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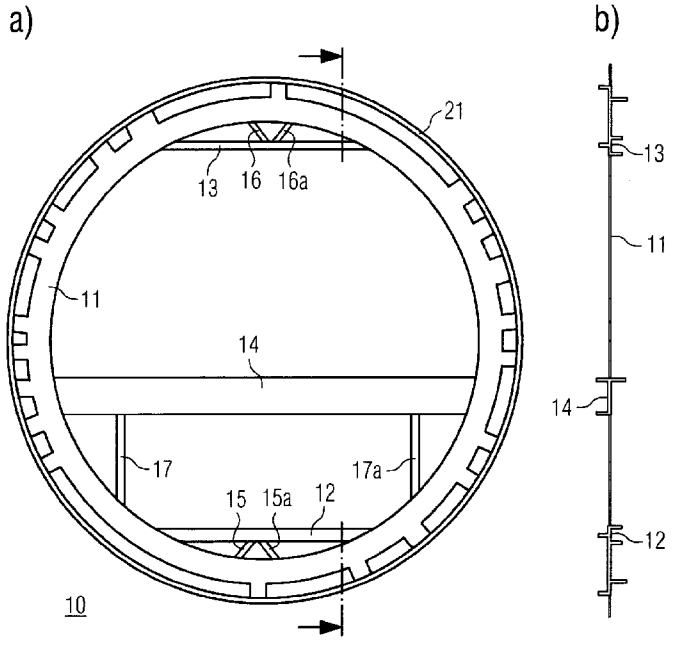
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(54) Title: AIRCRAFT FUSELAGE STRUCTURE AND METHOD FOR PRODUCING IT



(57) Abstract: An aircraft fuselage structure is described with frames running in the circumferential direction, stringers running in the longitudinal direction and a skin which is arranged thereon and outwardly seals the aircraft fuselage in a compression-proof manner. According to the invention, it is provided that the aircraft fuselage structure contains prefabricated integral units (10) which each run in the circumferential direction of a fuselage segment and in which the frame (11) of a fuselage segment and connecting elements (17, 18) for connection to skin elements (20) comprising stringers (22) and skin (21) are formed.

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AIRCRAFT FUSELAGE STRUCTURE AND METHOD FOR PRODUCING IT

The invention relates to an aircraft fuselage structure with frames running in the circumferential direction, stringers running in the longitudinal direction and a skin which is arranged thereon and outwardly seals the aircraft fuselage in a compression-proof manner. Furthermore, the invention relates to an integral unit for an aircraft fuselage structure of this type, and to a method for producing the same.

Pressurized fuselages of commercial aircraft are typically assembled nowadays from sections which are each constructed from a plurality of shells in which a skin, stringers and frames are connected to one another. Cross members for the hold, main deck and hatrack are subsequently riveted onto the frames, and supporting rods are fitted between cross member and frame and bolted onto joining fittings which are correspondingly riveted on.

It is an object of the invention to provide an aircraft fuselage structure which is weight-saving and can be constructed from few individual parts.

This object is achieved by an aircraft fuselage structure with the features of Claim 1.

The invention also provides an integral unit for an aircraft fuselage structure of this type and a method for producing an aircraft fuselage structure of this type.

The respective embodiments and developments are provided in the subclaims.

The invention provides an aircraft fuselage structure with frames running in the circumferential direction, stringers running in the longitudinal direction and a

skin which is arranged thereon and outwardly seals the aircraft fuselage in a compression-proof manner. According to the invention, it is provided that the aircraft fuselage structure contains prefabricated integral units which each run in the circumferential direction of a fuselage segment and in which the frame of a fuselage segment and connecting elements for connection to skin elements comprising stringers and skin are formed.

Furthermore, the invention provides an integral unit for an aircraft fuselage structure with frames running in the circumferential direction, stringers running in the longitudinal direction and a skin which is arranged thereon and outwardly seals the aircraft fuselage in a compression-proof manner. According to the invention, it is provided that the integral unit contains the frame of a fuselage segment and connecting elements for connection to skin elements comprising stringers and skin, and is prefabricated.

Finally, the invention provides a method for producing an aircraft fuselage structure with frames running in the circumferential direction, stringers running in the longitudinal direction and a skin which is arranged thereon and outwardly seals the aircraft fuselage in a compression-proof manner. According to the invention, it is provided that integral units are produced which contain the frame of a fuselage segment and connecting elements for connection to skin elements comprising stringers and skin, and are prefabricated, skin elements are produced which contain skin and stringers, the integral units are arranged on an installation apparatus and adjusted, and the skin elements are mounted on the integral units and connected thereto.

Exemplary embodiments of the invention are explained below with reference to the drawing, in which:

Fig. 1(a) shows a plan view and (b) a side view of an integral unit which is provided for an aircraft fuselage structure according to an exemplary embodiment of the invention;

Figs 2(a) and (b) show respective connecting elements for connection of an integral unit of the type shown in Fig. 1 to skin elements, comprising stringers and skin, according to one exemplary embodiment of the invention;

Figs 3(a), (b) and (c) show a schematic illustration of a method for producing an aircraft fuselage structure, in which prefabricated integral units and prefabricated skin are joined together to form an aircraft fuselage structure, according to one exemplary embodiment of the invention.

Fig. 1 shows an integral unit 10 which serves for the production of an aircraft fuselage structure which is to contain frames running in the circumferential direction, stringers running in the longitudinal direction and a skin which is arranged thereon and is intended for the compression-proof sealing of the aircraft fuselage to the outside. The integral unit 10 shown in plan view in Fig. 1(a) and in side view in Fig. 1(b) contains a frame 11 of a fuselage segment, i.e. a plane intersecting the aircraft fuselage perpendicularly with respect to its longitudinal direction, and connecting elements 18, 19, which will be illustrated in more detail further on, for connection to skin elements comprising stringers and skin.

In the exemplary embodiment illustrated, the integral units 10 are each prefabricated in one piece and run in an annularly completely closed manner over the entire circumference of a fuselage segment.

The integral unit 10 comprises a main body which runs in the plane of a fuselage segment and forms the frame 10, and connecting elements 18, 19 which protrude therefrom and are intended for the connection to skin elements comprising stringers 22 and skin 21. These connecting elements 18, 19, which are illustrated in more detail in Figs 2(a) and (b), comprise a force-transmission comb 18 which is formed by teeth protruding perpendicularly with respect to the main body of the integral unit 10, which main body forms the frame 11. The skin elements 20 are fixed in a frictional or interlocking manner to said teeth. The fixing can take place by riveting by means of titanium bolts, as also can the closing of longitudinal seams between the skin elements 20.

As Fig. 1 shows, the integral units 10 contain a hold cross member 12, a hatrack stiffening means 13 and a main cross member 14. The hold cross member 12 is supported against the main body of the integral unit 10 by respective supporting elements 15, 15a, the hatrack cross member 13 is supported against the main body of the integral unit 10 by respective supporting elements 16, 16a, and the main deck cross member 14 is supported against the main body of the integral unit 10 by respective supporting elements 17, 17a. In the exemplary embodiment illustrated, the hold cross member 12, the hatrack cross member 13 and the main deck cross member 14 and also the supporting elements 15, 15a, 16, 16a and 17, 17a thereof are designed as integral, single-piece components of the integral unit 10.

The integral units 10 of the exemplary embodiment described are produced from fibre-reinforced plastic, namely from carbon-fibre-reinforced plastic.

The production of the integral units 10 can take place, in particular, in one operation, with all of the necessary components being produced in one piece, i.e.

integrally. Production can take place, in particular, in a negative mould in such a manner that tolerances which occur are each apportioned to the side which is unimportant for installation, i.e. on the internal flange of the main body of the integral unit 10, which main body forms the frame, and on the lower side of the cross members 12, 13 and 14.

The integral formation in the integral unit of all of the support and connecting elements occurring in a fuselage segment, together with the weight-saving CFRP construction described reduce the weight and increase the strength, and a large number of joining and connecting points between the respective elements are omitted.

A method for producing an aircraft fuselage structure according to the invention is to be described below with reference to Fig. 3. Said method contains the production of the integral units 10 of the type described above, which are required for the aircraft fuselage structure and contain the frame 11 of a fuselage segment, the connecting elements 18, 19 for connection to skin elements 20 comprising the stringers 22 and the skin 21, and the cross members 12, 13, 14 and the supporting elements 15, 15a, 16, 16a and 17, 17a, and optionally further elements which are not illustrated specifically here. Furthermore, the skin elements 20 which contain the skin 21 and the stringers 22 are produced. Furthermore, the skin elements 20 may already be completed with window frames, door frames and the like. The completed integral units 10 are illustrated in schematic form in Fig. 3(a). The integral units 10 are then arranged on an installation apparatus 30 and adjusted, and the skin elements 20 are mounted on the integral units 10 and are connected thereto, as illustrated in schematic form in Fig. 3(c).

During the production of the skin elements 20, glass-fibre and aluminium composite tabs ("GLARE") can be provided at critical points, in particular at those which are subsequently located in the region of the integral units 10. Composite tabs of this type are formed by a laminate of layers of a thin sheet of an aluminium alloy and a textile fibre material, that is a woven fabric or insert of glass fibres or similar suitable fibres which are alternately layered one above another. Composite tabs of this type serve to compensate for different thermal coefficients of expansion of light metal alloys and fibre-reinforced plastics. Their composite structure enables them to adapt the different coefficients of expansion of the materials involved. Composite tabs of this type can also be provided at the connecting points of skin elements 20 adjacent to the skin 21.

Frame angle brackets 18 which are formed on the integral units 10 are riveted to the skin elements 20. All of the longitudinal members to be provided in the aircraft fuselage structure, such as seat rails and the supports thereof, are then introduced and bolted down.

The skin shells 20, the skin 21 thereof and the stringers 22 thereof can be produced from a fibre-reinforced plastic material (CFRP) or from light metal. If they are not composed of a fibre-reinforced plastic material, the different thermal coefficients of expansion of integral unit 10 and skin element 20 have to be dealt with by the force-transmission comb 18, the riveting and the skin 21 in the circumferential direction. A compensation of different thermal coefficients of expansion can take place by means of the above-described glass-fibre and aluminium composite tabs. Composite tabs of this type can also be used in order to strengthen the skin elements 20 against possible large longitudinal tears if the aircraft fuselage structure is subjected to unusual stresses.

The aircraft fuselage structure produced in the manner described can then also be supplemented by a cockpit unit and a corner section, which supports the tail unit, to provide the complete aircraft fuselage.

List of Reference Numbers

10	Integral unit
11	Frame, main body
12	Hold cross member
13	Hatrack cross member
14	Main deck cross member
15, 15a	Supporting element
16, 16a	Supporting element
17, 17a	Supporting element
18	Force-transmission comb
19	Frame bracket
20	Skin element
21	Skin
22	Stringer
30	Installation apparatus

Patent Claims

1. Aircraft fuselage structure with frames running in the circumferential direction, stringers running in the longitudinal direction and a skin which is arranged thereon and outwardly seals the aircraft fuselage in a compression-proof manner, characterized in that the aircraft fuselage structure contains prefabricated integral units (10) which each run in the circumferential direction of a fuselage segment and in which the frame (11) of a fuselage segment and connecting elements (17, 18) for connection to skin elements (20) comprising stringers (22) and skin (21) are formed.

2. Aircraft fuselage structure according to Claim 1, characterized in that the integral units (10) are each prefabricated in one piece.

3. Aircraft fuselage structure according to Claim 1 or 2, characterized in that the integral units (10) each have a main body essentially running in the plane of a fuselage segment and forming the frame (11), and connecting elements (17, 18) which protrude therefrom and are intended for connection to skin elements (20) comprising stringers (22) and skin (21).

4. Aircraft fuselage structure according to Claim 1, 2 or 3, characterized in that the integral units (10) run in an annularly closed manner over the entire circumference of a fuselage segment.

5. Aircraft fuselage structure according to one of Claims 1 to 4, characterized in that the integral units (10) contain a hold cross member (12).

6. Aircraft fuselage structure according to one of Claims 1 to 5, characterized in that the integral units (10) contain a hatrack stiffening means (13).

7. Aircraft fuselage structure according to one of Claims 1 to 6, characterized in that the integral units (10) contain a main deck cross member (14).

8. Aircraft fuselage structure according to one of Claims 5 to 7, characterized in that the integral units (10) contain supporting elements (15, 15a, 16, 16a, 17, 17a) for the cross members (12, 13, 14).

9. Aircraft fuselage structure according to one of Claims 1 to 8, characterized in that the integral units (10) are produced from fibre-reinforced plastic.

10. Aircraft fuselage structure according to Claim 9, characterized in that the integral units (10) are produced from carbon-fibre-reinforced plastic.

11. Aircraft fuselage structure according to one of Claims 1 to 10, characterized in that the aircraft fuselage structure is assembled from a number of prefabricated integral units (10) and a number of prefabricated skin elements (20) which are connected to the latter and contain skin (21) and stringers (22).

12. Aircraft fuselage structure according to Claim 11, characterized in that the connecting elements (17, 18) are formed by a force-transmission comb (18) with teeth which protrude from the main body of the integral unit (10), which main body forms the frame (11), and the skin elements (20) are fixed to said force-transmission comb.

13. Integral unit for an aircraft fuselage structure with frames running in the circumferential direction, stringers running in the longitudinal direction and a skin which is arranged thereon and outwardly seals the aircraft fuselage in a compression-proof manner, characterized in that the integral unit (10) contains the frame (11) of a fuselage segment and connecting

elements (17, 18) for connection to skin elements (20) comprising stringers (22) and skin (21), and is prefabricated.

14. Integral unit according to Claim 13, characterized in that the integral unit (10) is prefabricated in one piece.

15. Integral unit according to Claim 13 or 14, characterized in that the integral unit (10) contains a main body which runs essentially in the plane of a fuselage segment and forms the frame (11), and connecting elements (17, 18) which protrude from said main body and are intended for connection to skin elements (20) comprising stringers (22) and skin (21).

16. Integral unit according to Claim 13, 14 or 15, characterized in that the integral unit (10) runs in an annularly closed manner over the entire circumference of a fuselage segment.

17. Integral unit according to one of Claims 13 to 16, characterized in that the integral unit (10) contains a hold cross member (12).

18. Integral unit according to one of Claims 13 to 17, characterized in that the integral unit (10) contains a hatrack stiffening means (13).

19. Integral unit according to one of Claims 13 to 18, characterized in that the integral unit (10) contains a main deck cross member (14).

20. Integral unit according to one of Claims 17 to 19, characterized in that the integral unit (10) contains supporting elements (15, 15a, 16, 16a, 17, 17a) for the cross members (12, 13, 14).

21. Integral unit according to one of Claims 13 to 20, characterized in that the integral unit (10) is produced from fibre-reinforced plastic.

22. Integral unit according to Claim 21, characterized in that the integral unit (10) is produced from carbon-fibre-reinforced plastic.

23. Integral unit according to one of Claims 13 to 21, characterized in that the integral unit (10) is provided for constructing the aircraft fuselage structure from a number of prefabricated integral units (10) and a number of prefabricated skin elements (20) which are connected to said integral units and contain skin (21) and stringers (22).

24. Integral unit according to Claim 23, characterized in that the connecting elements (17, 18) are formed by a force-transmission comb (17) with teeth which protrude from the main body of the integral unit (10), which main body forms the frame (11), and the skin elements (20) are fixed to said teeth.

25. Method for producing an aircraft fuselage structure with frames running in the circumferential direction, stringers running in the longitudinal direction and a skin which is arranged thereon and outwardly seals the aircraft fuselage in a compression-proof manner, characterized in that integral units (10) are produced which contain the frame (11) of a fuselage segment and connecting elements (17, 18) for connection to skin elements (20) comprising stringers (22) and skin (21), in that skin elements (20) are produced which contain skin (21) and stringers (22), in that the integral units (10) are arranged on an installation apparatus (30) and adjusted, and in that the skin elements (20) are mounted on the integral units (10) and connected thereto.

26. Method according to Claim 25, characterized in that force-transmission combs (18) formed on the integral units (10) are connected to the skin elements (20).

27. Method according to Claim 25 or 26, characterized in that frame angle brackets (19) formed on the integral units (10) are riveted to the skin elements (20).

28. Method according to Claim 25, 26 or 27, characterized in that, in the region of the integral units (10), glass-fibre and aluminium composite tabs are provided as a reinforcement means on the inside of the skin (21) of the skin elements (20).

29. Method according to one of Claims 25 to 28, characterized in that glass-fibre and aluminium composite tabs are provided at connecting points of skin elements (20) and connect the skin (21) of adjacent skin elements (20).

30. Method according to one of Claims 25 to 29, characterized in that the skin elements (20) are completed with stringers (22), and window frames and door frames, prior to installation.

FIG 1

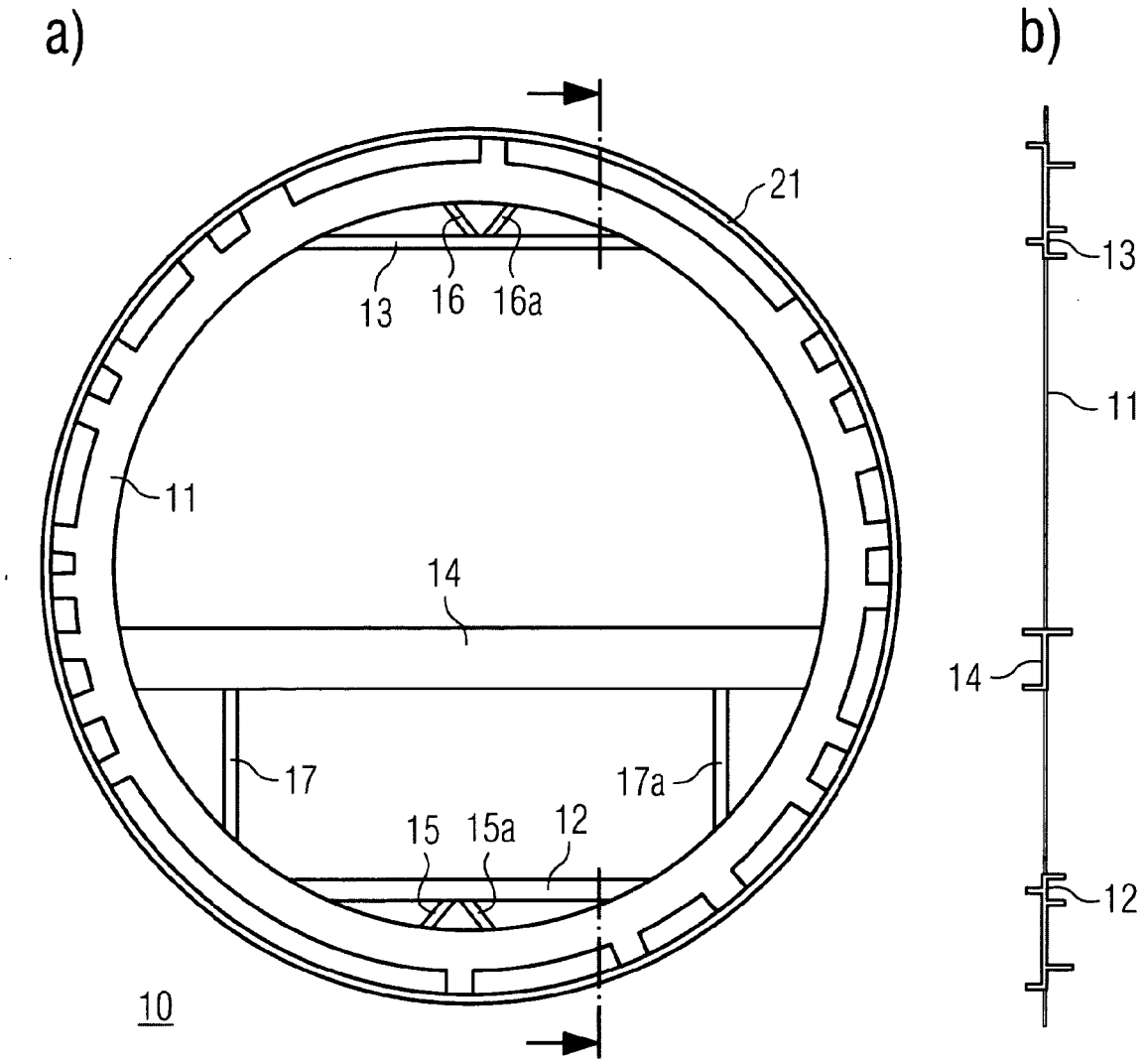
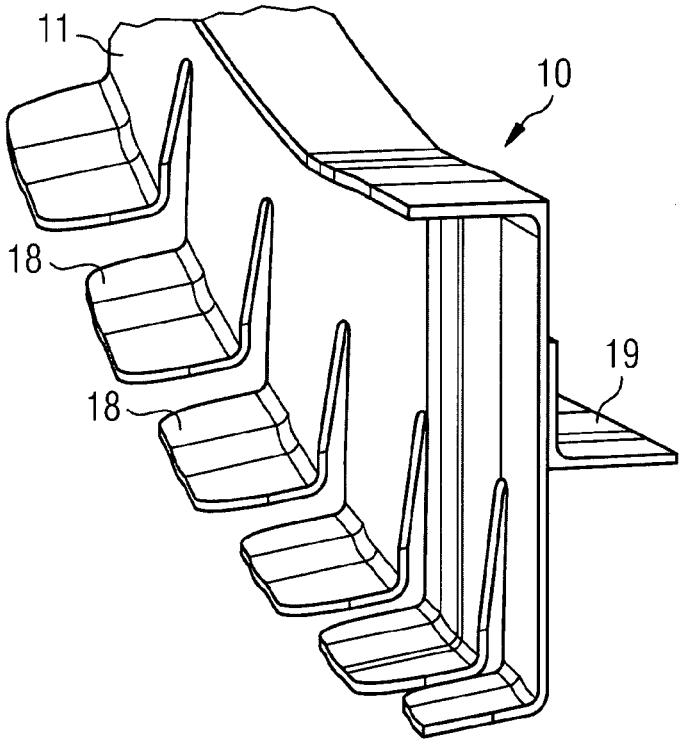


FIG 2

a)



b)

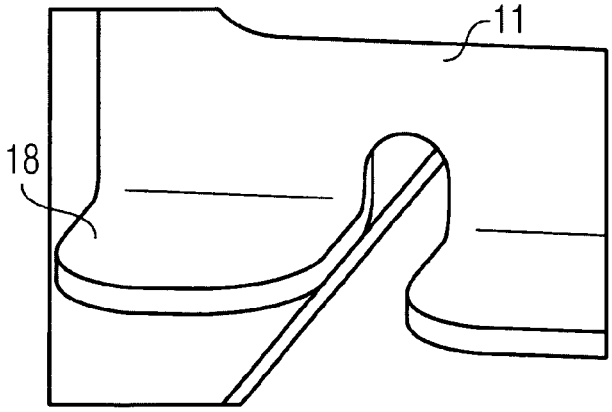
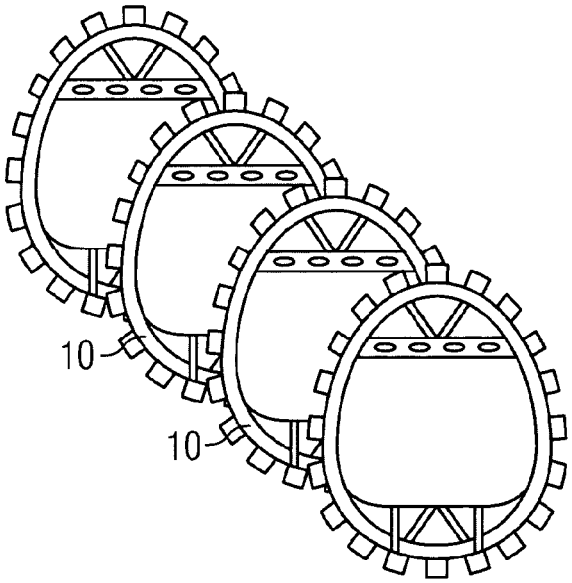
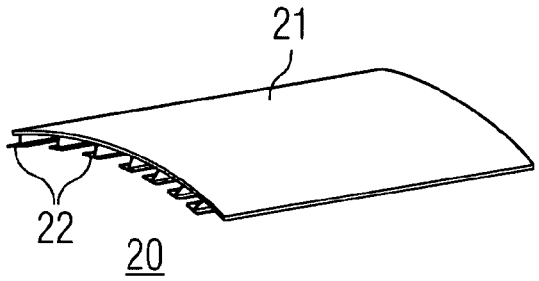


FIG 3

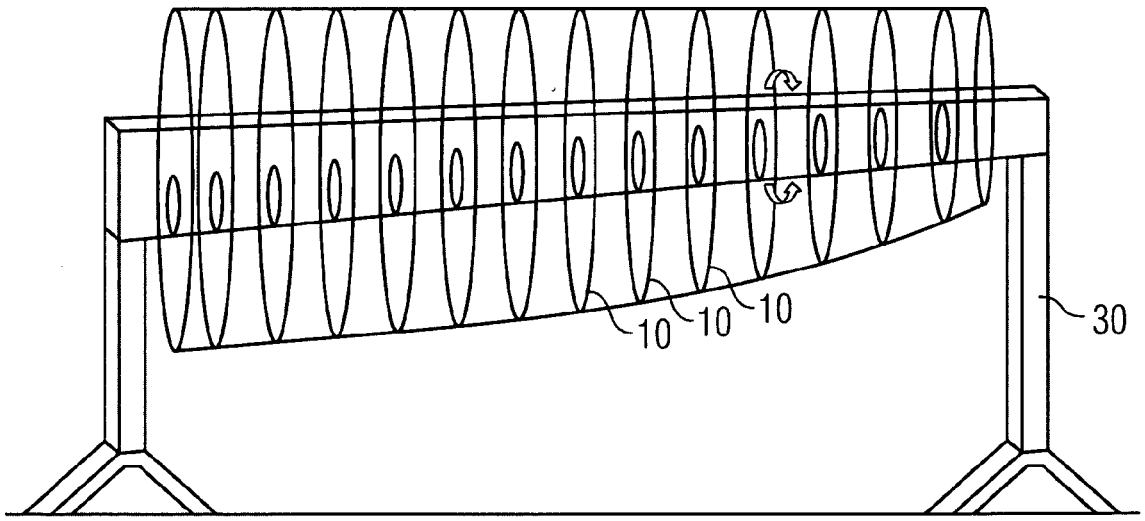
a)



b)



c)



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2007/055519

A. CLASSIFICATION OF SUBJECT MATTER
INV. B64C1/06

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	WO 2006/051235 A (AIRBUS FRANCE [FR]; CACCIAGUERRA BRUNO [FR]) 18 May 2006 (2006-05-18) the whole document	1,3-8, 13,15-20

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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
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Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No
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