

**UAV HAVING HERMETICALLY SEALED MODULARIZED COMPARTMENTS AND
FLUID DRAIN PORTS**

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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.

[0003] What is needed is an amphibious UAV that can withstand high impact ground landings.

SUMMARY

[0004] In one possible embodiment, an amphibious unmanned aerial vehicle is provided, which includes a fuselage comprised of a buoyant material. Separators within the

fuselage form separate compartments within the fuselage. Mounts associated with the compartments for securing waterproof aircraft components within the fuselage. The compartments each have drainage openings in the fuselage extending from the interior of the fuselage to the exterior of the fuselage.

[0005] In one possible embodiment, an amphibious unmanned aerial vehicle is provided, which includes a fuselage constructed of a buoyant material and separators within the fuselage forming separate battery, payload, and avionics compartments within the fuselage. Mounts associated with the compartments are provided for securing a battery, a payload, and avionics within the fuselage. Drainage openings extend through the wall of fuselage to connect the compartments with the exterior of the unmanned aerial vehicle.

[0006] In one possible embodiment, an amphibious unmanned aerial vehicle is provided including a fuselage constructed of a buoyant material with separators in the fuselage forming separate battery, payload, and avionics compartments within the fuselage. The battery compartment and the avionics compartment have a drainage channels having a weep holes through the fuselage. The payload compartment has an open bottom. Mounting surfaces within the battery, payload, and avionics compartments are provided for mounting a battery module, a payload module, and an avionics module within the fuselage.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The features and advantages of the present invention will be better understood with regard to the following description, appended claims, and accompanying drawings where:

[0008] **FIG. 1** shows a simplified perspective view of an amphibious unmanned aerial vehicle.

[0009] **FIG. 2** shows a simplified top view of the fuselage of the amphibious unmanned aerial vehicle of **FIG. 1**.

[00010] **FIG. 3** shows a simplified side view of the fuselage of an amphibious unmanned aerial vehicle of **FIG. 1**.

DESCRIPTION

[00011] **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.

[00012] **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.

[00013] 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.

[00014] 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.

[00015] 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.

[00016] 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.

[00017] 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.

[00018] 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.

[00019] 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.

[00020] **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**).

[00021] 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.

[00022] The fluid drainage openings may be weep holes, fluid drainage ports, or the like.

[00023] 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, various embodiments achieve 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.

[00024] 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).

[00025] This also allows the volume within the aircraft that needs to be waterproof to be minimized, thus reducing weight and overall system complexity.

[00026] 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.

[00027] 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.

[00028] 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.

[00029] The illustrations and examples provided herein are for explanatory purposes and are not intended to limit the scope of the appended claims. This disclosure is to be considered an exemplification of the principles of the invention and is not intended to limit the spirit and scope of the invention and/or claims of the embodiment illustrated.

[00030] Those skilled in the art will make modifications to the invention for particular applications of the invention.

[00031] The discussion included in this patent is intended to serve as a basic description. The reader should be aware that the specific discussion may not explicitly describe all embodiments possible and alternatives are implicit. Also, this discussion may not fully explain the generic nature of the invention and may not explicitly show how each feature or element can actually be representative or equivalent elements. Again, these are implicitly included in this disclosure. Where the invention is described in device-oriented terminology, each element of the device implicitly performs a function. It should also be understood that a variety of changes may be made without departing from the essence of the invention. Such

changes are also implicitly included in the description. These changes still fall within the scope of this invention.

[00032] Further, each of the various elements of the invention and claims may also be achieved in a variety of manners. This disclosure should be understood to encompass each such variation, be it a variation of any apparatus embodiment, a method embodiment, or even merely a variation of any element of these. Particularly, it should be understood that as the disclosure relates to elements of the invention, the words for each element may be expressed by equivalent apparatus terms even if only the function or result is the same. Such equivalent, broader, or even more generic terms should be considered to be encompassed in the description of each element or action. Such terms can be substituted where desired to make explicit the implicitly broad coverage to which this invention is entitled. It should be understood that all actions may be expressed as a means for taking that action or as an element which causes that action. Similarly, each physical element disclosed should be understood to encompass a disclosure of the action which that physical element facilitates. Such changes and alternative terms are to be understood to be explicitly included in the description.

[00033] 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.

WHAT IS CLAIMED IS:

1. An amphibious unmanned aerial vehicle comprising:
 - a) a fuselage comprised of a buoyant material walls;
 - b) separators within the fuselage forming separate compartments within the fuselage;
 - c) mounts associated with the compartments for securing waterproof aircraft components within the fuselage;and
 - d) the compartments each having drainage openings in the fuselage extending from the interior of the fuselage to the exterior of the fuselage.
2. The amphibious unmanned aerial vehicle of Claim 1, wherein the drainage openings in at least some of the compartments comprise weep holes through a wall of the fuselage.
3. The amphibious unmanned aerial vehicle of Claim 1, wherein at least one of the compartments comprises a drainage channel at a bottom thereof, and wherein the drainage channel comprises at least one drainage opening associated therewith.
4. The amphibious unmanned aerial vehicle of Claim 3, wherein the at least one drainage opening comprises a weep hole.
5. The amphibious unmanned aerial vehicle of Claim 3, wherein the at least one drainage opening comprises a plurality of weep holes.
6. The amphibious unmanned aerial vehicle of Claim 1, wherein the separate compartments comprise:

- a) a forward battery compartment;
- b) a central payload compartment; and
- c) a rear avionics compartment.

7. The amphibious unmanned aerial vehicle of Claim 1, further comprising at least one skid pad on a bottom of the fuselage.

8. The amphibious unmanned aerial vehicle of Claim 1 further comprising drainage openings extending through the separators within the fuselage.

9. The amphibious unmanned aerial vehicle of Claim 1 further comprising securing mechanisms associated with the compartments to secure the waterproof aircraft components in the compartments.

10. The amphibious unmanned aerial vehicle of Claim 1, wherein at least some of the mounts within the compartments comprise integrated connectors for electrically connecting a corresponding aircraft component upon mounting of the corresponding aircraft component within a respective compartment.

11. The amphibious unmanned aerial vehicle of Claim 1, wherein the compartments comprise a battery compartment comprising a surface mount connector flush with a mounting surface of the mounts within the battery compartment.

12. The amphibious unmanned aerial vehicle of Claim 1, wherein the compartments comprise a payload compartment comprising a surface mount connector flush with a mounting surface of the mounts within the payload compartment.

13. The amphibious unmanned aerial vehicle of Claim 1, wherein the compartments comprise a payload compartment comprising an open bottom.

14. The amphibious unmanned aerial vehicle of Claim 13, wherein there is substantially no fuselage wall below the payload compartment.

15. The amphibious unmanned aerial vehicle of Claim 1, wherein the compartments comprise an avionics compartment comprising a heat sink opening.

16. An amphibious unmanned aerial vehicle comprising:
a) a fuselage constructed of a buoyant material;
b) separators within the fuselage forming separate battery, payload, and avionics compartments within the fuselage;

c) mounts associated with the compartments for securing a battery, a payload, and avionics within the fuselage; and

d) drainage openings extending through the wall of fuselage to connect the compartments with the exterior of the unmanned aerial vehicle.

17. The amphibious unmanned aerial vehicle of Claim 16, wherein the battery compartment further comprises at least one drainage channel.

18. The amphibious unmanned aerial vehicle of Claim 17, wherein the at least one drainage channel comprises at least one of the drainage openings therein.

19. The amphibious unmanned aerial vehicle of Claim 18, wherein the at least one of the drainage openings comprises a plurality of weep holes.

20. The amphibious unmanned aerial vehicle of Claim 16, wherein the avionics compartment further comprises at least one drainage channel.

21. The amphibious unmanned aerial vehicle of Claim 20, wherein the at least one drainage channel comprises at least one of the drainage openings therein.

22. The amphibious unmanned aerial vehicle of Claim 21, wherein the at least one of the drainage openings comprises a plurality of weep holes.

23. An amphibious unmanned aerial vehicle comprising:

- a) a fuselage constructed of a buoyant material;
- b) separators within the fuselage forming separate battery, payload, and avionics compartments within the fuselage, the compartments comprising:
 - (1) the battery compartment comprising a drainage channel comprising at least one weep hole through the fuselage;
 - (2) the payload compartment comprising an open bottom; and
 - (3) the avionics compartment comprising a drainage channel comprising at least one weep hole through the fuselage; and
- c) mounting surfaces within the battery, payload, and avionics compartments for mounting a battery module, a payload module, and an avionics module within the fuselage.