation of the sealing gasket 17 to seal the connection end faces of the first plastic piece 8 and the second plastic piece 12.

**[0055]** To facilitate the mounting of the second plastic piece 12 into the connection slot 5, a mounting plate 11 is provided inside the connection slot 5 in the present embodiment. A second mounting hole 22 is provided on the mounting plate 11, and the second plastic piece 12 is fixedly installed in the second mounting hole.

**[0056]** Specifically, it should be noted that in the present embodiment, a mounting chamber is further provided at the bottom of the connection slot 5, electronic devices such as an electronic speed controller board 20 are arranged in the mounting chamber. The mounting chamber is in a communication state with the connection slot 5. To achieve waterproof treatment, one mounting plate 11 needs to be arranged to isolate the mounting chamber from the upper space of the connection slot 5, and at the same time, the mounting plate 11 and an inner wall of the mounting chamber need to be performed sealing treatment, which can be specifically achieved by arranging the sealing rings. The mounting plate 11 for isolation also serves as a mounting base for the second plastic piece 12. The second electrical connector 15 inside the second plastic piece 12 needs to pass through the mounting plate 11 and then connect to the electronic speed controller board 20 located in the mounting chamber.

**[0057]** For this purpose, in the present embodiment, a second mounting hole 22 is provided on the mounting plate 11. A lower part of the second plastic piece 12 passes through the second mounting hole 22, and an upper part extends upwards out of the second mounting hole 22. To achieve sealing at the connection between the second plastic piece 12 and the second mounting hole 22, in the present embodiment, an adhesive injection groove 16 is provided on the second mounting hole 22 at an end facing the first plastic piece 8. Sealing adhesive is injected into the adhesive injection groove 16 to seal the connection between the second mounting hole and the second plastic piece 12.

**[0058]** In the present embodiment, an adhesive injection groove 16 is arranged around the second plug-in portion 121 and is located on an outer ring of the sealing gasket 17. The present application achieves sufficient waterproof sealing performance between the first electrical connector 18 and the second electrical connector 15 through the arrangement of the sealing ring 19 and the

sealing gasket 17. Through the arrangement of the adhesive injection groove 16, sufficient waterproof sealing performance is also achieved between the second plastic piece 12 and the mounting hole.

**[0059]** To facilitate the docking between the first electrical connector 18 and the second electrical connector 15, as shown in Fig. 3, it is necessary to provide a certain amount of positional float for the first electrical connector 18 during the connection process. For this purpose, in the present embodiment, a first mounting hole is provided on the first connection portion 3. A connection hole corresponding to the first mounting hole is provided on the first plastic piece 8, and a positioning pin 9 is provided inside the connection hole;

the diameter of the positioning pin 9 is smaller than the inner diameter of the connection hole, two ends of the positioning pin 9 pass through the connection hole and are fitted with buffer pads 10, which abut against two sides of the first plastic piece 8; an end, away from the second plastic piece 12, of the positioning pin 9 is fixedly connected to the first connection portion 3.

**[0060]** Specifically, it should be noted that the connection holes can be provided as four and located at four corners of the first plastic piece 8, and the corresponding first mounting holes are also provided as four. Since the diameter of the positioning pin 9 is smaller than the diameter of the connection hole, when the positioning pin 9 is fixedly connected to the first mounting hole, the first plastic piece 8 can move forward, backward, left, and right horizontally relative to the positioning pin 9, and the diameter difference between the positioning pin 9 and the connection hole is equivalent to the maximum movement amount of the first plastic piece 8 in all directions from the central position.

**[0061]** On this basis, to prevent the first plastic piece 8 from swaying randomly, in the present embodiment, buffer pads 10 are fitted onto the positioning pin 9, which abut against the surface of the first plastic piece 8. The arrangement of the buffer pads 10 increases the friction force of the movement of the first plastic piece 8, so that the first plastic piece 8 maintains a certain range of float while remaining relatively stable.

**[0062]** In the present embodiment, the first electrical connector 18 and the second electrical connector 15 form the connector between the mast assembly 1 and the fuselage 4. There will be contact resistance between the two. If the connection device is unreliable, excessive contact resistance during operation can easily lead to overheating at this part, which may affect the charging power output in mild cases or cause thermal runaway of the connector and lead to safety accidents in severe cases. If the connection ports experience wear during long-term plug-in, resulting in incomplete plug-in of the connection ports, the resistance at the connection will be too high, leading to excessive temperature at the connection ports. To address the issue of connector overheating, a usual solution is to add a temperature protection device, which includes a temperature detection and

control circuit. In the solution of connector selection and temperature detection, the difficulty lies in balancing the cost of the connector with the safety issues of the temperature detection circuit and the high-voltage circuit. The existing solution is to fix a plug-in temperature sensor on a connector housing using thermal adhesive and the connector housing is usually made of plastic material. This method has two problems. First, the selection of connectors is limited, and they must have an insulating housing material, which is relatively costly. Second, the production process is complex, requiring an additional step of fixing the temperature sensor to the connector using adhesive.

**[0063]** For this purpose, the power assembly 21 in the present embodiment further includes a temperature sensor (not shown in the drawings) provided close to the second electrical connector 15 to detect the temperature at the connection between the second electrical connector 15 and the first electrical connector 18.

**[0064]** Specifically, it should be noted that the temperature sensor can be soldered and attached to an electronic speed controller board 20 at a position close to the second electrical connector 15 to detect the temperature at the connection between the second electrical connector 15 and the first electrical connector 18. Alternatively, the temperature sensor and the electronic speed controller board 20 can be connected through wires, so that the temperature sensor can be located more freely, which enables the temperature sensor to maintain a safe distance from the connection ports while being as close as possible to the heat source, thereby obtaining a more accurate temperature of the connection ports.

**[0065]** In another embodiment, since the contact resistance increases when the connection is unreliable, the voltage and/or current of the connection ports can also be detected to determine whether the voltage and/or current are within a preset normal threshold or range, thereby determining whether there is a connection abnormality at the connection ports.

**[0066]** Specifically, in the present embodiment, the power assembly 21 further includes a current/voltage detection module (not shown in the drawings), the current/voltage detection module is configured to detect the current and voltage of the second electrical connector 15 and the first electrical connector 18.

**[0067]** In yet another embodiment, the connection abnormality at the connection ports can also be determined through sensors used for position detection. Specifically, the power assembly 21 further includes a position detection sensor (not shown in the drawings) provided on the fuselage 4 and/or the mast assembly 1 to detect the relative position of the second electrical connector 15 and the first electrical connector 18.

**[0068]** For example, the connection of the connection ports can be determined through a Hall effect sensor. When the Hall effect sensor detects a change in the magnetic field, which can be when the magnetic field reaches a preset threshold or when the range of the

magnetic field change exceeds a preset range, it can be determined that there is a connection abnormality at the current connection ports. Another example is that the connection of the connection ports can be determined through infrared detection. An infrared receiver (or transmitter) is provided inside the first electrical connector 18 (or the second electrical connector 15), and a corresponding infrared transmitter (or receiver) is provided inside the second electrical connector 15 (or the first electrical connector 18). If the infrared receiver cannot receive the infrared light emitted by the corresponding infrared transmitter, it can be determined that there is a connection abnormality between the two connection ports.

**[0069]** When it is determined through the above methods that there is a connection abnormality at the connection ports, a prompt message can be issued to alert a user. For example, an abnormality alert can be displayed on a remote control that communicates with the hydrofoil board to control the hydrofoil board.

**[0070]** Further, the power system further includes a main control system 2 and a power supply system (not shown in the drawings). The main control system 2 is electrically connected to the power supply system, and the main control system 2 is electrically connected to the electronic speed controller assembly through the second electrical connector 15 and the first electrical connector 18. In one embodiment, the main control system 2 is provided at an upper end of the mast assembly 1, and the power supply system is provided inside a board body of the hydrofoil board. As shown in Fig. 1, the main control system 2 is removably connected to the board body through the second connection portion 22 on the mast assembly 1 and is also removably electrically connected to the power supply system. It is electrically connected to the electronic speed controller assembly (electronic speed controller board 20) inside the fuselage 4 after the first electrical connector 18 and the second electrical connector 15 are docked.

**[0071]** The removable electrical connection between the first connection portion 3 and the power supply system can be achieved using electrical connectors, specifically through a plug-and-pull connection and disconnection method. It should be understood that the connection between the first connection portion 3 and the power supply system may also adopt the same connection and cooperation method as the first electrical connector 18 and the second electrical connector 15 described in the above embodiments, which will not be further elaborated by the present embodiment.

**[0072]** In the prior art, when users disassemble the mast assembly 1 and the power assembly 21 by plugging and unplugging the connection ports, they need to turn off the power first to facilitate the disassembly of the power assembly 21 and avoid the risk of arcing caused by hot-plugging and unplugging (plugging and unplugging while powered on). However, in many cases, users cannot avoid performing hot-plugging and unplugging directly,

and turning off the power before disassembling the power assembly 21 requires flipping the hydrofoil board back and forth, which is cumbersome for users and results in a poor experience.

**[0073]** Therefore, the present application further enables automatic power-off at the moment when the user performs hot-plugging and unplugging by detecting the board body or the connection ports, thereby avoiding the occurrence of arcing during the user's plugging and unplugging process, i.e., achieving "hot-plugging and unplugging" from the user's experience perspective.

**[0074]** In one embodiment, the power system for a hydrofoil board further includes an attitude detection sensor (not shown in the drawings), such as a gyroscope configured to detect the attitude of the board body. When the attitude of the board body is in a preset attitude, the attitude detection sensor sends an electrical signal to the main control system 2, which receives the signal and then controls the power supply system to turn off.

**[0075]** Since in most cases, users need to flip the board body during the plugging and unplugging process, the attitude detection sensor can send an instruction to the main control system 2 when it detects that the board body has flipped to a preset attitude, and the main control system 2 turns off the power supply system based on this instruction.

**[0076]** In another embodiment, the power assembly 21 further includes a position detection sensor (not shown in the drawings) provided on the fuselage 4 and/or the mast assembly 1 to detect the relative position of the second electrical connector 15 and the first electrical connector 18; when the relative position of the second electrical connector 15 and the first electrical connector 18 is in a preset position, the position detection sensor sends an electrical signal to the main control system 2, which receives the signal and then controls the power supply system to turn off.

**[0077]** Specifically, a sensor used for position detection can also be provided at the connection ports to determine whether the connection ports are in a disconnected state. When it is determined that the connection ports are in a disconnected state, an instruction can be sent to the main control system 2 to cause it to control the power supply system to turn off, thereby avoiding the occurrence of arcing during the user's plugging and unplugging process, i.e., achieving "hot-plugging and unplugging" from the user's experience perspective. For example, when the Hall effect sensor detects a change in the magnetic field, which can be when the magnetic field reaches a preset threshold or when the range of the magnetic field change exceeds a preset range, it can be determined that the current connection ports are in a disconnected state, and an instruction can be sent to the main control system 2, which responds to the instruction and turns off the power. Similarly, the connection state of the main control system 2 can also be determined through infrared detection.

**[0078]** Preferably, a solution that combines attitude

detection and detection of whether the connection ports are in a disconnected state can be used. If the board body is detected to flip to a preset attitude and it is determined that the connection ports are in a disconnected state, an instruction can be sent to the main control system 2 to cause it to control the hydrofoil board to turn off the power, which is conducive to improving the accuracy of the determination and avoiding power-off caused by false triggering.

**[0079]** According to another aspect of the present application, an electric hydrofoil board is provided, including a board body and the above-mentioned power system. A second end of the mast assembly 1 is removably connected to the board body through a second connection portion 22.

**[0080]** The foregoing is merely illustrative of the preferred embodiments of the present application and is not intended to limit the same. A person skilled in the art will appreciate that various modifications and variations may be made to the present application. Any modification, equivalent replacement, improvement, or the like, made within the spirit and principles of the present application shall fall within the scope of protection thereof.

## Claims

1. A power system for a hydrofoil board, comprising: a mast assembly (1) and a power assembly (21); wherein

a first end of the mast assembly (1) is provided with a first connection portion (3);

the power assembly (21) comprises a fuselage (4), with a front hydrofoil and a rear hydrofoil (7) provided at two ends of the fuselage (4), and a connection slot (5) is provided on the fuselage (4); and

the connection slot (5) is provided as a through slot, and the first connection portion (3) is configured to be removably inserted into the connection slot (5) in a plug-in manner, with side-walls of the connection slot (5) tightly abutted against two ends of the first connection portion (3), and the connection slot (5) is configured to inwardly squeeze and clamp the first connection portion (3) under lift force of the front hydrofoil and the rear hydrofoil (7).

2. The power system for a hydrofoil board according to claim 1, wherein the first connection portion is provided with a first electrical connector (18), and the connection slot is provided with a second electrical connector (15); and the second electrical connector (15) and the first electrical connector (18) are configured to mutually cooperate to achieve electrical connection.

3. The power system for a hydrofoil board according to claim 2, wherein the fuselage (4) is provided therein with an electronic speed controller assembly located at the bottom of the connection slot (5), and the second electrical connector (15) is electrically connected to the electronic speed controller assembly.
4. The power system for a hydrofoil board according to claim 3, wherein the electronic speed controller assembly comprises an electronic speed controller board (20), which is perpendicular to the mast assembly (1), and the second electrical connector (15) is vertically fixed on the electronic speed controller board (20) and has an electrical connection to the electronic speed controller board (20); and the first electrical connector (18) and the second electrical connector (15) are oppositely arranged.
5. The power system for a hydrofoil board according to claim 1, wherein the first connection portion (3) is further provided with a retention groove, and the connection slot (5) is provided with a retention protrusion removably engaged in the retention groove.
6. The power system for a hydrofoil board according to claim 4, wherein mounting portions (14) located above the electronic speed controller board (20) are provided at two sides of the connection slot (5); and the first connection portion (3) is fixedly connected to the mounting portion (14) by screws.
7. The power system for a hydrofoil board according to claim 1, wherein the first connection portion (3) is provided with a first plastic piece (8), and the connection slot (5) is provided with a second plastic piece (12), and the second electrical connector (15) is provided in the second plastic piece (12), and the first electrical connector (18) is provided in the first plastic piece (8);  
  
the first plastic piece (8) is provided with a first plug-in portion (81), and the second plastic piece (12) is provided with a second plug-in portion (121), a docking portion of the second electrical connector (15) is located in the second plug-in portion (121), and a docking portion of the first electrical connector (18) is located in the first plug-in portion (81), the second plug-in portion (121) and the first plug-in portion (81) are in plug-in cooperation, and the docking portion of the second electrical connector (15) and the docking portion of the first electrical connector (18) are in plug-in cooperation; and a sealing ring (19) is provided between the second plug-in portion (121) and the first plug-in portion (81).
8. The power system for a hydrofoil board according to claim 7, wherein end faces of the second plastic piece (12) and the first plastic piece (8) abut against each other, and a sealing gasket (17) is embedded at the abutment, and the sealing gasket (17) is arranged around the second plug-in portion (121).
9. The power system for a hydrofoil board according to claim 8, wherein the connection slot (5) is provided with a mounting plate (11), and the mounting plate (11) is provided with a second mounting hole (23), and the second plastic piece (12) is fixedly installed in the second mounting hole (23); and the second mounting hole (23) is provided with an adhesive injection groove (16) at an end facing the first plastic piece (8), and the adhesive injection groove (16) is filled with sealing adhesive to seal a connection between the second mounting hole (23) and the second plastic piece (12).
10. The power system for a hydrofoil board according to any one of claims 7 to 9, wherein the first connection portion (3) is provided with a first mounting hole, and the first plastic piece (8) is provided with a connection hole corresponding to the first mounting hole, and a positioning pin (9) is provided in the connection hole; the diameter of the positioning pin (9) is smaller than the inner diameter of the connection hole, and two ends of the positioning pin (9) pass through the connection hole and are provided with buffer pads (10), which abut against two sides of the first plastic piece (8); an end, away from the second plastic piece (12), of the positioning pin (9) is fixedly connected to the first connection portion (3).
11. The power system for a hydrofoil board according to any one of claims 1 to 9, wherein the power assembly (21) further comprises a temperature sensor provided close to the second electrical connector (15) to detect the temperature at a connection between the second electrical connector (15) and the first electrical connector (18).
12. The power system for a hydrofoil board according to any one of claims 1 to 9, wherein the power assembly (21) further comprises a current/voltage detection module configured to detect current and voltage of the second electrical connector (15) and the first electrical connector (18).
13. The power system for a hydrofoil board according to any one of claims 1 to 9, wherein the power assembly (21) further comprises a position detection sensor provided on the fuselage (4) and/or the mast assembly (1) to detect a relative position between the second electrical connector (15) and the first electrical connector (18).

14. The power system for a hydrofoil board according to any one of claims 3 to 9, further comprising a main control system (2) and a power supply system, wherein the main control system (2) and the power supply system are in electrical connection, and the main control system (2) is electrically connected to the electronic speed controller assembly through the second electrical connector (15) and the first electrical connector (18). 5
15. The power system for a hydrofoil board according to claim 14, further comprising an attitude detection sensor configured to detect an attitude of the board body, and when the attitude of the board body is in a preset attitude, the attitude detection sensor sends an electrical signal to the main control system (2), and the main control system (2) controls the power supply system to cut off power after receiving the electrical signal. 10 15
16. The power system for a hydrofoil board according to claim 14 or 15, wherein the power assembly (21) further comprises a position detection sensor provided on the fuselage (4) and/or the mast assembly (1) to detect the relative position between the second electrical connector (15) and the first electrical connector (18); 20 25
- when the relative position between the second electrical connector (15) and the first electrical connector (18) is in a preset position, the position detection sensor sends an electrical signal to the main control system (2), and the main control system (2) controls a power supply system to cut off power after receiving the electrical signal. 30 35
17. An electric hydrofoil board, comprising a board body and the power system according to any one of claims 1 to 16, and a second end of the mast assembly (1) is removably connected to the board body through a second connection portion (22). 40

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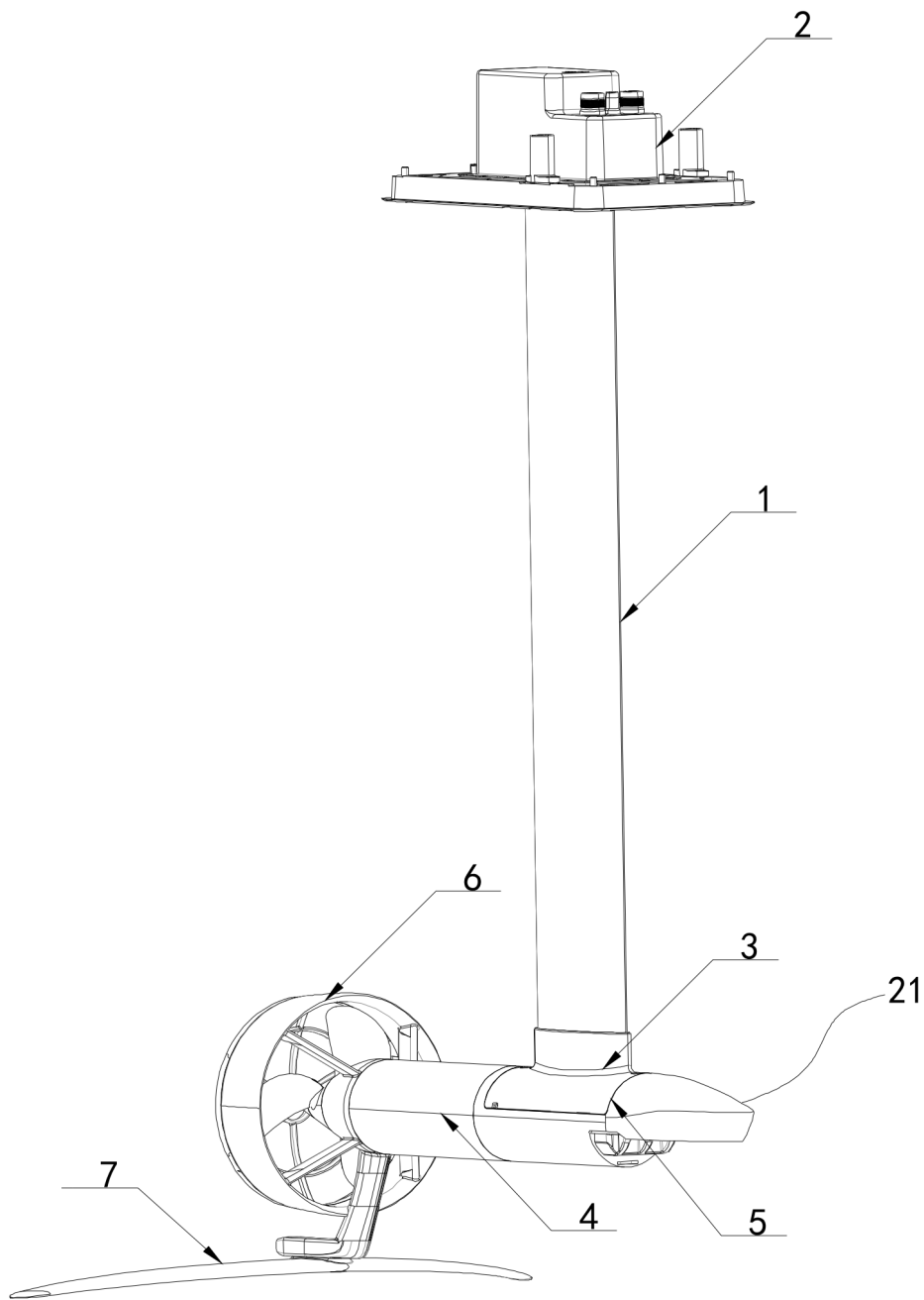


Fig. 1

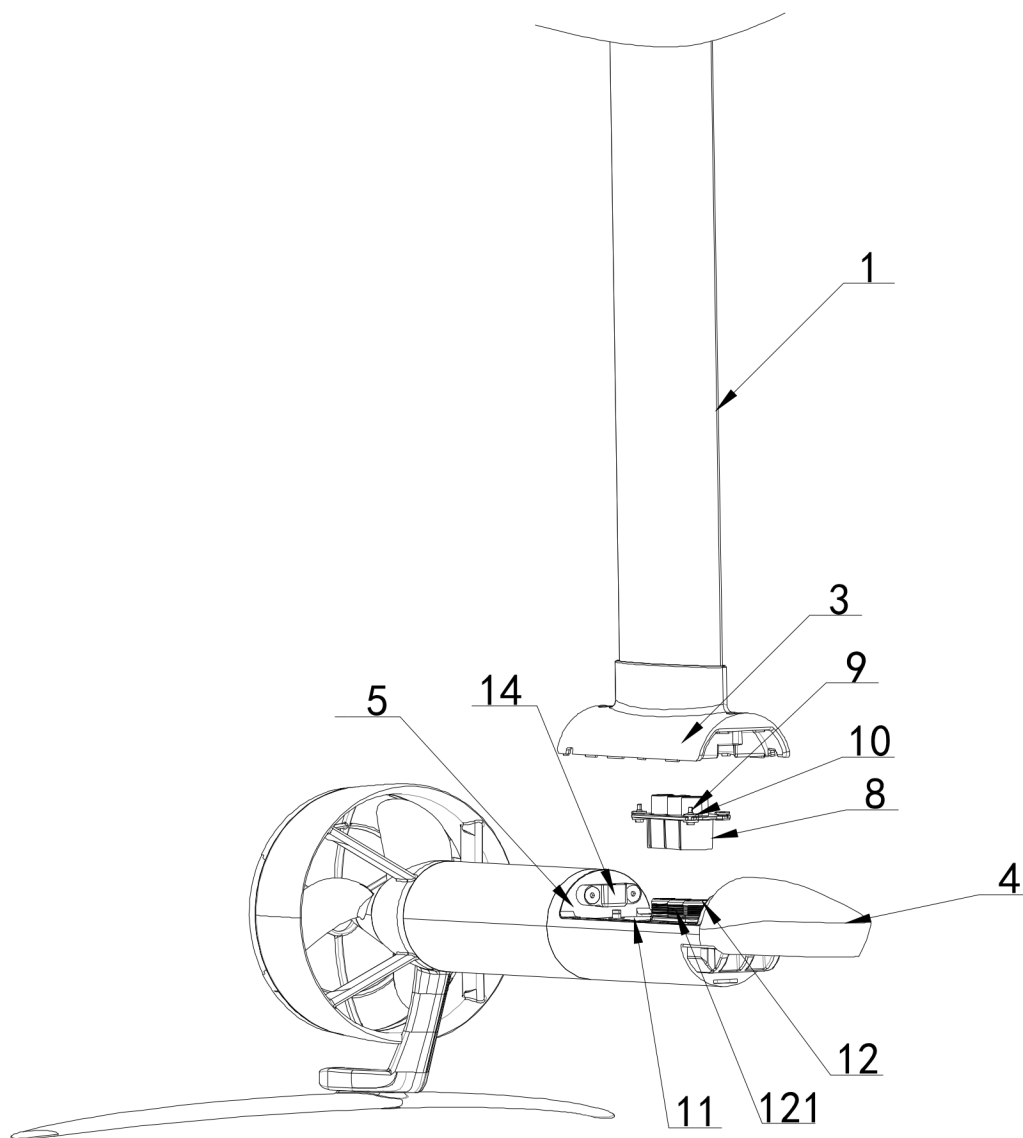


Fig. 2

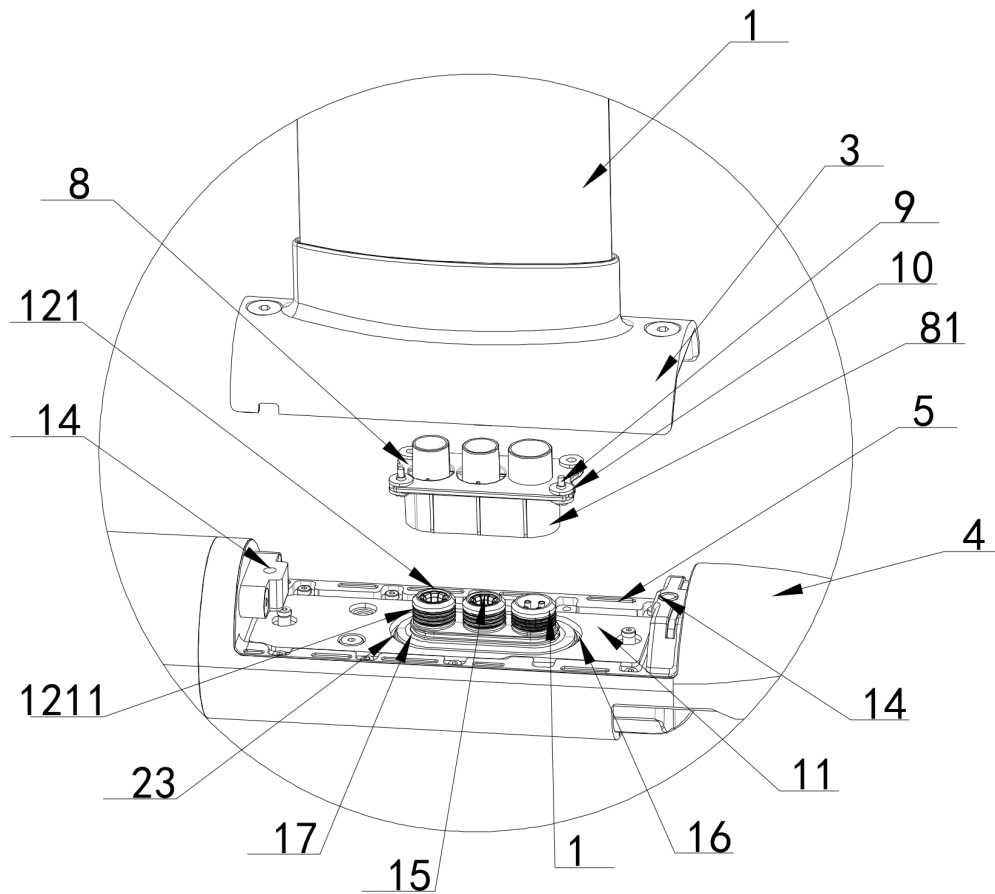


Fig. 3

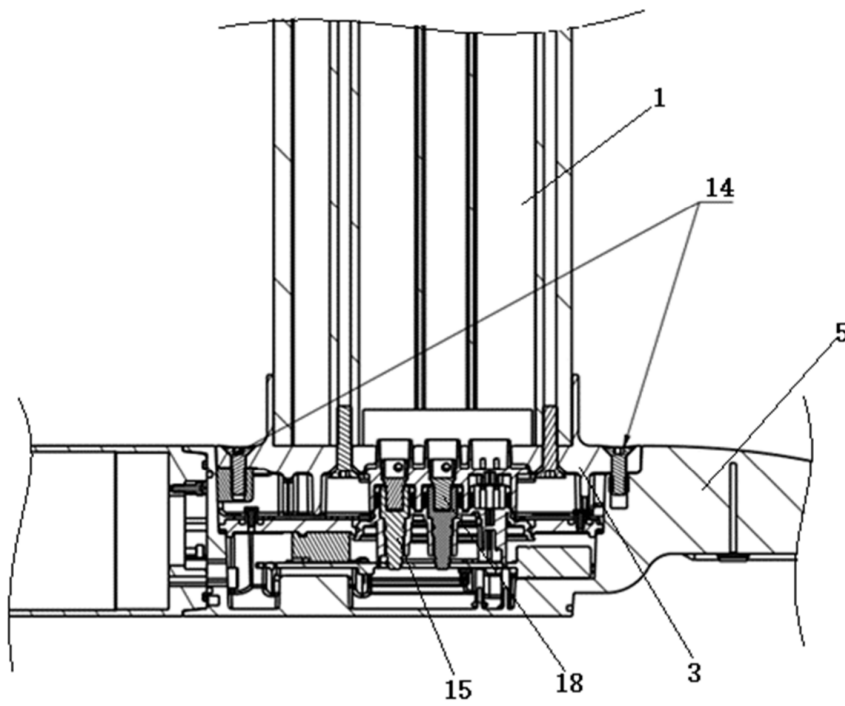


Fig. 4

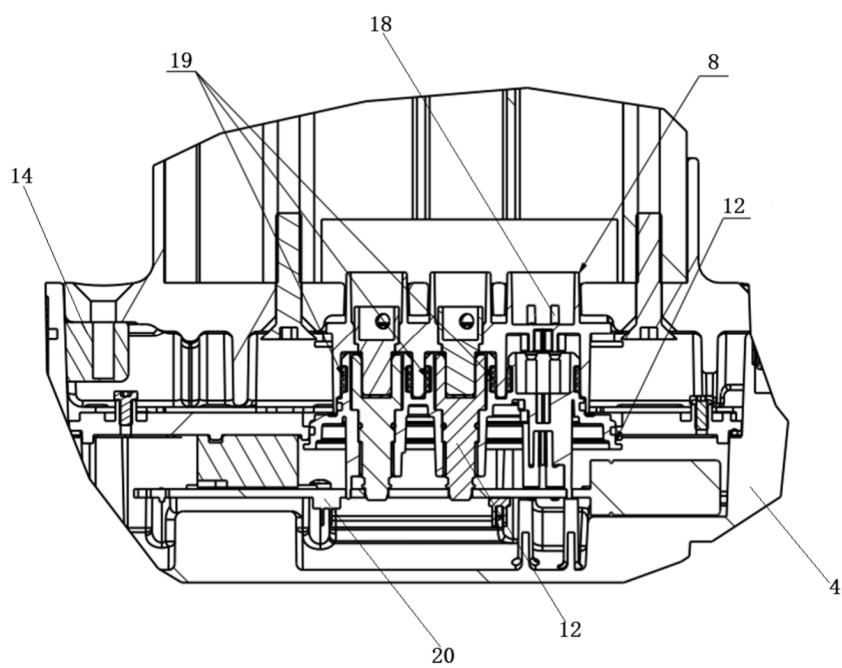


Fig. 5

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2024/107960

## A. CLASSIFICATION OF SUBJECT MATTER

B63B32/10(2020.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC:B63B32

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNTXT: ENTXT; DWPI; CJFD: 水翼板, 桅杆, 动力, 连接槽, 通槽, 插接, 挤压, 升力, foil, board, hydrofoil, plate, mast, connect+, groove

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                   | Relevant to claim No. |
|-----------|----------------------------------------------------------------------------------------------------------------------|-----------------------|
| PX        | CN 116767433 A (SHENZHEN WEIDU INTELLIGENT TECHNOLOGY CO., LTD.) 19 September 2023 (2023-09-19) claims 1-17          | 1-17                  |
| A         | US 2021107602 A1 (KARR RICKY) 15 April 2021 (2021-04-15) description, embodiments, and figures 1-2                   | 1-17                  |
| A         | CN 116395087 A (SHENZHEN WEIDU INTELLIGENT TECHNOLOGY CO., LTD.) 07 July 2023 (2023-07-07) entire document           | 1-17                  |
| A         | CN 215205272 U (TIANJIN LITTLE SHARK INTELLIGENT TECHNOLOGY CO., LTD.) 17 December 2021 (2021-12-17) entire document | 1-17                  |
| A         | US 2020407026 A1 (NORTH KITEBOARDING AUSTRALASIA, LTD.) 31 December 2020 (2020-12-31) entire document                | 1-17                  |

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

|                                                                                                                                                                         |                                                                                                                                                                                                                                                  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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| "P" document published prior to the international filing date but later than the priority date claimed                                                                  |                                                                                                                                                                                                                                                  |

Date of the actual completion of the international search

23 October 2024

Date of mailing of the international search report

04 November 2024

Name and mailing address of the ISA/CN

China National Intellectual Property Administration (ISA/  
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China No. 6, Xitucheng Road, Jimenqiao, Haidian District,  
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Telephone No.

## INTERNATIONAL SEARCH REPORT

### Information on patent family members

International application No.

**PCT/CN2024/107960**

| Patent document cited in search report |            |    | Publication date (day/month/year) | Patent family member(s) | Publication date (day/month/year) |
|----------------------------------------|------------|----|-----------------------------------|-------------------------|-----------------------------------|
| CN                                     | 116767433  | A  | 19 September 2023                 | None                    |                                   |
| US                                     | 2021107602 | A1 | 15 April 2021                     | None                    |                                   |
| CN                                     | 116395087  | A  | 07 July 2023                      | None                    |                                   |
| CN                                     | 215205272  | U  | 17 December 2021                  | None                    |                                   |
| US                                     | 2020407026 | A1 | 31 December 2020                  | DE                      | 202019103496 U1 12 September 2019 |
|                                        |            |    |                                   | DE                      | 102020116552 A1 31 December 2020  |
|                                        |            |    |                                   | DE                      | 102020116552 B4 31 August 2023    |
|                                        |            |    |                                   | US                      | 11345449 B2 31 May 2022           |