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(71) Applicant (for all designated States except US): **AIRBUS
DEUTSCHLAND GMBH** [DE/DE]; Kreetslag 10, 21129
Hamburg (DE).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **BOLD, Jens** [DE/DE];
Heussweg 22A, 20255 Hamburg (DE).

(74) Agent: **DILG, Andreas**; Maiwald Patentanwalts GmbH,
Elisenhof, Elisenstrasse 3, 80335 München (DE).

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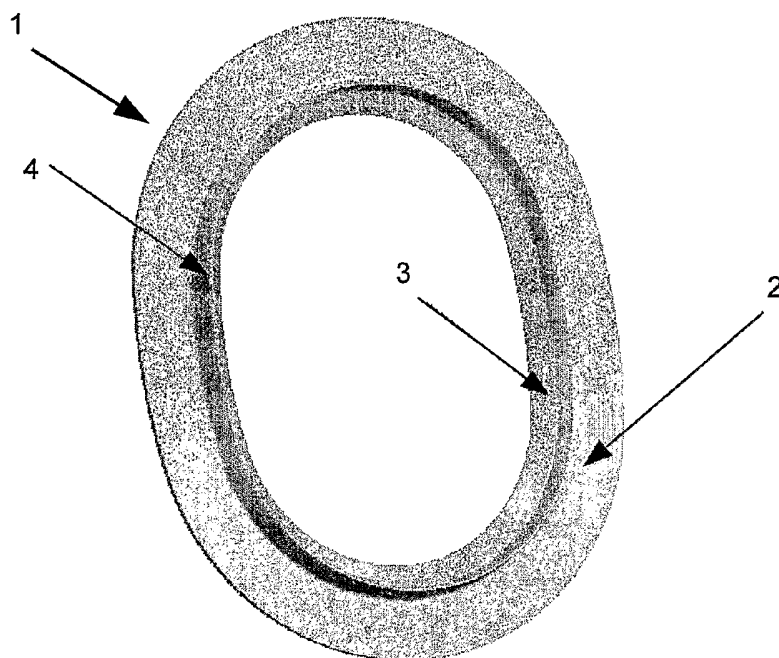
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(54) Title: WINDOW FRAME FOR AIRCRAFT



(57) Abstract: A window frame (1) for installation in the exterior shell (5) of an aircraft, which comprises in each case at least one outer flange (2), one inner flange (3), and one vertical flange (4) arranged perpendicular and between these flanges, is manufactured from a fiber-reinforced thermoplastic material, by, first, manufacturing a semifinished part from webbing and thermoplastic material, which subsequently is deep-drawn in a molding tool. The window frame (1) comprises multiple substructures (16-19) welded to one another and has a core (17) comprising a unidirectional-running webbing.

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Window Frame For Aircraft

This application claims the benefit of the filing date of United States Provisional Patent Application No. [60/600,100] filed August 9, 2004 and of the German Patent Application No. 10 2004 025 376.5 filed May 24, 2004, the disclosure of which is hereby incorporated herein by reference.

The invention relates to a window frame for installation in the exterior shell of an aircraft, comprising at least one outer flange, one inner flange, and a vertical flange arranged perpendicular to and between these flanges, wherein the connection with the aircraft structure takes place via the outer flange, and wherein on the inner flange, a window element to be held is attached, which is held via the vertical flange. Further, the invention relates to a method for manufacturing such a window frame.

In most of the aircraft manufactured and in operation today, window frames made of aluminum are used, which comprise a part which is made by forging and truing. The component is organized into a total of three regions: an outer flange, an inner flange, and a vertical flange arranged perpendicular to and between these two flanges. The window frames are typically connected with two rows of rivets over the outer flange with the aircraft structure or with the exterior shell of the aircraft. A window element rests on the inner flange, which, in turn, usually comprises two panes and a sealing arranged therebetween and which is held in its position via a downholder, which is connected with the vertical flange.

In addition to fixing the window element, such a window frame also has the function of absorbing the strain increase, which occurs on the edge of the comparably large cut-out for the window mounted in the load-transferring exterior shell. The outer flange of the window frame thereby serves, on the one hand, for reinforcement of this cut-out and on the other hand, via the outer flange, the frame and the exterior shell are connected to one another

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by means of rivets. Since the manufacture of the known aluminum window frame typically takes place by means of forging, it is not possible to achieve a cross-sectional distribution of the frame profile that is favorable for the rivet force distribution, since the slant of the flange may amount to a maximum of approximately two angular degrees, in order to enable a simple riveting. The inner flange serves to receive the window element, wherein here a slanting of the mounting of the window is simplified. Simultaneously, the existing load from the interior pressure, which prevails in the passenger cabin, is transferred via this inner flange to the exterior shell of the aircraft.

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The vertical flange serves exclusively as a reinforcement rib on the frame, in order to minimize the tension in the exterior shell with the least possible weight. On this vertical flange, also the eye bolts are attached, with which, typically, the downholder or retainer for the window elements are held in their position. Simultaneously, the vertical flange also forms the guide upon mounting of the window element.

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An object of the present invention is to provide a window frame of the above-described type, which makes possible a considerable weight savings compared to the window frames used today for this application. Simultaneously, the costs for the manufacture of such a window frame should be as low as possible. In addition, by means of the present invention, a simple and cost-effectively performed method for manufacturing such a window frame should be provided.

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The invention solves the first object, in that it contemplates that such a window frame comprises a fiber-reinforced thermoplastic material. The solution of the further object takes place by means of a method, in which a semifinished part made from webbing and thermoplastic material is made as

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a quasi-isotropic sheet material and is transformed in a deep-drawing process.

5 The invention makes possible the use of a window frame, which is made in fiber-composition construction, and which yields a weight savings of approximately 20 percent relative to the aluminum window frames used up to now. In spite of this great weight savings potential, the costs for such a component, compared to a window frame made from an aluminum forged part, do not rise.

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At the same time, it is possible to make the fiber window frame according to the present invention with a tolerance of only approximately 0.5 mm with an average wall thickness of 5 mm, which corresponds to a manufacturing tolerance of approximately 10 percent. With aluminum forged frames, in contrast, depending on the manufacturing method, tolerances of approximately 1.5 mm are accepted, which corresponds to a manufacturing tolerance of approximately 30 percent with the same wall thickness.

15 Therefore, by means of the present invention, not only the weight fluctuations between the individual window frames are substantially reduced, but also, at the same time, the installation of the frame in an aircraft or the mounting of the window element in the frame is simplified considerably. Finally, further advantages are increased safety as well as a greatly improved thermal insulation of the window frame according to the invention.

20 Next, the invention will be described in greater detail with reference to one embodiment shown in the accompanying figures. In the figures:

Fig. 1 shows a window frame in perspective view;

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Fig. 2 shows a detail section through the installation position of a window frame according to Fig. 1;

Fig. 3 shows the structure of the window frame of Fig. 1 in an exploded view;

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Fig. 4 shows a detail section through a window frame according to Fig. 1;

Fig. 5 shows a representation of the main directions with a window frame according to Fig. 1; and

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Fig. 6 shows a detail representation of the region in Fig. 5 designated with VIII.

The window frame 1 shown in Fig. 1 is made with a fiber construction and, like the known aluminum forged frames, also has an outer flange 2, an inner flange 3, as well as a vertical flange 4 arranged between these two flanges. In contrast to common aluminum window frames, the outer flange 1 in this case, however, has a uniform circumferential edge, which, again in contrast to the aluminum forged part, has a constant thickness. Fig. 2 shows in a detail section the installation position of such a window frame 1 in the exterior shell 5 of an aircraft. Indicated in this figure are also the rivet positions 6 for the connection of the frame with the exterior shell 5, as well as two window panes 7 and 8, which together with the sealing 9 form the window element.

25 The fiber window frame 1 is manufactured by means of the so-called thermoplastic, deep-drawing technology. With this technology, first, as a primary material, a semifinished part is made from reinforcing webbing and thermoplastic, which is deep-drawn subsequently as a quasi-isotropic sheet material. The semifinished part 10 itself is made in the shape of individual

- 5 -

substructural elements 16 to 19, as are shown in the exploded representation in Fig. 3, whereas in Fig. 4, the structure of the complete thermoplastic window frame 1 with the individual substructures 16 to 19 is shown in a sectional representation. The substructures 16 and 19 are, respectively,
5 deep-drawn from a thin plate, whereas the substructure 18 is developed from a thick plate and is machine finished. These three substructures have a quasi-isotropic layer structure, with reference to a fixed coordinate system shown in Fig. 5. The substructure 17, in contrast, is a unidirectional substructure, in which reinforcement fibers run in the circumferential direction
10 of the frame.

The direction of the individual fiber layers is critical for the weight savings achievable with the window frame described here. The principle layer direction with the main direction 0° and 90° is shown in Fig. 5. In this regard,
15 the 0° direction represents the lateral direction and the 90° direction represents the elevation direction of the frame 1. For the 0° -wound semifinished part, that is, the substructure 17, the circumferential direction is critical, shown by the arrow in Fig. 6. The assembly of the individual substructures takes place in the sequence originating from the exploded view
20 of Fig. 5 with thermoplastic welding.

The window frame 1 manufactured in this manner has an approximately 20 percent weight savings with approximately the same manufacturing costs compared to the common aluminum window frames. Its tolerances are
25 essentially lower than the tolerances of the corresponding aluminum components. At the same time, the frame offers higher safety and better thermal insulation than the common aluminum window frame.

Patent Claims

1. Window frame for installation in the exterior shell of an aircraft,
comprising at least one outer flange, at least one inner flange, and at
5 least one vertical flange arranged perpendicular to and between the at
least one outer flange and the at least one inner flange, wherein the
connection with the aircraft structure is realized via the at least one
outer flange and wherein on the at least one inner flange, a window
element to be held is attached, which is held via the at least one
10 vertical flange, characterized in that the window frame (1) comprises a
fiber-reinforced thermoplastic material.
2. Window frame of claim 1, characterized in that the window frame (1)
comprises multiple substructures (16-19) welded to one another.
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3. Window frame of claim 1 or 2, characterized in that the window frame
(1) has a core (17) comprising a unidirectional-running webbing.
4. Method for manufacturing a window frame of any one of claims 1 to 3,
20 characterized in that a semifinished part comprising webbing and
thermoplastic material is manufactured as a quasi-isotropic sheet
material and is transformed in a deep-draw process.
5. Method of claim 4, characterized in that first by deep-drawing, multiple
25 substructures (16-19) are manufactured and these are subsequently
combined by means of thermoplastic welding.

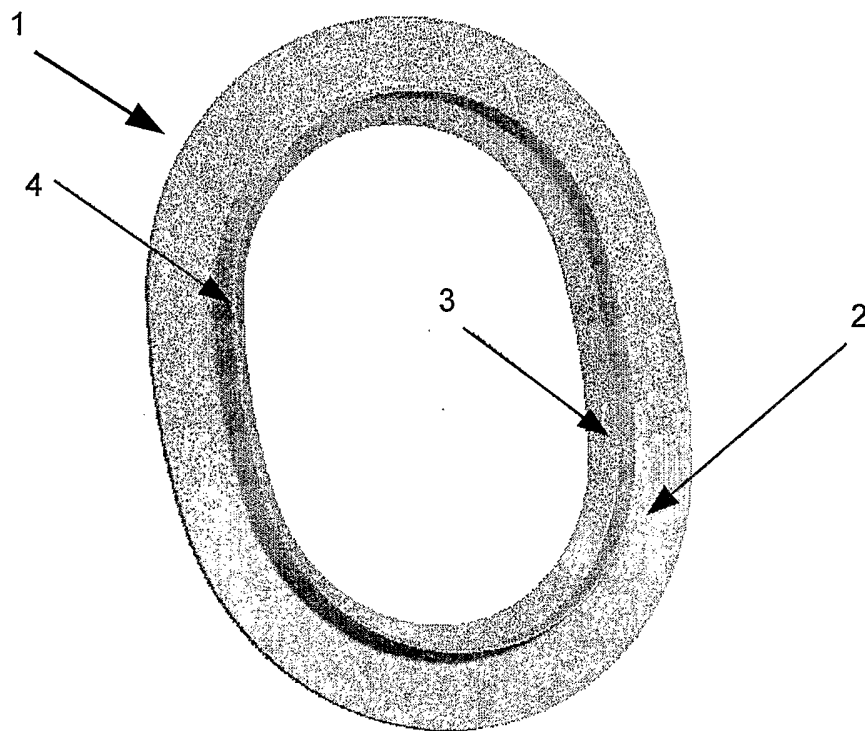


Fig. 1

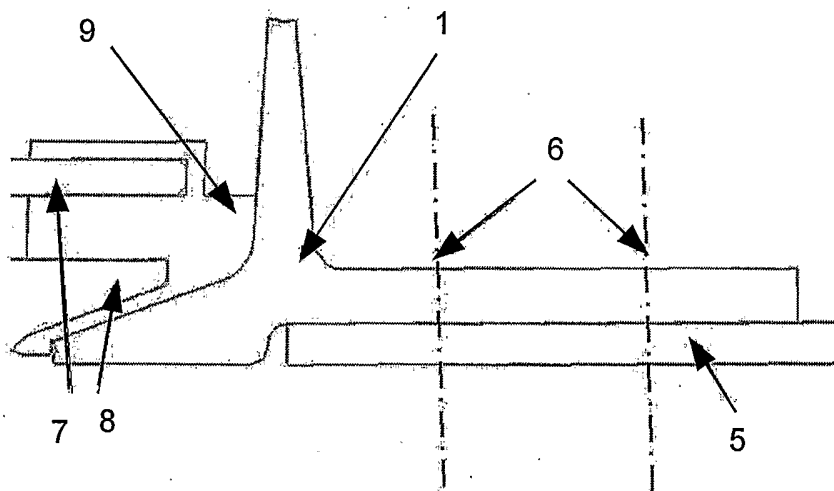


Fig. 2

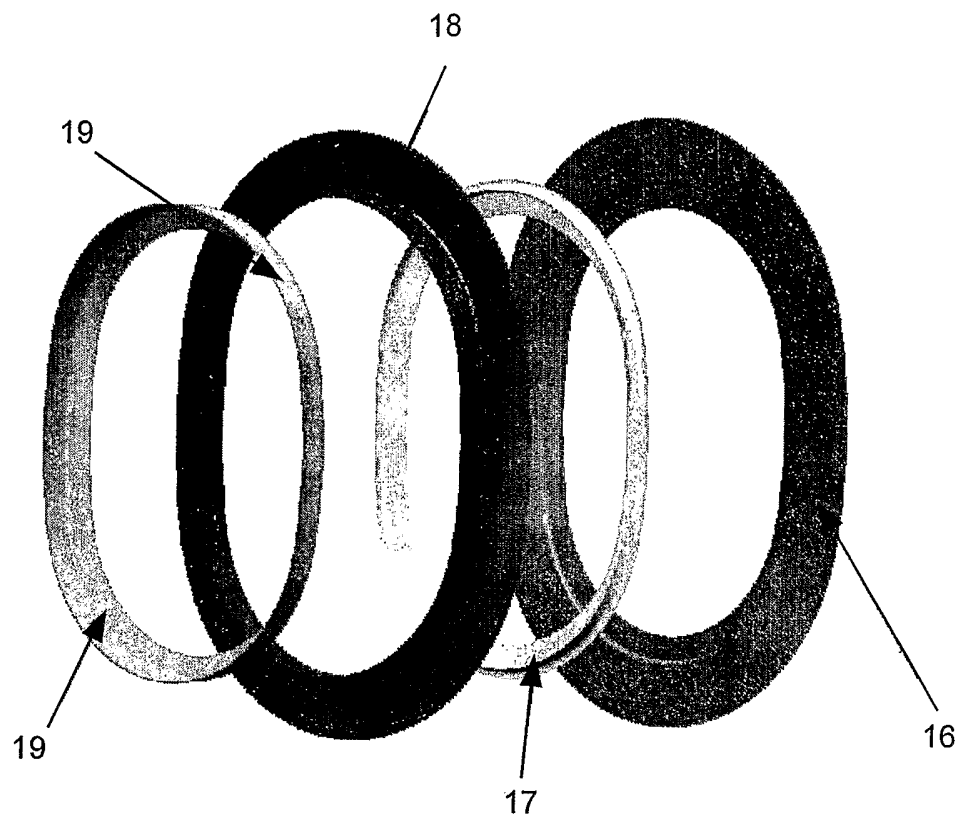


Fig. 3

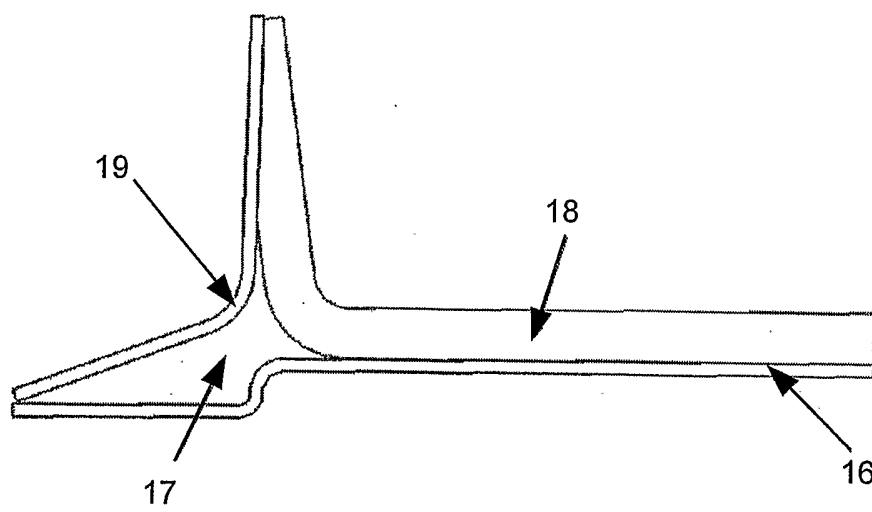


Fig. 4

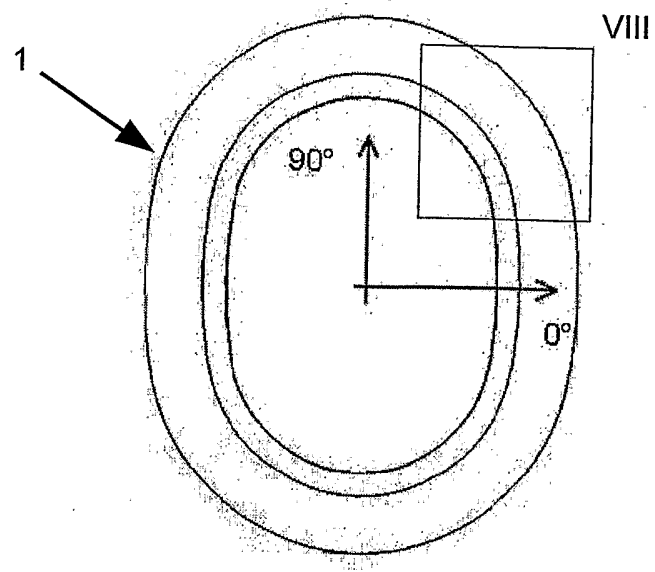


Fig. 5

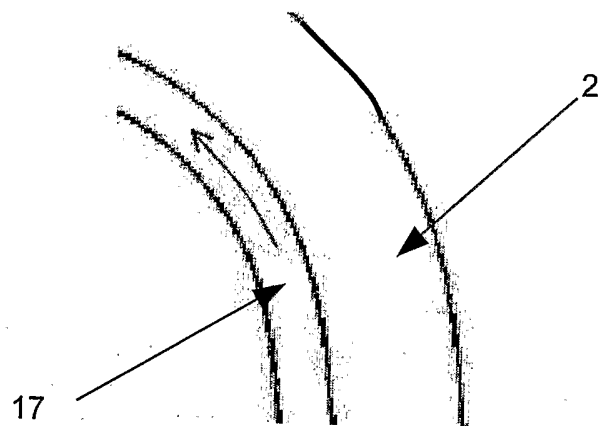


Fig. 6

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B64C B29B

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)

EP0-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2003/168775 A1 (EBERTH ULRICH ET AL) 11 September 2003 (2003-09-11) paragraphs '0003! - '0006! paragraphs '0030! - '0042! figures 1-6	1-5
A	WO 2004/016844 A (SHIKIBO LTD; SAKONJO, HIDEKI; ISHIBASHI, MASAYASU; TANAMURA, TAKESHI;) 26 February 2004 (2004-02-26) the whole document	1-5

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Weber, C

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US 2003168775 A1	11-09-2003	DE 10251580 A1	25-09-2003
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