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(54) Benævnelse: **Amphibie UAV med fluid dræningsåbninger**

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GB-A- 565 692
US-A- 1 746 669
US-A- 2 444 332
US-A- 3 092 060
US-A- 5 666 900
US-A1- 2003 066 932
US-A1- 2010 065 691
US-B2- 7 097 136

DESCRIPTION

BACKGROUND

[0001] Reducing weight and size are paramount in the design of small unmanned vehicles. Small unmanned aerial vehicles or UAVs typically are designed to be launched from, and land on dry land. Such vehicles are now being sought that can operate while being exposed to, or after being exposed to aquatic environments. For example, it may be preferred to land an unmanned aerial vehicle on water, rather than on land, either to lessen the impact of landing, or because it is more easily retrievable location. Typically, amphibious aircraft, both manned and unmanned, are able to take off and land in water.

[0002] Hand launched amphibious UAVs though are not required to take off from the water, but are required to land on dry land, or on water. Some hand launched UAVs are designed to land by skidding along, or impacting the ground, which is considerably more abrupt than water landings. Various amphibious vehicles are disclosed in the United States patent publications US 2444332 A, US 1746669 A, and US 3092060 A. From the United States patent application publication US 2010/065691 A1 a securing mechanism for the battery module in an airplane is known. Further, from the United States patent application publication US 2003/066932 A1 a surface mount connector and an open bottom of the fuselage for providing a camera window are known.

[0003] What is needed is an amphibious UAV that can withstand high impact ground landings and has the ability to land both on water and rugged terrain while protection of the electrical and electronic components is not dependent on maintaining the integrity of the fuselage.

[0004] This and other objects are achieved by the features as claimed in claim 1. Advantageous further embodiments are claimed in the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] The features and advantages of the present invention will be better understood with regard to the following description, appended claims, and accompanying drawings where:

FIG. 1 shows a simplified perspective view of an amphibious unmanned aerial vehicle.

FIG. 2 shows a simplified top view of the fuselage of the amphibious unmanned aerial vehicle of **FIG. 1.**

FIG. 3 shows a simplified side view of the fuselage of an amphibious unmanned aerial vehicle of **FIG. 1.**

DESCRIPTION

[0006] FIG. 1 shows a simplified perspective view of an amphibious unmanned aerial vehicle or UAV 10. The UAV 10 has a fuselage 100 of the amphibious unmanned aerial vehicle 10 has modularized compartments 120, 130, and 140 to contain modular components or modules, such as a battery module 20, a payload module 30, and avionics electronics module 40. In various embodiments, the wings 15 and/or 16 may be constructed of multiple pieces, which may separate, and/or "break away" or separate from the fuselage 100 during landings.

[0007] FIG. 2 shows a simplified top view of the fuselage 100 of the amphibious unmanned aerial vehicle 10 of **FIG. 1.** The walls 110 of the fuselage 100 are composed of a buoyant material so that the fuselage 100 will float without wings (not shown) attached when the fuselage is fully loaded with components, such as the battery 20, the payload 30, and the avionics electronics 40, shown in **FIG. 1,** and other aircraft parts and components. For example, the walls 110 may have a molded foam core sealed with a waterproof skin, though this is not required. The walls 110 may be a single continuous wall or multiple wall sections, or the like.

[0008] In this embodiment, the fuselage is separated into three compartments, a forward battery compartment 120, a central payload compartment 130, and a rear avionics compartment 140. The forward battery compartment 120 is separated from the central payload compartment 130 by separator wall 150. The central payload compartment 130 is separated from the rear avionics compartment 140 by separator wall 160. In the embodiment shown, tabs 104, 105, and 106 are employed as a means to secure the components (not shown) in the compartments 120, 130, and 140. The tab 105 may be rotated by hand using the pivotable handle 105h to allow installation of a battery (not shown) and then rotated back to the position shown to lock the battery in the forward battery compartment 120. Other securing mechanisms may be used instead or in addition to the rotatable tabs 104, 105, and 106.

[0009] The battery compartment 120 has mounting surfaces 122 which support a battery (not show). In this embodiment, a connector 124, which may be a surface mount connector or the like, is generally flush with the mounting surfaces 122. Channels 126f and 126r are recessed below the mounting surfaces 122. Drainage openings such as weep holes 128b in the channel 126f extend through the bottom wall 110b of the fuselage 100. Weep holes 128s (shown in **FIGS. 1-3)** in the channel 126r extend through the side wall 110s of the fuselage 100.

[0010] The mating surface 124m of the connector 124 is located above the channels 126f and 126r so that the mating surface is not submerged in water when the battery 20 **(FIG. 1)** is connected/disconnected, if the fuselage is out of the water. Wiring 123f and 123b may be routed in the channels 126f and 126b, respectively, and recessed and/or embedded through the fuselage 100 to provide power to the motor (not show) and avionics electronics module 40

and/or a payload module 30.

[0011] The central payload compartment 130 has front and rear mounting surfaces 132f and 132r which support a payload, such as a camera assembly (not shown). The payload module 30 may contain the imaging, sensing, or other passive, active, non-lethal, or lethal payload devices. In this embodiment, a connector 134, which may be a surface mount connector or the like, is generally flush with the mounting surface 132r. The mounting surface 132r may form an enclosure 163 to contain the connector 134 and associated wiring. The enclosure may form a lower part of the separator wall 160. Weep holes 228s (shown in **FIGS. 1-3)** may extend from inside the enclosure 163 through the side wall 110s to allow water to exit the enclosure 163. In this embodiment, the central compartment 130 has a large opening 131 in the bottom so that a camera can be utilized, such as by viewing downward or by lowering it into the airstream through the large opening 131. The large opening 131 also allows drainage of fluid from the central compartment 130.

[0012] In various embodiments, the mating surface 134m of the connector 134 may be located high above the opening 131, on the top of the enclosure 163, so that the mating surface is not submerged in water when the payload 30 **(FIG. 1)** is connected/disconnected, even if the fuselage is not completely out of the water.

[0013] The rear avionics compartment 140 has a mounting surface 142 in a bottom of the avionics compartment 140. The mounting surface 142 has a forward channel 146f and a rear channel 146r. Channels 146f and 146r are recessed below the mounting surface 142. Drainage openings such as weep hole 228s (shown in **FIGS. 1-3)** in channel 146f extends through the side wall 110s of the fuselage 100. Weep holes 228b (shown in **FIGS. 2 and 3)** in the channel 146r extend through the bottom wall 110b of the fuselage 100. A sloping recess 229 in the mounting surface 142 drains water off the mounting surface 142 and into the channel 146r.

[0014] The embodiment shown in **FIG.** 3 has an opening 141 in the side wall 110s of fuselage 110, to expose a heat sink 41 **(FIG. 1)** and allow heat generated by the avionics electronics 40 **(FIG. 1)** to be released.

[0015] FIG. 3 shows a simplified side view of the fuselage 100 of an amphibious unmanned aerial vehicle 10 of **FIG. 1.** In this embodiment, optional skid pads 180 and 190 are secured to the bottom wall 110b of the fuselage 100. The skid pads 180 and 190 are used in this embodiment for landing on hard surfaces. The skid pad 180 may be located directly below the forward compartment 120 and may be fabricated of a durable shock absorbing material of sufficient thickness and density to further protect from impact the component within the compartment 120, such as the battery 20 **(FIG 1).** Similarly, the skid pad 190 may be located directly below the rear compartment 140, and may be fabricated of a durable shock absorbing material of sufficient thickness and density to further protect from impact a component within the compartment 140, such as the avionics electronics 40 **(FIG. 1).**

[0016] Weep holes 128s extend through the side wall 110s of the fuselage 100. The weep hole 128s extends through the side wall 110s and into rear channel 126r of the battery compartment 120. The weep hole 228s extends through the side wall 110s and into the enclosure 163 of the central payload compartment 130.

[0017] The fluid drainage openings may be weep holes, fluid drainage ports, or the like.

[0018] Various embodiments provide a fuselage 100 for a UAV which can land both on water and rugged terrain. Instead of sealing the entire aircraft from water intrusion, the present invention achieves the ability to land on water by having just the individual electrical and electronic components, i.e. battery, payload, avionics electronics, and associated connectors and wiring, hermetically sealed.

[0019] This allows the rest of the aircraft to remain buoyant and any water in the aircraft draining by a set of fluid drain ports when the UAV is retrieved from the water. In this manner, the protection of the electrical and electronic components is not dependant on maintaining the integrity of the fuselage 100 or the exterior walls 110, which is likely to be damaged during landings on hard and/or rugged surfaces (typical of land landings).

[0020] This also allows the volume within the aircraft that needs to be waterproof to be minimized, thus reducing weight and overall system complexity.

[0021] Further, the aircraft's ability to land on hard surfaces or rugged terrain without damage to the electrical and electronic components is achieved not just by having these components encased in modularized compartments 120, 130, and 140, but also by allowing the walls 110 of the compartments 120, 130, and 140 to be partially compromised without necessarily causing failure of the UAV. The walls 110 create an impact zone around the electrical and electronic components within the compartments 120, 130, and 140, and the separators inhibit the components 20, 30, and 40 from impacting each other. Optionally, in some embodiments, the walls 110 and mounts 122, 132f, 132r, and 142 are such that the components 20, 30, and 40 **(FIG. 1)** are recessed from the walls 110 and/or their respective separators 150 and 160 **(FIG. 2).** Additional shock absorbing material (not shown) may be added within the compartments 120, 130, or 140 to further reduce any chance of damage to the components 20, 30, or 40 from impacts.

[0022] As illustrated in **FIGS. 1 and 2,** the fuselage 110 may contain an optional exterior channel 110c in the side 110s of the fuselage 110, extending rearward from a hole 218 in the side wall 110s at the avionics compartment 140, to the tail section of the aircraft 10. Wiring 203 extends through the hole 218 and along the exterior channel 110c to connect the avionics component 40 to an actuator assembly 202 for actuating the control surfaces in the tail of the aircraft 10. The exterior channel 110c allows the wiring to be easily accessed for inspection, repair, and replacement.

[0023] It is worthy to note that any reference to "one embodiment" or "an embodiment" means

that a particular feature, structure, or characteristic described in connection with the embodiment may be included in an embodiment, if desired. The appearances of the phrase "in one embodiment" in various places in the specification are not necessarily all referring to the same embodiment.

[0024] The illustrations and examples provided herein are for explanatory purposes and are not intended to limit the scope of the appended claims.

[0025] Those skilled in the art will make modifications to the invention for particular applications of the invention.

[0026] Having described this invention in connection with a number of embodiments, modification will now certainly suggest itself to those skilled in the art. The example embodiments herein are not intended to be limiting, various configurations and combinations of features are possible. As such, the invention is not limited to the disclosed embodiments, except as required by the appended claims.

REFERENCES CITED IN THE DESCRIPTION

Cited references

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US2444332A **[0002]**
- US1746669A **[0002]**
- US3092060A **[0002]**
- US2010065691A1 **[0002]**
- US2003066932A1 **[0002]**

PATENTKRAV

1. Ubemandet amfibie-luftfartøj omfattende:

en krop (100) med vægge (110);
skilleelementer (150, 160) i kroppen, som danner separate batteri-, last- og flyelektronik-kamre (120, 130, 140) i kroppen (100), hvilke kamre (120, 130, 140) omfatter:
montageflader (122, 142) i batteri-, last- og flyelektronik-kamrene (120, 140) til montering af et batterimodul (20), et lastmodul (30) og et flyelektronikmodul (40) i kroppen (100);
hvor
batterikammeret (120) omfatter en drænkanal (126r) omfattende i det mindste et drænudløbshul igennem kroppen (128s);
lastkammeret (130) omfatter en åben bund;
flyelektronikkammeret (140) omfatter en drænkanal (146r) omfattende i det mindste et drænudløbshul (228b) igennem kroppen;
væggene (110) i kroppen er konstruerede af et opdriftsmateriale således, at kroppen (100) vil flyde i vand uden vingerne forbundet og
kamrene er konstruerede til individuelt at omgive batterimodulet, lastmodulet og flyelektronikmodulet, men hvor kamrene ikke er forseglede mod vandind-trængning, medens batteri-, last- og flyelektronik-komponenterne og associerede forbindelser og ledninger er hermetisk forseglede således, at det ubemandede amfibie-luftfartøj er i stand til at lande på land og på vand uden beskadigelse af elektriske og elektroniske komponenter.

2. Ubemandet amfibie-luftfartøj ifølge krav 1, som yderligere omfatter drænåbninger, som forløber igennem skilleelementerne (150, 160) i kroppen (100).

3. Ubemandet amfibie-luftfartøj ifølge krav 1, hvor batterikammeret (120) er placeret foran lastkammeret (130), flyelektronikkammeret (140) er placeret bagved lastkammeret og lastkammeret er placeret imellem batterikammeret og flyelektronikkammeret.

4. Ubemandet amfibie-luftfartøj ifølge krav 1, som yderligere omfatter i det mindste én glidepude (180) på en bund af kroppen (100).

5. Ubemandet amfibie-luftfartøj ifølge krav 1, hvor lastkammeret er placeret centralt i kroppen.

6. Ubemandet amfibie-luftfartøj ifølge krav 1, som yderligere omfatter sikringsmekanismer (104, 105, 106) knyttet til kamrene (120, 130, 140) til at sikre batterimodulet (20), lastmodulet (30) og flyelektronikmodulet (40) i batterikammeret (120), lastkammeret (130), henholdsvis flyelektronikkammeret (140).

7. Ubemandet amfibie-luftfartøj ifølge krav 1, hvor i det mindste nogle af montagefladerne i kamrene omfatter integrerede konnektorer (124, 134) til elektrisk at forbinde en tilsvarende flykomponent ved montage af den tilsvarende flykomponent i et respektivt kammer.

8. Ubemandet amfibie-luftfartøj ifølge krav 7, hvor batterikammeret omfatter en overflade-monteret konnektor (124) i plan med montagefladen i batterikammeret (120).

9. Ubemandet amfibie-luftfartøj ifølge krav 7, hvor lastkammeret omfatter en flademonteret konnektor (134) i plan med montagefladen i lastkammeret (130).

10. Ubemandet amfibie-luftfartøj ifølge krav 1, hvor der ikke er nogen kropvæg under lastkammeret (130).

11. Ubemandet amfibie-luftfartøj ifølge krav 1, hvor åbningen i lastkammeret (130) er dimensioneret til at tillade udkøringen af et kamera fra lastkammeret.

12. Ubemandet amfibie-luftfartøj ifølge krav 1, hvor flyelektronikkammeret omfatter en varmesænkningsåbning (141).

13. Ubemandet amfibie-luftfartøj ifølge krav 1, hvor kroppen omfatter en udvendig kanal (110c) i én side af kroppen, som strækker sig bagud langs sidevæggen på kroppen fra ydersiden af flyelektronikkammeret til en halesektion på det ubemandede amfibie-luftfartøj.

14. Ubemandet amfibie-luftfartøj ifølge krav 1, hvor batteri-, last- og flyelektronik-kamrene er modulariserede kamre omfattende åbninger til at tillade indføring af et batterimodul, et lastmodul hhv. et flyelektronikmodul deri, og hvor batteri-, last- og flyelek-

tronik-kamrene ikke er forseglede mod vandindtrængning, men hvor kroppen flyder, når kroppen er belastet med et batteri, en last og flyelektronik.

DRAWINGS

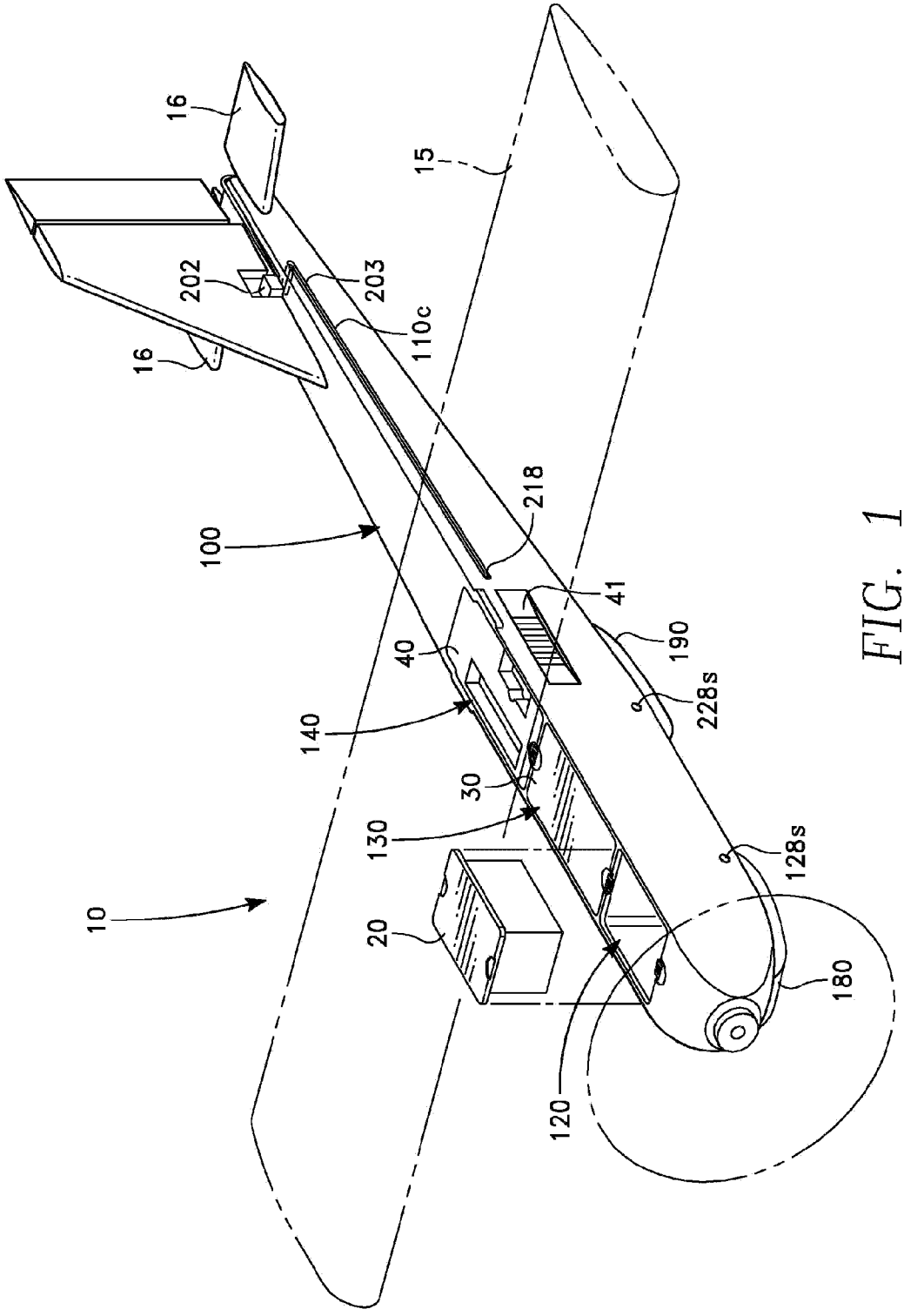

FIG. 1

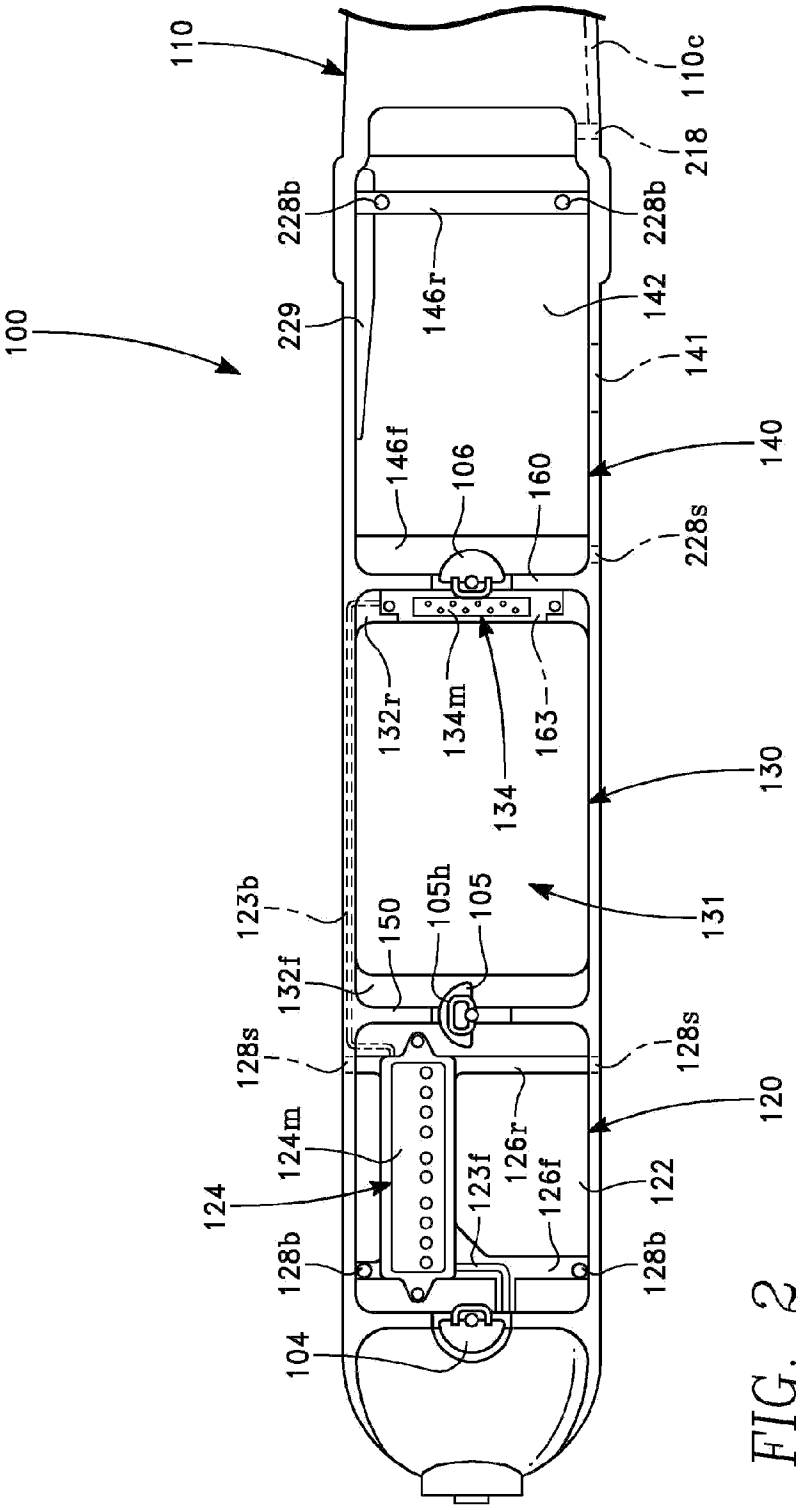
110
110c
218
228b
228b
146r
142
229
141
100
146f
106
160
140
228s
132r
134m
163
134
130
123b
150
105h
105
131
132f
128s
128s
120
124m
126r
124
123f
126f
122
128b
128b
104

FIG. 2

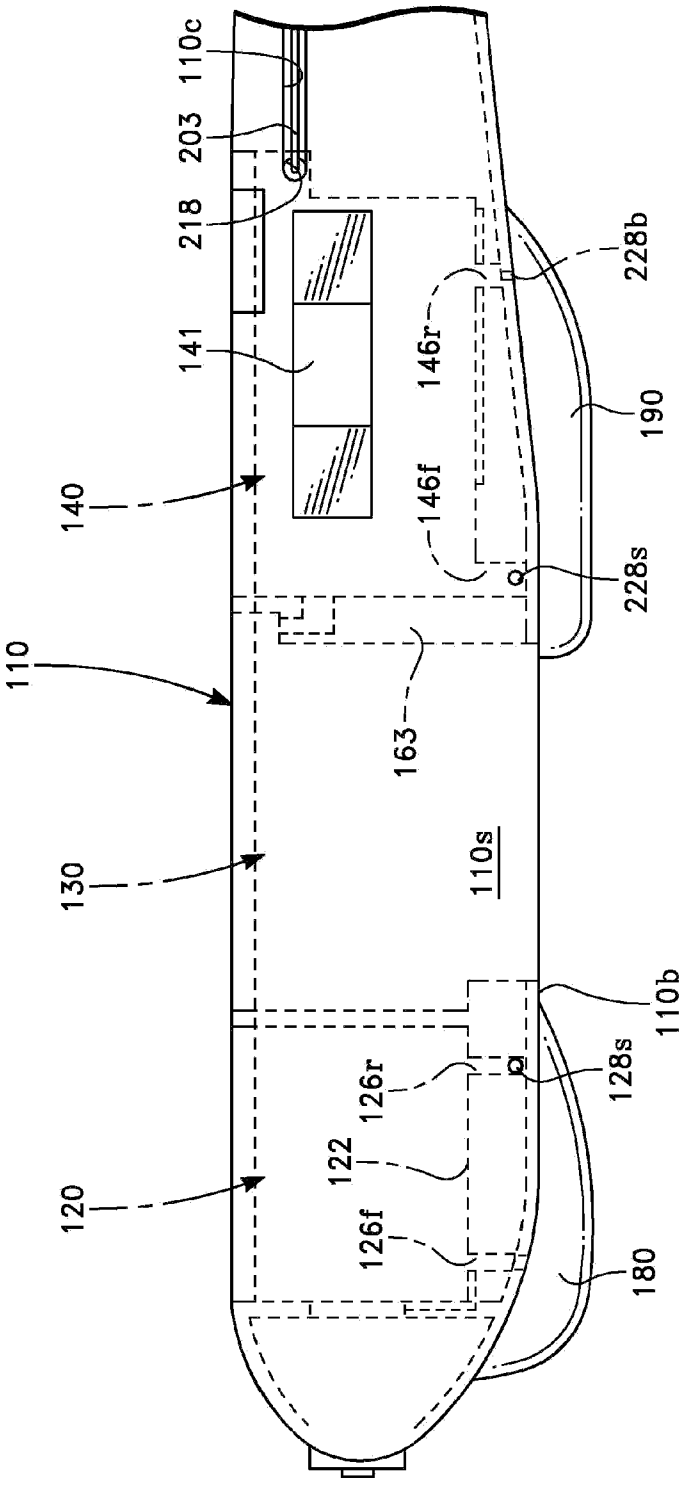
110c
203
218
141
140
110
130
120
146r
146f
228b
190
228s
163
110s
110b
128s
126r
122
126f
180

FIG. 3