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**Datasheet for the decision
of 7 November 2013**

Case Number: T 2418/11 - 3.2.01

Application Number: 06748623.3

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Language of the proceedings: EN

Title of invention:
COMPOSITE SKIN AND STRINGER STRUCTURES AND METHODS FOR FORMING
THE SAME

Applicant:
The Boeing Company

Headword:

Relevant legal provisions:
EPÜ 1973 Art. 56

Keyword:
Inventive step (yes , after amendments)
Remittal to the department of first instance - (yes)

Decisions cited:

Catchword:



**Beschwerdekammern
Boards of Appeal
Chambres de recours**

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Case Number: T 2418/11 - 3.2.01

D E C I S I O N
of Technical Board of Appeal 3.2.01
of 7 November 2013

Appellant: The Boeing Company
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Representative: Boulton Wade Tennant
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Decision under appeal: **Decision of the Examining Division of the
European Patent Office posted on 5 July 2011
refusing European patent application No.
06748623.3 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman: G. Pricolo
Members: Y. Lemblé
D. T. Keeling

Summary of Facts and Submissions

- I. The appeal is directed against the decision of the Examining Division posted 5 July 2011 to refuse the European patent application No. 06 748 623.3.
- II. The Examining Division held that that the subject-matter of claim 1 then on file did not involve an inventive step in view of the prior art. As prior art, especially the following documents have been considered:
- D1: US-A-4 966 802,
D2: XP 002395791, DANIEL GAY: "Matériaux composites", HERMES, PARIS, 1997,
D3: XP 002581212, "Fabrics and Preforms" In: D. B. Miracle & S. L. Donaldson: "Composites", December 2001 (2001-12), ASM international , USA, ISBN: 0871707039, vol. 21, pages 59-68.
- III. Oral proceedings were held before the Board on 7 November 2013. The Appellant (Applicant) requested that the decision under appeal be set aside and that a patent be granted on the basis of the request filed at the oral proceedings on 7 November 2013.
- IV. Independents claim 1 and 10 according to this request read as follows:
- "1. An aerospace vehicle, comprising:
a polymer-based elongated stringer (12) having reinforcing fibers positioned in a plurality of adjacent layers, the reinforcing fibers of a first layer being oriented at +5 degrees relative to a reference direction, and the reinforcing fibers of a second layer being oriented at -5 degrees relative to

the reference direction, and the reinforcing fibers of a third layer being oriented at +65 degrees relative to the reference direction, and the reinforcing fibers of a fourth layer being oriented at -65 degrees relative to the reference direction; wherein the first layer and the second layer comprise approximately about eighty percent of the stringer and wherein the third layer and the fourth layer comprise approximately about twenty percent of the stringer;
a polymer-based and fiber-reinforced skin member (20) that adjoins the stringer (12); and
an adhesive material interposed between the stringer (12) and the skin member (20)."

"10. A method for fabricating a stringer and skin structure, comprising:
forming a stringer by repetitively bonding fiber-reinforced layers of a polymer material to impart a predetermined shape to the stringer, the reinforcing fibers of a first layer being oriented at +5 degrees relative to a reference direction, and the reinforcing fibers of a second layer being oriented at -5 degrees relative to the reference direction, and the reinforcing fibers of a third layer being oriented at +65 degrees relative to the reference direction, and the reinforcing fibers of a fourth layer being oriented at -65 degrees relative to the reference direction; wherein the first layer and the second layer comprise approximately about eighty percent of the stringer and wherein the third layer and the fourth layer comprise approximately about twenty percent of the stringer;
forming a skin member by repetitively bonding fiber reinforced layers of a polymer material to impart a predetermined shape to the skin member; and
adhesively joining the stringer portion to the skin member."

V. The Appellant's submissions made in writing and at the oral proceedings, insofar as they are relevant to the present decision, can be summarised as follows:

All the previously filed requests were withdrawn and replaced by a sole request. Independent claims 1 and 10 were now limited to a stringer and a method of fabricating a stringer which only included layers having reinforcing fibers oriented at $\pm 5^\circ$ and $\pm 65^\circ$ relative to a reference direction, whereby the totality of the stringer was made up of these layers in a proportion of 80% for the layers oriented $\pm 5^\circ$ and a proportion of 20% for the layers oriented at $\pm 65^\circ$. There was a clear basis for this limitation in the application documents as originally filed.

The subject-matter of these claims was novel and inventive over the cited prior art documents cited by the Examining Division. The technical problem solved by the claimed subject-matter was to propose a composite stringer and skin structure which had a better strength/weight ratio and was cheaper to fabricate and at the same time fulfilled all the requirements for passing the multiple tests and checks such components needed for their acceptance in an aerospace vehicle. Such an optimization work was not trivial and was achieved with the very specific orientations taken by the reinforcing fibers in the different layers and in a specific proportion thereof, as set out in the claims. An orientation of $\pm 5^\circ$ surprisingly increased the resistance to splitting quite significantly and at the same time limited the propagation of cracks. An orientation of $\pm 65^\circ$ provided for a good bearing stress, transverse strength and shear stress stiffness, while greatly reducing the danger of delamination of the free

edges. The table filed with the letter dated 7 October 2013 showed that the Filled Hole Tension (FHT) of stringers made in accordance with the invention was more than 10% higher than the FHT of the prior art. Although the claimed $\pm 5^\circ/\pm 65^\circ$ arrangement of the present invention had a slightly lower resistance in tension, the claimed structure was an highly desirable improvement, since it was the balance between raw strength in tension and bearing strength and large notch damage growth rates that was key. The conventional arrangements of the prior art ($0^\circ/45^\circ/90^\circ$ lay up at 50%/40%/10% or $0^\circ/45^\circ/90^\circ$ lay up at 60%/30%/10%), whilst doing better in tension, split too easily when subjected to bearing. The claimed combination was thus a better overall package, which was also 13% lighter.

In view of the limitations made to the claimed subject-matter, some embodiments of the originally filed documents might not longer be covered by the claims. Thus, the adaptation of the description and figures was not straightforward and rather complex. For this reason, it was requested that the case be remitted to the first instance to adapt the description and the figures to the claims.

Reasons for the Decision

1. The appeal is admissible.
2. There are no formal objections under Article 123(2) EPC to the amendments made to the claims.
 - 2.1 Claim 1 is based on claim 1 as originally filed.

The "first portion" which was mentioned in claim 1 as originally filed and which comprised "the reinforcing fibers being oriented at a relatively shallow angle" relative to a reference direction, has been replaced by the mention of the specific fibers forming that first portion, namely the reinforcing fibers of a first layer and of a second layer (see first part of claim 12 as filed in combination with the embodiment shown in Fig. 3 as filed), whereby the respective specific values of the shallow angle (+5 degrees and -5 degrees) are taken from claim 3 as originally filed and are now part of claim 1.

In the same way, the second portion mentioned in claim 1 as originally filed and which comprised "the reinforcing fibers being oriented at a relatively broad angle" relative to a reference direction, has been replaced by the mention of the specific fibers forming that second portion, namely the reinforcing fibers of a third layer and a fourth layer (see first part of claim 12 as filed in combination with the embodiment shown in Fig. 3 as filed), whereby the respective specific values of the broad angle (+65 degrees and -65 degrees) are taken from claim 3 as originally filed and are also part of claim 1.

Moreover, the feature "wherein the first layer and the second layer comprise approximately about eighty percent of the stringer and wherein the third layer and the fourth layer comprise approximately about twenty percent of the stringer", now introduced in claim 1, is taken from dependent claim 7 as originally filed.

2.2 Independent method claim 10 is based on method claim 16 as originally filed and is completed by the same

features as those introduced in present claim 1 and mentioned in the paragraph above.

2.3 Dependent claims 4 to 6, 8, 12 (part), 13 to 15 as originally filed are now dependent claims 2 to 9. Dependent claims 19 to 22 as originally filed are now dependent claims 11 to 14.

3. Novelty and inventive step

3.1 The subject-matter of the claims is novel over the prior art. Since novelty has not been an issue in the first instance proceedings there is no necessity to justify this in detail.

3.2 Following the amendments made in claim 1 and method claim 10, the claimed subject-matter is now clearly limited to a stringer and skin structure, respectively to a method of fabricating a stringer and skin structure, in which the stringer only includes layers having reinforcing fibers oriented at $\pm 5^\circ$ and $\pm 65^\circ$ relative to a reference direction, whereby the totality of the stringer is made up of these layers in a proportion of 80% for the layers having fibers oriented $\pm 5^\circ$ and a proportion of 20% for the layers having fibers oriented at $\pm 65^\circ$.

Although the person skilled in the art (a specialist in light-weight, polymer based aircraft structures) is aware of the possibility of using other angles for the orientation of a ply, depending on the kind of demands made on the structures (see D2: page 107, especially the "Remarque" referring to orientations at $\pm 30^\circ$ and $\pm 60^\circ$), the Appellant was able to convince the Board that the combination of layers having reinforcing fibers oriented at the selected angles of $\pm 5^\circ$ and $\pm 65^\circ$

and in the claimed proportion of 80% and 20% respectively, is not an arbitrary selection deprived of any advantages. More particularly, the experimental tests produced by the Appellant (see table of letter dated 7 October 2013) render plausible that layers having reinforcing fibers at the claimed orientations result in an improved resistance of the stringer to splitting and crack propagation.

None of the documents D1 to D3 or any of the other documents cited in the search report suggests this combination of features in a polymer-based stringer and skin structure or in a method for manufacturing the same. For the Board, the limitations introduced in independent claims 1 and 10 stand out against the traditional ply orientation ($0^\circ, \pm 45^\circ, 90^\circ$) and clearly overcome the objection of lack of inventive step made by the Examining Division.

- 3.3 The Board concludes from the above considerations that the subject-matter of independent claims 1 and 10 involves an inventive step.
4. Dependent claims 2 to 9 and 11 to 19 define additional features to those specified in the independent claim 1 or 11 to which they respectively refer and, by virtue of their dependency, contain all of the features of the respective independent claim. The above conclusions regarding novelty and inventive step therefore equally apply to those dependent claims.
5. The Appellant requested remittal to the first instance for the adaptation of the description. Moreover, in the present case, the adaptation of the description is not straightforward as it requires a careful examination of what embodiments still fall under the scope of the

claims. Under these circumstances, the Board considers that it is appropriate to remit the case to the first instance.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the Examining Division for further prosecution.

The Registrar:

The Chairman:



B. Atienza Vivancos

G. Pricolo

Decision electronically authenticated