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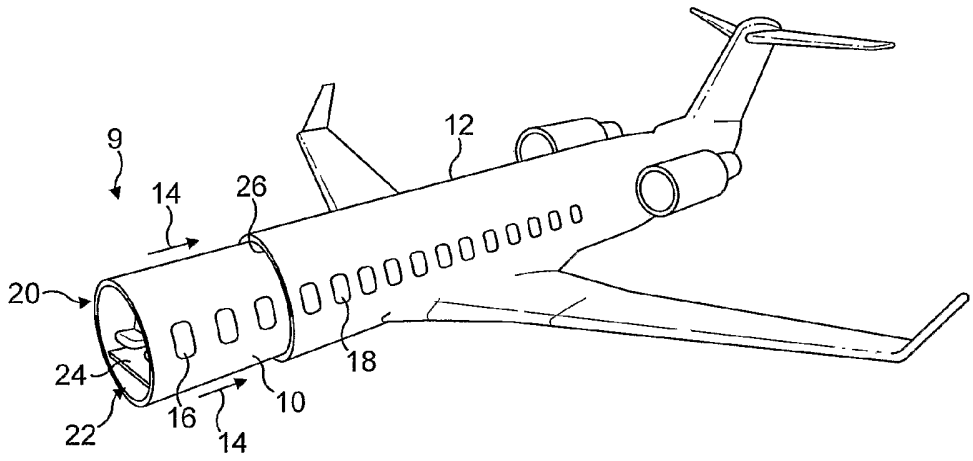
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(54) **Title:** AIRCRAFT INTERIOR MODULE



(57) **Abstract:** An aircraft interior module (9) is described which can be manufactured independently of an aircraft fuselage (12) to define a passenger cabin (20) therein. The module (9) can be inserted into the fuselage (12) prior to final assembly, thereby parallelising some of the manufacturing process resulting in time savings and more efficient utilisation of resources. The disclosed new manufacturing method is particularly, although not exclusively, applicable to small jets and turboprop aircrafts.

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AIRCRAFT INTERIOR MODULE

The present invention relates to a method of aircraft manufacture and to aircraft interior modules therefor.

Known methods of aircraft manufacture involve the assembly of the aircraft to a so-called "green stage", which is followed by a separate fitting out stage during which the interior components of the aircraft are added. This series of manufacturing steps means the total manufacturing time for the aircraft includes assembling the aircraft to the green stage and only then adding the interior fittings.

The passenger seats for a commercial aircraft are generally bolted to sets of tracks in the floor of the aircraft cabin. The means of attachment of an aircraft seat is a structurally weak point. It would be desirable to increase the strength of the attachment of the seats.

It is also generally desirable to reduce the weight of an aircraft to make it more fuel efficient. At the same time, essential requirements of the aircraft cabin, such as providing a pressurised environment for the passengers, and generally addressing passenger safety, must be maintained.

In a first aspect of the invention, there is provided a method of aircraft manufacture as defined in claim 1. According to embodiments of the invention an aircraft interior module is inserted into an aircraft fuselage to provide a passenger cabin. Manufacturing time is reduced as compared with the conventional method of manufacturing because the interior fitting can be incorporated within the fuselage at the same time as the aircraft is being assembled to the green stage.

The module may be tubular and may be inserted into the shell in a longitudinal direction. Preferably, the module has an exterior shape that substantially complements the interior shape of the fuselage. Preferably, the module is inserted through the front of the fuselage before the nose cone of the aircraft is put in place. Advantageously, the module may include all interior fittings of the passenger cabins. The manufacture of the aircraft fuselage and the module may be carried out in parallel, thereby shortening the manufacturing time as both the fuselage and the module are being assembled in parallel and combined

In a further aspect of the invention, there is provided an aircraft interior module as defined in claim 6.

The module may include one or more connectors which are arranged to mate with corresponding connectors on the shell when the module is inserted into the fuselage in order to establish the required electrical, hydraulic or pneumatic connections between the module and the fuselage. This provides for a form of 'plug and play' connection. The module may further define a cabin floor of the passenger cabin. Advantageously, the module may have seat structures integrally moulded therewith, for example with the cabin floor. This may result in a significant weight reduction for a given specification of seat rigidity and strength. The cabin floor may be integrally moulded with the rest of the module. The module may be manufactured from fibre-reinforced composite materials, for example the tubular structure may be made from filament wound fibre reinforced composite material. Preferably, each module has an integrity which allows it to be pressurisable either as an item or when connected as a series of modules in a fuselage.

In a further aspect of the invention, there is provided an aircraft as defined in claim 13. Preferably, the module is arranged as a pressurisable vessel to

maintain cabin pressure inside the aircraft. Preferably, the module is secured to the fuselage of the aircraft by a frangible connection. Advantageously, breaking of the frangible connection in the event of an aircraft crash and the resulting relative motion of the module with respect to the fuselage can absorb some of the energy of the impact of the crash resulting in increased crash protection for the passengers of the aircraft.

Exemplary specific embodiments are now described with reference to the accompanying drawings in which:

Figure 1 is a flow diagram of a manufacturing method according to the specific embodiment;

Figure 2 illustrates insertion of an aircraft interior module into a fuselage; and

Figure 3 is a cross-sectional view of the module inserted into the fuselage.

The method of aircraft manufacture according to a specific embodiment of the invention is now described with reference to Figure 1. As in conventional aircraft manufacture, the fuselage of the aircraft is assembled to a 'green' stage at step 2, which would normally be followed by a series of steps fitting out the interior of the aircraft. Independently of the assembly of the fuselage at step 2, an aircraft interior module is assembled at step 4. This may happen at the same time as step 2, or the module may have been manufactured previously to step 2 and been kept in stock for future use. Of course, it is understood that step 4 may be carried out at any time independent of step 2. The aircraft interior module contains the interior fittings of the aircraft such that the aircraft is fitted out in a single step 6 when the module is inserted into the fuselage. Insertion of the module at step 6 is then followed by final assembly at step 8, including

connecting electrical, hydraulic and/or pneumatic connections as required. In the specific embodiment, the module is inserted into the fuselage before assembly of a nose cone of the aircraft and thus the final assembly 8 includes the assembly of the nose cone after the module has been inserted.

The aircraft interior module and its insertion into the fuselage is now described in further detail with reference to Figures 2 and 3. The module 9 includes a tubular structure 10 which is inserted into the fuselage 12 along its longitudinal direction indicated by arrows 14. The module is generally a complementary clearance fit within the fuselage. Where required, the tubular structure includes openings 16 arranged to line up with windows 18 in the fuselage. The module defines a passenger cabin and cargo space therein, the passenger cabin 20 and cargo space 22 being separated by a cabin floor 24 formed inside the module. In the specific embodiment shown in Figure 2, the fuselage is only partially assembled leaving a forward opening 26 through which the module is inserted. The fuselage may be assembled as far as possible to still allow insertion of the module. Typically, the fuselage will be assembled up to the point of assembly of the nose cone, which is assembled after insertion of the module at step 8.

Figure 3 depicts a cross-section through the fuselage 12 and module 9. The interior of the module includes passenger seats 28 supported above the cabin floor 24 and luggage compartments 30. Of course, it will be understood that the interior fittings of the module will depend on the specific application and can be varied in a manner to suit a particular application as will be apparent to the skilled person.

The seats 28 and luggage compartments 30, as well as any other suitable interior fittings may be moulded together with the tubular structure 10 or cabin floor 24 of the module, resulting in significant weight savings. For example,

the tubular structure 10, the cabin floor 24, and all interior fittings may be manufactured from fibre-reinforced composite materials which can provide structures which are at the same time sufficiently stiff and tough, as well as lightweight. Fibre reinforced composite materials have mechanical properties which are non-isotropic and in order to maximise weight savings, the orientation of the fibres may be arranged such that the materials have maximal strength in the most critical directions.

The tubular structure 10 of the module 9 is secured to the fuselage 12 of the aircraft by supporting structures 32 arranged around the circumference of the tubular structure 10. In one specific embodiment, the supporting structures 32 may define frangible connections between the module 9 and the fuselage 11, which are sufficiently strong to withstand normal operating conditions but are arranged to break when exposed to forces of a magnitude typically encountered during an aircraft crash. Thus, in the event of an aircraft crash, the frangible connections 32 absorb some of the energy of the crash as their fracture energy and further energy of the crash is absorbed by relative motion of the module 9 with respect to the fuselage 11. This absorption of energy may be increased, for example, by providing the outer surface of the tubular structure 10 and the inner surface of fuselage 12 with friction enhancing materials. Thus, this arrangement reduces the amount of energy absorbed by the passengers during an aircraft crash thereby increasing passenger safety.

In another specific embodiment, a fibre reinforced hull of the module is bonded to the fuselage by an adhesive, possible using a honeycomb interface/substrate. Further weight savings may be achieved by also making the fuselage from fibre reinforced material (e.g. filament wound), the required strength being provided by the bonded structure of the composite module and fuselage.

Although Figure 2 depicts the module as being open at its front end (and the module may also be open at its back end, not shown in Figure 2), the module may advantageously be closed at both its ends and may then provide a self-contained pressurisable vessel for maintaining cabin pressure. This reduces the stress on the fuselage which is then not required to maintain cabin pressure. This can be exploited to obtain advantageous weight savings by using lighter materials for the whole of the fuselage. Of course, this means that the tubular structure or hull of the module will have to be produced to a higher specification in order to withstand the pressure differential across it. This can be efficiently achieved by using a filament wound fibre reinforced material for the hull of the module.

The module can be formed to fill an aircraft fuselage on its own. Alternatively, modules can be used as sections which, when inserted one after another, fill in the fuselage. In this case suitable seats are arranged on the fore and aft edges to seal against adjacent modules.

In order to maximise the benefits of the new manufacturing technology disclosed herein, the layout of services to the cabin interior is preferably adapted to allow for efficient connection of any electric, hydraulic or pneumatic connections to the module. In order to increase manufacturing efficiency, these connections should be provided with as few as possible connection points. In one particularly advantageous embodiment, the connections are provided in a 'plug and play' manner such that the respective connectors of the module and the fuselage mate automatically (for example slidingly) as the module is inserted into the fuselage.

The disclosed new manufacturing method is particularly, although not exclusively, applicable to small jets and turboprop aircrafts.

The skilled person will appreciate that variations of the disclosed arrangements are possible without departing from the invention. Accordingly, the above description of specific embodiments is made by way of example and not for the purposes of limitation. It will be clear to the skilled person that minor modifications can be made to the arrangements without significant changes to the operation described above. The present invention is intended to be limited only by the spirit and scope of the following claims.

CLAIMS:

1. A method of aircraft manufacture including inserting an aircraft interior module into an aircraft fuselage; wherein the module includes at least some of the interior fittings of the aircraft and defines a passenger cabin therein.

2. A method as claimed in claim 1 in which the module is inserted before assembly of the nose cone of the aircraft.

3. A method as claimed in claim 1 or claim 2 in which the module is inserted in a longitudinal direction.

4. A method as claimed in claim 1, claim 2 or claim 3 in which the module includes all interior fittings of the cabin.

5. A method as claimed in any one of the preceding claims in which the fuselage and module are manufactured in parallel.

6. An aircraft interior module insertable into an aircraft fuselage, the module including a hull having a substantially tubular section and defining a passenger cabin therein.

7. A module as claimed in claim 6 in which one or more connectors on the module are arranged to slidingly mate with corresponding connectors of the fuselage, thereby establishing one or more of electrical, hydraulic or pneumatic connections between the module and the fuselage.

8. A module as claimed in claim 6 or claim 7 which defines a cabin floor therein.

9. A module as claimed in claim 8 which defines passenger seat structures integrally moulded therewith.

10. A module as claimed in claim 8 or claim 9 in which the cabin floor is integrally moulded with the module.

11. A module as claimed in any one of claims 6 to 10 which is manufactured from fibre reinforced composite.

12. A module as claimed in claim 11 in which the hull is manufactured from filament wound composite material.

13. An aircraft including a module as claimed in any one of claims 6 to 12.

14. An aircraft as claimed in claim 13 in which the module is arranged to act as a pressurisable vessel.

15. An aircraft as claimed in claim 13 or claim 14 in which the module is secured by a frangible connections to a fuselage of the aircraft, thereby partially absorbing impact energy in the event of an aircraft crash.

16. An aircraft as claimed in claim 13 or claim 14 when dependent on claim 11 or 12 in which the module is bonded to the fuselage using an adhesive.

17. An aircraft as claimed in claim 16, in which the module is bonded using a honeycomb interface or substrate.

18. An aircraft as claimed in claim 17 in which the fuselage is ??? from fibre reinforced concrete.

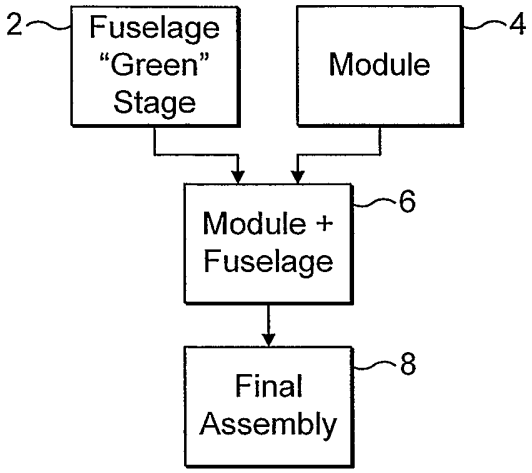


FIG. 1

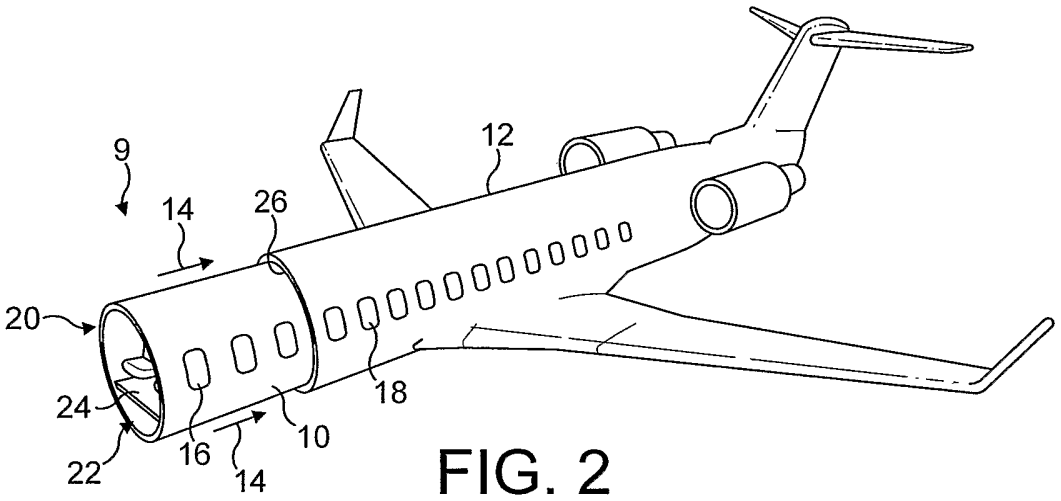


FIG. 2

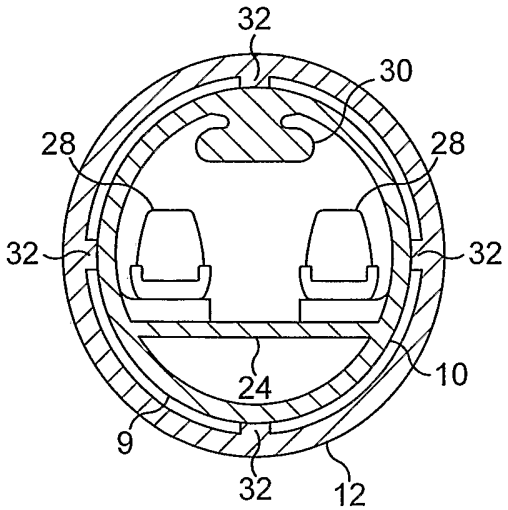


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2006/002245

A. CLASSIFICATION OF SUBJECT MATTER
INV. B64C1/00 B64D11/00

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)
B64C B64D

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 practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 213 427 B1 (MARESKA EDWIN) 10 April 2001 (2001-04-10)	1,3,4, 6-9,11, 13-15
Y	column 2, line 9 - line 42; figures 1-3,7,8 column 3, line 8 - column 5, line 13	12
X	US 4 379 533 A (CALDWELL ET AL) 12 April 1983 (1983-04-12)	1-4,6,8, 13,14
Y		11
A	column 3, line 37 - column 4, line 59; figures 4,11	12

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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
15 September 2006	26/09/2006

Name and mailing address of the ISA/	Authorized officer
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International application No
PCT/GB2006/002245

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	US 4 699 336 A (DIAMOND ET AL) 13 October 1987 (1987-10-13) column 2, line 28 - column 3, line 26; figures 1-4,7	1,4,6-8, 13,14 11,12
X A	US 5 921 504 A (ELIZONDO ET AL) 13 July 1999 (1999-07-13) column 3, line 9 - column 4, line 4; figures 1,4	1,3,4, 6-8,13, 14 11,12
X A	DE 103 09 436 A1 (BORGWARD, GLENN ROLUS) 16 September 2004 (2004-09-16) paragraph [0039] - paragraph [0049]; figures 3a,3b,13c,18,19	1,3,4,6, 8,13,14 11,12
X A	US 2002/043587 A1 (WOLTER DIETMAR) 18 April 2002 (2002-04-18) paragraphs [0011] - [0027], [0033] - [0037]; figures 1-4	1,4,6,8, 13,14 11,12
X A	US 6 494 404 B1 (MEYER JOHN C) 17 December 2002 (2002-12-17) column 4, line 30 - column 5, line 15; figures 1,2,4	1,4,6-8, 13,14 11,12
X	US 2 120 477 A (ADAMS HERBERT LUTHER) 14 June 1938 (1938-06-14) the whole document	1,4,6-8, 13,14
Y A	DE 198 41 799 A1 (GROB, BURKHART, DR. H.C. DIPL.-ING. ETH, 86825 BAD WOERISHOFEN, DE) 8 July 1999 (1999-07-08) the whole document	11,12 1,6
A	DE 42 18 197 A1 (DEUTSCHE AEROSPACE AG, 80804 MUENCHEN, DE; DAIMLER-BENZ AEROSPACE AKTI) 9 December 1993 (1993-12-09) abstract; figures 1-5	1,6

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2006/002245

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6213427 B1	10-04-2001	NONE	
US 4379533 A	12-04-1983	NONE	
US 4699336 A	13-10-1987	NONE	
US 5921504 A	13-07-1999	NONE	
DE 10309436 A1	16-09-2004	WO 2004078588 A1	16-09-2004
US 2002043587 A1	18-04-2002	DE 19908861 A1	07-09-2000
US 6494404 B1	17-12-2002	NONE	
US 2120477 A	14-06-1938	NONE	
DE 19841799 A1	08-07-1999	NONE	
DE 4218197 A1	09-12-1993	NONE	