(12) UK Patent (19) GB (11) 2584833 (13) B

(45) Date of B Publication 08.06.2022

(54) Title of the Invention: Methods and assemblies for mounting equipment to an aircraft

(51) INT CL: ***B64C 1/36*** (2006.01) ***B64C 5/02*** (2006.01) ***B64C 5/06*** (2006.01) ***B64C 7/00*** (2006.01)

(21) Application No: **1908241.1**

(22) Date of Filing: **10.06.2019**

(43) Date of A Publication **23.12.2020**

(56) Documents Cited:

EP 3239038 A1
EP 2100811 A2
CN 109305323 A
US 8063837 B1
US 20190162268 A1
US 20180351243 A1

(58) Field of Search:

As for published application 2584833 A viz:
INT CL **B64C**
Other: **WPI, EPODOC**
updated as appropriate

Additional Fields
INT CL **B64C, B64D, B64F, H01Q**
Other: **WPI, EPODOC**

(72) Inventor(s):

Andrew Giles Pursey
Laurence Baron

(73) Proprietor(s):

Raytheon Systems Limited
Kao One, Kao Park, HARLOW, Essex, CM17 9NA, United Kingdom

(74) Agent and/or Address for Service:

Carpmaels & Ransford LLP
One Southampton Row, London, WC1B 5HA, United Kingdom

GB 2584833 B

FIG. 1 (prior art)

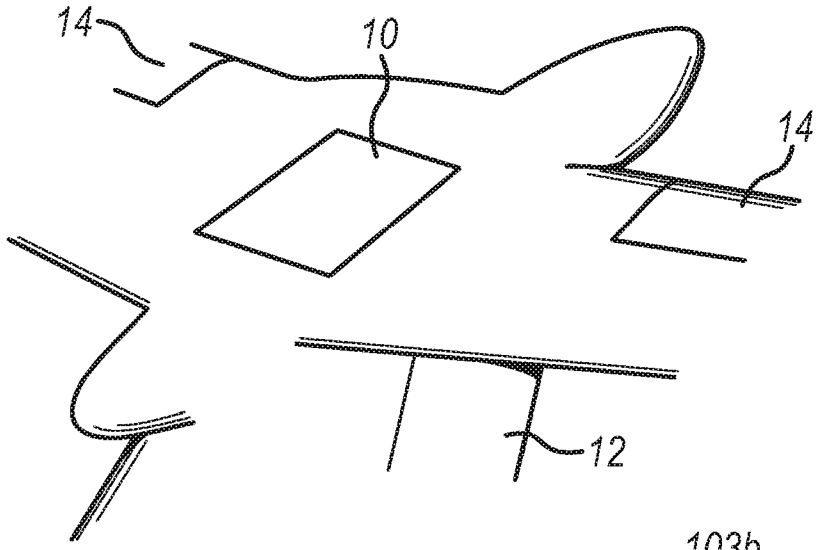


FIG. 2a

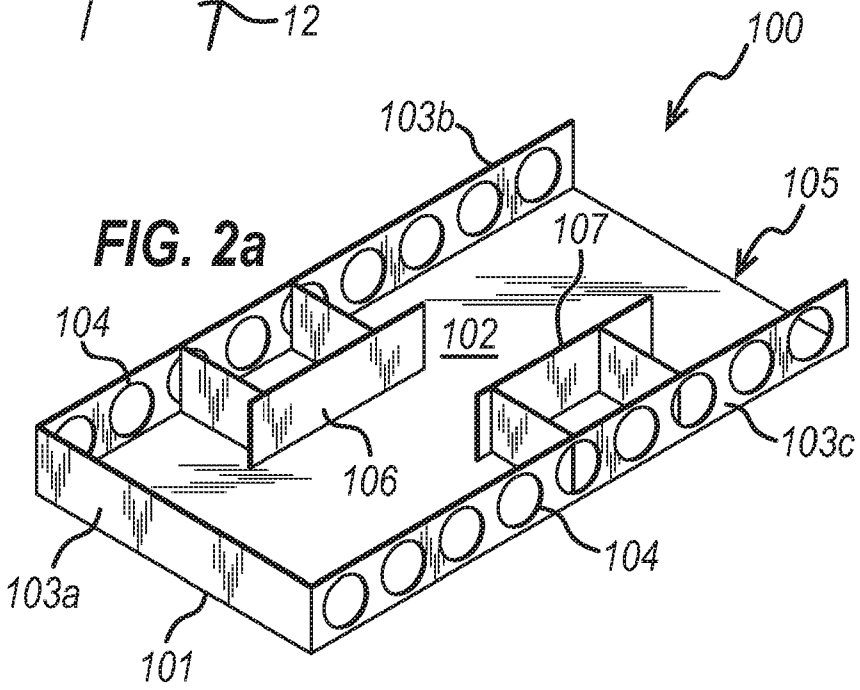
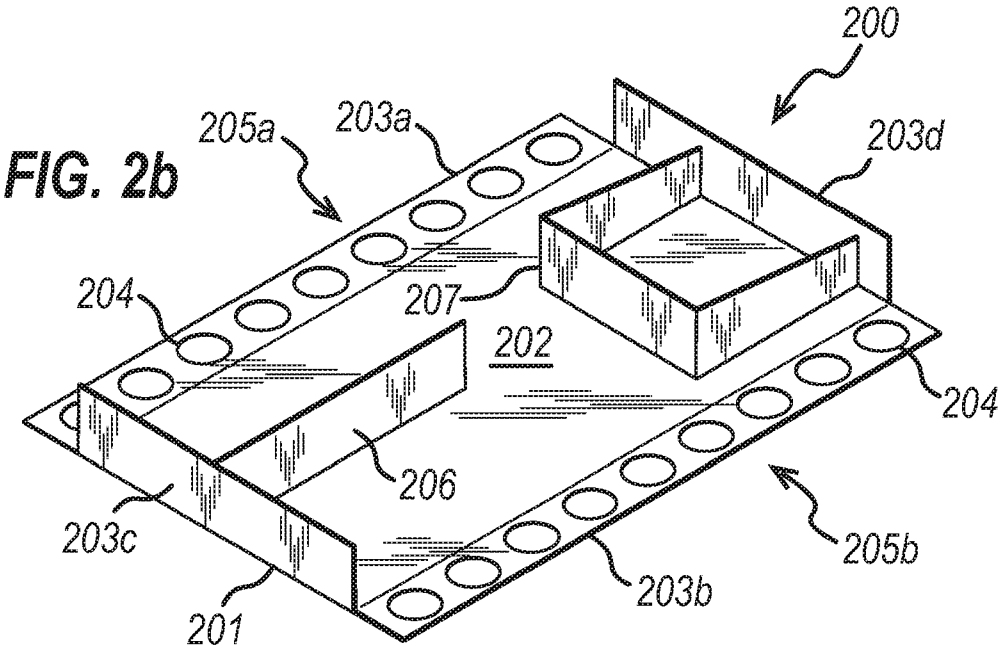


FIG. 2b



10 09 20

FIG. 3

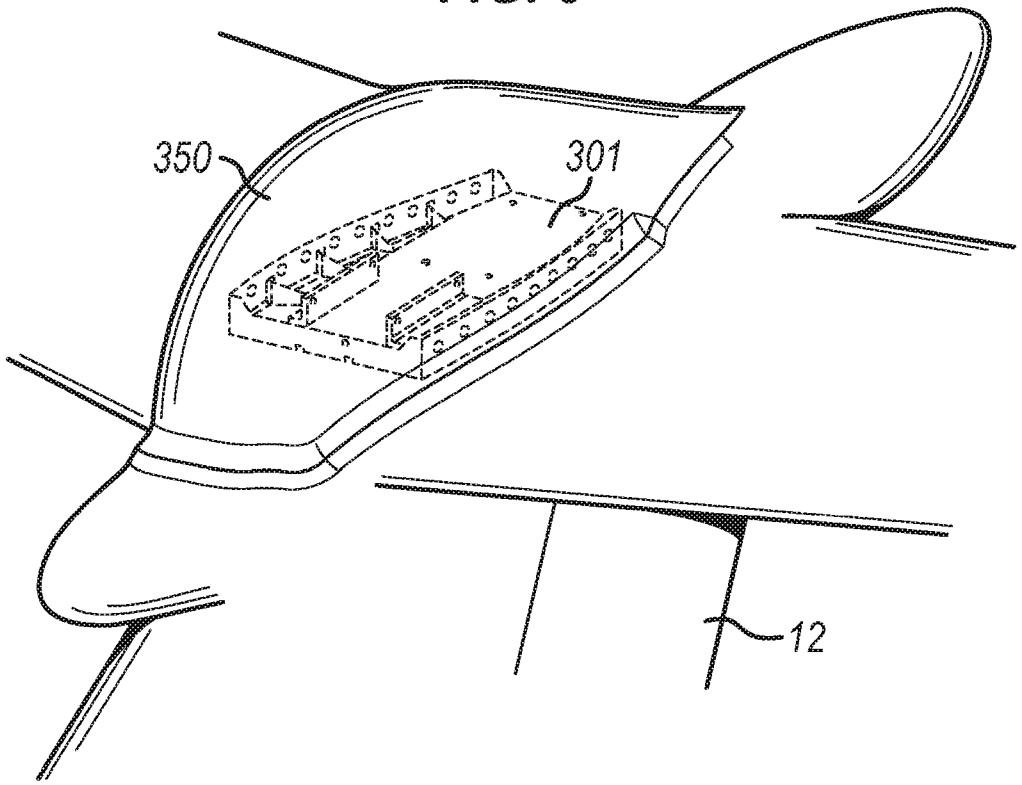


FIG. 4

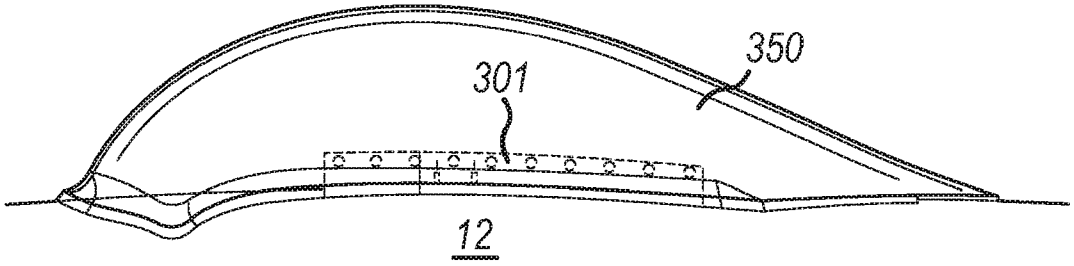
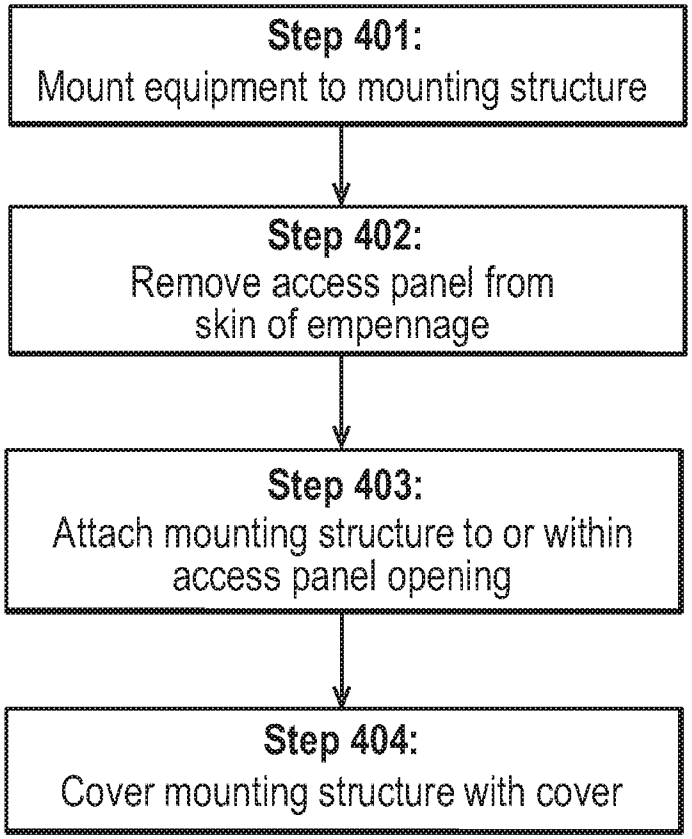


FIG. 5



Methods and assemblies for mounting equipment to an aircraft

Field of the Invention

[001] The present invention relates to a method of mounting equipment to an aircraft, and in particular mounting equipment to an aircraft having an empennage. In one aspect, the invention relates to a method of mounting equipment to a tailplane. An equipment assembly is also provided, along with a structure for an aircraft for attaching the equipment assembly. A tailplane comprising the structure for attaching the equipment assembly is also provided, along with an empennage or an aircraft comprising the structure for attaching the equipment assembly.

Background

[002] Equipment such as sensors, recording equipment and electronic equipment or systems, including electronic circuits can be added to the exterior of an aircraft as circumstances dictate. Whilst one might suppose that a number of different locations on an aircraft may be used for these purposes, in fact it is the case that adverse effects can arise in respect of both equipment and aircraft performance, depending on the nature of the equipment and the site for the equipment. For example, mounting equipment to the outside of the aircraft's main body or fuselage may significantly adversely affect the aerodynamic profile of the aircraft. Furthermore, positioning equipment such as sensors, recording equipment or electronic equipment or systems, including electronic circuits in certain locations inside or outside the aircraft may not be optimal, for instance due to presence of wings, engine parts, and so on.

[003] KR101092752B discloses equipment that is internal to the aircraft and is protected by a structure that conforms to the aircraft vertical stabiliser. US3613098A also discloses equipment that is internal to the aircraft and is protected by a structure that is flush with the aircraft's vertical stabiliser. Because in both of these cases the equipment is located inside the aircraft body, its performance is affected. Moreover, there is often difficulty mounting equipment in such a location. US4057104A discloses a rounded aerofoil-shaped pod mounted on top of a vertical stabiliser of an aircraft. The longitudinal axis of the pod is aligned with the top of the vertical stabiliser. Again, accessing the space inside the pod can be difficult, and moreover the space afforded by such an arrangement is highly constrained.

[004] There is thus a need for a simple way to attach equipment to the exterior of an aircraft whilst maximising ease of installation and available space for the equipment without adversely affecting its performance or the aerodynamic profile of the aircraft.

Summary of the Invention

[005] In a first aspect, the present invention provides a method of mounting equipment to an aircraft having an empennage. The method comprises mounting equipment to a mounting structure for mounting to the aircraft. Prior to, contemporaneously with or after this step is performed, the method comprises removing an access panel from the outer skin of the empennage of the aircraft to reveal an access panel opening into the empennage. Aircraft engineers are familiar with access panels on aircraft body structures, including empennage structures, and the step of removing an access panel from the outer skin of the empennage is straightforward and can be achieved with conventional tools.

[006] Once the access panel opening is revealed, the method comprises attaching the mounting structure to or within the access panel opening such that at least a portion of the equipment extends beyond the outer skin of the empennage. In placing at least a portion of the equipment such that it extends beyond the outer skin of the empennage, the performance of the equipment is compromised as little as possible; that is, the effect of the aircraft structures on the equipment will be reduced compared with mounting the equipment within the aircraft.

[007] In attaching the mounting structure to or within the access panel opening, the shape of the mounting structure at least partly conforms to the shape of the access panel opening so as to facilitate the attachment between the two structures and minimise undesirable gaps in the surface of the structure or skin of the aircraft.

[008] The method comprises covering the mounting structure and the equipment mounted thereon with a cover, and attaching the cover to the mounting structure or the empennage. Placing a cover over the equipment preserves as far as possible the trim of the aircraft and minimises drag, whilst avoiding interference with the performance of the equipment. For instance, the cover may preferably be constructed from materials which compromise the performance of the equipment to a lesser extent than the aircraft structure, for example a composite material, a reinforced plastic material, a carbon fibre material or a metal to suit the

equipment being covered by the cover. For instance, if the equipment includes a camera, the cover may be transparent.

[009] Preferably the access panel is a planar (i.e. flat) inspection panel. This facilitates mounting of a mounting structure which preserves as far as possible the performance of the equipment mounted thereon, and provision of a cover which interferes with the trim of the aircraft as little as possible. Preferably the access panel opening is a planar inspection panel opening for providing access to the empennage of the aircraft. By 'access' it is meant access to the interior structure of the empennage beneath the skin of the aircraft.

[010] Whilst the invention may be performed on an empennage of any construction, preferably the empennage has T-tail configuration comprising a fin mounted to a fuselage of the aircraft at its lower end, and a tailplane mounted to the fin at its upper end. In that case, the step of removing an access panel comprises removing an access panel from the upper surface of the tailplane. It will be appreciated that locating equipment on the upper surface of a tailplane that is mounted to the upper end of a fin extending from the fuselage will provide the equipment with more space than would otherwise be available, and minimise the effect on the equipment from other aircraft structures.

[011] In the case of an empennage having a T-tail configuration, preferably the step of removing an access panel comprises removing an access panel from a central region of the upper surface of the tailplane. Preferably, the central region is located equidistantly between two control surfaces on the empennage. Typically, such control surfaces on the tailplane of a T-tail empennage are elevators, and locating the equipment in an access panel opening here will locate it away from structures and systems which may get in the way of, or otherwise interfere with, the equipment. Thus, this location facilitates mounting the equipment to the aircraft.

[012] As described in more detail elsewhere herein, preferably the mounting structure is a tray comprising a planar base and at least one mounting portion extending in parallel with or orthogonally to the base. For example, the planar base may have one or more sides, forming the at least one mounting portion, which may be upstanding around at least part of the periphery of the base. The sides may extend in one or both directions away from the plane of the planar base, and may extend around some or all of the periphery. Alternatively, the at least one mounting portion may extend in the same plane as the planar base, again around at least some or all of the periphery. The mounting portion may extend parallel with the base, but in a different plane and be attached to the base via a stepped arrangement. In

any event, the step of attaching the mounting structure to or within the access panel opening preferably comprises passing one or more fasteners through the at least one mounting portion. The fasteners are preferably one or more of screws, nuts and bolts, but may be another suitable fastening mechanism. Of course, in other embodiments, the mounting structure may be welded or glued in place.

[013] Preferably the fasteners extend from or are passed though the at least one mounting structure to engage a corresponding one or more fastening sites in the access panel opening or in an adjacent empennage structure. Preferably they pass through holes in the mounting structure.

[014] Prior to the invention taking place, these fastening sites may be used to locate the access panel to the empennage. Thus, in some preferred embodiments, the step of removing the access panel from the outer skin of the empennage of the aircraft comprises removing one or more fasteners passing through the access panel from the said one or more fastening sites.

[015] Similarly, as described in more detail elsewhere herein, the cover has a lower portion, beneath a main wall of the cover, which is used to attach the cover to the empennage. For example, the cover may have one or more sides at the lower portion, which may extend at least partially obliquely, preferably laterally, around at least part of the periphery of the lower edge of the cover. Alternatively, the lower portion may extend in the same plane as the cover wall, again around at least some or all of the periphery. The mounting portion may extend parallel with the cover wall, but in a different plane and be attached to the cover wall via a stepped arrangement.

[016] In any event, preferably the step of attaching the cover to the mounting structure or the empennage comprises passing one or more fasteners through the lower portion of the cover to a corresponding one or more fastening sites in the mounting structure, in the access panel opening or in an adjacent empennage structure. Again, the fasteners may be one or more of screws, nuts and bolts or other suitable fastening mechanism. Of course, in other embodiments, the mounting structure may be welded or glued in place.

[017] In some embodiments, a method according to the invention further comprises the step of routing cables from the aircraft to the equipment on the mounting structure. The cables may transmit electrical power and/or communication or control signals. The cables

may be coupled to the equipment from any suitable location about the aircraft, including from the aircraft cockpit, cabin or avionics equipment bays.

[018] In some cases, it may be preferable to remove an anti-collision light or any other part conventionally located on the empennage from its location (nominally a 'first' location) on the empennage. This may be done prior to at least the step of attaching the mounting structure to or within the access panel opening, and possibly prior to other of the method steps. The anti-collision light may prevent or hinder removal of the access panel, and/or attachment of the mounting structure to or within the access panel opening. Furthermore, the anti-collision light may effect the performance of the equipment.

[019] Preferably the method further comprises the step of reattaching the anti-collision light to a different location (nominally a 'second' location) on the empennage, or in some cases elsewhere on the aircraft body altogether. Anti-collision lights are usually desirable, and so it is preferably to retain them where possible.

Brief Description of the Drawings

[036] The invention will now be described in detail with reference to the accompanying drawings, in which:

[037] Figure 1 shows a perspective view of a prior art empennage of an aircraft showing an exemplary inspection hatch in situ;

[038] Figure 2a shows a perspective view of an equipment assembly according to a first embodiment of the invention;

[039] Figure 2b shows a perspective view of an equipment assembly according to a second embodiment of the invention;

[040] Figure 3 shows a perspective view of an equipment assembly according to the present invention mounted to an empennage of an aircraft;

[041] Figure 4 shows a side view of the equipment assembly of Figure 3; and

[042] Figure 5 shows a flow diagram of a method according to the present invention.

Detailed Description

[043] With reference to the drawings, there is shown a system for providing equipment such as sensors, recording equipment and various electronic equipment or systems, including electronic circuits to the exterior of an aircraft. The system comprises a mounting structure 100, 200. The mounting structure in this example takes the form of a tray 101, 201 which comprises a base 102, 202 and edge portions 103 (or sides). In the examples shown in figures 2a and 2b, the base 102, 202 is substantially rectangular. In the example shown in figure 2a, the structure has three sides 103 extending perpendicular to the base. Two of the three sides 103b, 103c (in this case, the long sides) oppose either other; that is, they are provided on opposite sides of the base. The third side 103a extends between the two opposing sides at one end of the base 102. In the example shown in figure 2b, the structure has two opposing edge portions 203a, 203b (in this case, the long edges) extending in the same plane as the base, and two opposing sides portions 203c, 203d (in this case, the short edges) extending perpendicular to the base. However, the skilled person would appreciate that the base could take any shape, and be provided with any number of corresponding edge portions or sides. For example, a square/rectangular base with any two edges (i.e. adjacent, or opposing), three edges or four edges. Similarly, a circular base with a continuous edge can be used. In essence, the mounting structure is readily customisable as required.

[044] As shown in figures 3 and 4 of the drawings, the base and edges of the mounting structure are curved so as to conform to the curvature of an aircraft in which mounting structure may be mounted. Alternatively, the base and edges may be generally planar, as shown in figures 2a and 2b, for example. As another alternative, the surface of the base

which is closest to an aircraft can be curved to conform thereto and the opposite surface can be planar. In other words, the base thickness is not uniform and tapers as required.

[045] The edge portions or sides 103, 203 of the tray contain a series of openings or holes 104, 204. The holes provide the means by which the mounting structure 100, 200 may be attached to the aircraft. For example, a screw or bolt may be fed through each of the holes in the tray, and a corresponding opening or hole in the aircraft. Alternative fastening means will be readily apparent to the skilled person.

[046] In the examples shown, the dimensions of the tray 101, 201 are 400mm (width) by 300mm (length) by 60mm (height), though preferred dimensions may differ. For example, the tray's width may be between 100mm and 1000mm, preferably between 200mm and 800mm, preferably between 300mm and 600mm. The tray's length may be between 50mm and 800mm, preferably between 100mm and 600mm, preferably between 200mm and 400mm. The tray's height may be between 10mm and 110mm, preferably between 30mm and 90mm, preferably between 50mm and 70mm. Of course, these dimensions are purely exemplary for a typical aircraft and could be bigger or small depending on the application.

[047] The mounting structure is made from aluminium, but may be made from any suitable metal, including titanium, or conductive material, or a carbon fibre material or composite material or reinforced plastics material.

[048] As shown in figure 2a of the drawings, the tray 101 only has three perpendicularly extending sides. This means that the tray has an open end 105 which allow cables to be easily routed to and from the mounting structure 100. As shown in figure 2b of the drawings, the tray 201 has two edge portions extending in the same plane as the base. This means that the tray has two open sides 205a, 205b which allow cables to be easily routed to and from the mounting structure 200.

[049] The mounting structure 100, 200 has a number of brackets 106, 107, 206, 207 to assist with the mounting of equipment therein. The mounting tray 101, 201 can be compartmentalized to assist with the mounting of equipment and/or provision of isolation between different pieces of equipment.

[050] The tray comprises a variety of equipment (not shown) including sensors, recording equipment and various electronic equipment or systems, including electronic circuits. The equipment can be permanently attached to the tray 101, 102, for example via the one or

more brackets 106, 107, 206, 207, which means that different configurations of equipment can readily attached to the aircraft by changing the mounting structure. Alternatively, certain equipment can use a plug and socket architecture to facilitate change of individual components. Given that the surface of the base 102, 202 which is closest to an aircraft can be curved to conform thereto, this means that the opposite surface and equipment thereon is external to the main body of the aircraft. Accordingly, the equipment is less likely to be interfered with the aircraft body. The equipment can thus perform optimally. For example, certain circuits can be compartmentalised to further isolate them from the aircraft body.

[051] Of course, such equipment cannot be directly exposed to the environment in which the aircraft may operate. Accordingly the equipment is protected by a cover 350 as shown in figures 3 and 4 of the drawings. The cover 350 is configured to have a minimum width, length and height that covers the mounting tray 301 and equipment (not shown) installed therein. Whilst somewhat constrained by the dimensions of the mounting tray 301 and equipment installed therein, the overall shape of the cover 350 is optimised in a manner that preserves the aerodynamic profile of the aircraft. For example, if the mounting tray 301 was located on top of the T-Tail and centrally between the elevators on T-Tail, as shown in figure 3, the cover 350 could be shaped so that the trim of the aircraft is preserved. In effect, the system located on the T-Tail of an aircraft has no adverse aircraft performance characteristics. The skilled person in the field of aerodynamics can readily design a cover to cover the mounting structure and the equipment installed without adversely affecting the aircraft trim.

[052] To assist with the attaching the cover 350 to the mounting structure 300, the cover 350 can have series of holes (not shown) that correspond and align with the series of holes in the mounting structure 300. A screw or bolt may be fed through each hole in the cover and a corresponding hole in the both the mounting structure and aircraft to fasten both the mounting structure and cover to the aircraft. This helps maintain a secure alignment between the mounting structure and cover which in turn improves the seal therebetween.

[053] In performing a method according to the invention, equipment is mounted to the mounting structure (step 401). This can be done before or after attaching the system to the aircraft. To attach the system to a T-tail aircraft, a flat inspection panel 10 located on top of the T-Tail 12 and centrally between the elevators 14 on the T-Tail can be removed (step 402). An exemplary T-tail is shown in figure 1. Alternatively, the system could be fitted during manufacture of the aircraft instead of the flat inspection panel 10. The mounting structure 100, 200, 300 is then placed in the void left by the removal of the flat inspect panel

10 (step 403). The tray can either have equipment including sensors, recording equipment and various electronic equipment or systems, including electronic circuits pre-installed or alternatively it can be installed after placement of the mounting structure (e.g. using plug and socket architecture). Any cable connection (not shown) to/from the aircraft itself can be made using an open end (or hole) of the mounting tray, as described above. The cover 350 is then placed over and aligned with the mounting structure 100, 200, 300 (step 404). Redundant fastener locations that exist due to the removal of the flat inspection panel 10 can then be used to secure the system as explained above.

[054] In terms of equipment which may be placed in the mounting structure 100, 200, 300, a variety of uses are particularly advantageous. In particular, the mounting structure 100, 200, 300 may be configured to contain sensors and such like. Due to its particular location, and ease of access to the external environment, the mounting structure may contain or be configured to contain electrically sensitive or electrically noisy equipment, equipment such as sensors that would benefit from an uninterrupted field of view outside the aircraft, or equipment which may be useful to affect the balance of the aircraft. The mounting structure may contain or be configured to contain equipment for surveying or weather monitoring, such as cameras, sensors, and suchlike.

[055] It will be appreciated that, in use, the mounting structure 100, 200, 300 is unpressurised and unheated, such that when the aircraft is flying, for example at cruise altitude, it would be particularly advantageous to use it to provide a low temperature and low pressure environment, very close to ambient. This facilitates the use of the mounting structure to contain equipment that requires a low temperature or low pressure environment to operate, and/or is not capable of being actively cooled and therefore benefits from passive cooling from the surrounding environment. Such equipment may include high powered and/or acoustically noisy equipment, which may include avionics equipment, power converters or amplifiers that may operate with high power and therefore generate high temperatures during operation; or temperature sensing equipment that needs to operate frequently at sub-zero (deg C) temperatures.

[056] It will be appreciated that the location of the mounting structure 100, 200, 300 on the T-tail 12 means that it may be particularly advantageous to use it for storage of equipment to benefit the loading and/or balance of the aircraft. For example, where an aircraft may be loaded with significant weight toward the nose of the fuselage, equipment positioned in the mounting structure may act as a counterbalance.

[057] It will be appreciated that because the mounting structure 100, 200, 300 is external to the fuselage and thus isolated from the interior and the avionic systems contained therein, it would be particularly advantageous to use it to contain equipment that is either electrically sensitive (and would therefore be undesirably influenced by the electronic systems within the fuselage) or electrically noisy (and would therefore undesirably influence the aircraft systems within the fuselage). Thus, the mounting structure offers an optimal location in terms of achieving Electromagnetic Compatibility (EMC) and/or to isolate radiated emissions from inside or outside the aircraft. For example, since the mounting structure is located as far away as possible from the rest of the platform avionics systems as possible to reduce the risk of EMC interference.

[058] It will be appreciated that because the mounting structure is adjacent the empennage structure, it would be particularly advantageous to use it for datalogging equipment for measuring and/or and recording parameters related to the elevators, rudder and other equipment mounted in the tail, for the purposes of testing and evaluation.

[059] Thus, a method and system have been described with can allow the retrofitting of equipment to a T-tail aircraft in a location that provides an optimal position. The system is securely sealed and anchored to the aircraft and permits optimal equipment performance.

Claims

1. A method of mounting equipment to an aircraft having an empennage, the method comprising;

mounting equipment to a mounting structure for mounting to the aircraft;

removing an access panel from the outer skin of the empennage of the aircraft to reveal an access panel opening into the empennage;

attaching the mounting structure to or within the access panel opening such that at least a portion of the equipment extends beyond the outer skin of the empennage, and wherein the shape of the mounting structure at least partly conforms to the shape of the access panel opening; and

covering the mounting structure and the equipment mounted thereon with a cover, and attaching the cover to the mounting structure or the empennage.

2. The method of claim 1, wherein the access panel is a planar inspection panel, and wherein the access panel opening is a planar inspection panel opening for providing access to the empennage of the aircraft.

3. The method of any preceding claim, wherein the empennage has T-tail configuration comprising a fin mounted to a fuselage of the aircraft at its lower end, and a tailplane mounted to the fin at its upper end, and wherein the step of removing an access panel comprises removing an access panel from the upper surface of the tailplane.

4. The method of claim 3, wherein the step of removing an access panel comprises removing an access panel from a central region of the upper surface of the tailplane, wherein the central region is preferably located equidistantly between two control surfaces, preferably elevators, on the empennage.

5. The method of any preceding claim, wherein the mounting structure is a tray comprising a planar base and at least one mounting portion extending in parallel with or orthogonally to the base, and wherein the step of attaching the mounting structure to or within the access panel opening comprises passing one or more fasteners through the at least one mounting portion to a corresponding one or more fastening sites in the access panel opening or in an adjacent empennage structure.

6. The method of claim 5, wherein the step of removing the access panel from the outer skin of the empennage of the aircraft comprises removing one or more fasteners passing through the access panel from the said one or more fastening sites.

7. The method of any preceding claim, wherein the step of attaching the cover to the mounting structure or the empennage comprises passing one or more fasteners through a lower portion of the cover to a corresponding one or more fastening sites in the mounting structure, in the access panel opening or in an adjacent empennage structure.

8. The method of any preceding claim, wherein the equipment comprises one or more sensors, one or more pieces of recording equipment and/or one or more electronic equipment or systems, including electronic circuits.

9. The method of any preceding claim, further comprising the step of routing cables from the aircraft, preferably the aircraft cockpit or cabin, to the equipment on the mounting structure.

10. The method of any preceding claim, wherein prior to the step of attaching the mounting structure to or within the access panel opening, the method further comprises removing an anti-collision light from a first location on the empennage.

11. The method of claim 10, further comprising the step of reattaching the anti-collision light to a second location on the empennage, different from the first location.