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Datasheet for the decision of 30 June 2009

Case Number: T 1912/06 - 3.2.06

Application Number: 01302812.1

Publication Number: 1138431

IPC: B23P 6/00

Language of the proceedings: EN

Title of invention:
Method of repairing an airfoil

Patentee:
United Technologies Corporation

Opponent:
MTU Aero Engines GmbH

Headword:
-

Relevant legal provisions:
EPC Art. 54, 123
RPBA Art. 13(1)

Relevant legal provisions (EPC 1973):
EPC Art. 84

Keyword:
"Main request - lack of novelty and inventive step"
"Auxiliary request - admittance (yes)"
"Remittal to opposition division for further prosecution"

Decisions cited:
G 0001/95, G 0007/95

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 1912/06 - 3.2.06

D E C I S I O N
of the Technical Board of Appeal 3.2.06
of 30 June 2009

Appellant: (Opponent)
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Representative:
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Respondent: (Patent Proprietor)
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Decision under appeal:
Decision of the Opposition Division of the European Patent Office posted 8 November 2006 rejecting the opposition filed against European patent No. 1138431 pursuant to Article 102(2) EPC 1973.

Composition of the Board:

Chairman: P. Alting Van Geusau
Members: M. Harrison
K. Garnett

Summary of Facts and Submissions

I. The appellant (opponent) filed an appeal against the opposition division's decision rejecting the opposition against European patent number 1 138 431, and requested revocation of the patent.

With its appeal grounds, the appellant cited the following documents against novelty and/or inventive step:

D2: DE 43 27 189 A1
D5: DE 31 10 180 A1
D6: DE 29 15 200 A1

II. In reaching its decision, the opposition division exercised its discretion not to admit a new ground of opposition (lack of novelty) into proceedings, having found that D5, which was filed after expiry of the opposition period, was not *prima facie* relevant to that ground because it did not disclose "the consideration of dynamic, steady-state, and residual stresses when creating a stress profile for an airfoil in a process of repairing it" (item 11.1(a) and 11.3 of the decision under appeal).

D5 was however admitted into the proceedings by the opposition division in respect of objections concerning the ground of lack of inventive step.

III. In its response of 31 July 2007, the respondent (proprietor) requested dismissal of the appeal as a main request or alternatively maintenance of the patent

on the basis of any one of four auxiliary requests filed therewith.

IV. Together with the summons to oral proceedings, the Board issued a communication stating *inter alia* that the subject matter of claim 1 appeared to lack novelty with respect to D5.

V. With its letter of 28 May 2009, the respondent filed two additional auxiliary requests for maintenance of the patent in an amended form.

VI. During the oral proceedings held on 30 June 2009, the appellant confirmed its request for revocation of the patent.

The respondent confirmed its main request for dismissal of the appeal and replaced all auxiliary requests by a single auxiliary request containing claims 1 to 6, upon which maintenance of the patent in an amended form should be based.

VII. Claim 1 of the main request (i.e. claim 1 as granted) reads as follows,

"A method of repairing an airfoil, comprising the steps of:
determining one or more regions (32) of said airfoil (46) that are likely to be damaged during a period of operation; creating a stress profile for said airfoil (46); selecting a patch line (42) using said stress profile and said determination of said one or more regions likely to be damaged during a period of operation; providing an airfoil replacement section (44)

with a predetermined shape having a bond surface (48) that substantially mates with said patch line (42); removing a damaged portion of said airfoil up to said patch line (42); bonding said airfoil replacement section (44) to said airfoil along said patch line (42); and shaping said airfoil (42), characterized in that said stress profile considers dynamic, steady-state, and residual stresses."

VIII. Claim 1 of the auxiliary request reads as follows:

"A method of repairing an airfoil, comprising the steps of:
determining one or more regions (32) of said airfoil (46) that are likely to be damaged during a period of operation; creating a stress profile for said airfoil (46); selecting a patch line (42) using said stress profile and said determination of said one or more regions likely to be damaged during a period of operation; providing an airfoil replacement section (44) with a predetermined shape having a bond surface (48) that substantially mates with said patch line (42); removing a damaged portion of said airfoil up to said patch line (42); bonding said airfoil replacement section (44) to said airfoil along said patch line (42); and shaping said airfoil (42), wherein said stress profile considers dynamic, steady-state, and residual stresses; and characterised by said one or more regions (32) of said airfoil that are likely to be damaged during a period of operation being determined using empirical data, by said dynamic stresses, steady state stresses, and residual stresses expected to be created in said bonding process being individually determined and collectively mapped for the airfoil and by

comparing the collectively mapped stress at any given point along a potential patch line (42) to that of a predetermined stress value, said collectively mapped stress value being acceptable if it is below said predetermined stress value or a predetermined percentage of it, evaluating other points on the potential patch line in like manner until a complete stress picture of the potential patch line is developed, if a portion of the potential patch line exceeds the predetermined stress value or the predetermined percentage of it, then altering the patch line to avoid the unacceptably high stress region, and repeating the stress comparison and evaluation and altering of the potential patch line until a patch line is determined which extends through regions of acceptable stress, said patch line (42) extending from a leading or trailing edge of said airfoil to the tip of the airfoil in a straight line."

IX. The appellant's arguments may be summarised as follows:

Main request:

The subject matter of claim 1 lacked novelty with respect to D5. In particular, D5 disclosed the creation of a stress profile that considered dynamic, static and residual stresses. A stress profile was created in D5 since a patch line for the repair was located in an area of low mechanical stress; its placement there required implicitly that areas of low stress were identified, which was creating a stress profile. Similarly, the area of low mechanical stress was disclosed as being caused, for example, by bending forces. Such bending forces implicitly resulted in both

static and dynamic stresses. Residual stresses were also present unavoidably. If claim 1 were interpreted to mean that only residual stresses resulting from bonding were to be considered, which was anyway disputed, this was disclosed in the last paragraph of page 11. Static, dynamic and residual stresses were not individually mentioned in D5 with regard to the area of low mechanical stress, but their consideration was implicit to a skilled person.

Auxiliary request:

The request was late filed and should not be admitted; ample time had been available in the written proceedings to file such a request.

The amendments made to claim 1 were contrary to Article 123(2) EPC; the description in paragraphs [0026] to [0028] from where the amendment was taken related to a rotor blade, not merely an airfoil, so this was an unallowable generalisation; there was no disclosure of a patch line extending from a leading or trailing edge to the tip, and the letters L.E and T.E. in the Figures did not clearly disclose leading and trailing edges, nor did the terms leading edge or trailing edge appear in the description; there was no disclosure of the feature comparing "the collectively mapped stress at any given point" with a predetermined stress value, but instead only a disclosure of comparing "the expected collective stress at any given point" with a predetermined value, such that, when using the so-called novelty test, novel subject matter had unallowably been added; the terminology "altering the patch line to avoid the unacceptably high stress

region" was not disclosed, only altering the patch line to "avoid the high stress region", so no basis existed for this altered definition. Further, the terminology "repeating the stress comparison and evaluation" in claim 1 was not disclosed and not clear. Instead it was merely disclosed originally that "the process repeats itself", which was not clearly and unambiguously directed to a stress comparison and evaluation.

None of the documents in proceedings was prejudicial to the novelty of the subject matter of claim 1.

The invention defined by claim 1 could not be carried out, contrary to Article 83 EPC, since it was at least not sufficiently disclosed how to determine an expected residual stress which might be created by bonding, let alone how to collectively map this with other stresses. Due to the request having been submitted during oral proceedings, a further opportunity was required to submit evidence on this matter. No objection to possible remittal of the case to the department of first instance for further examination arose.

X. The respondent's arguments may be summarised as follows:

Main request:

D5 contained no disclosure of a stress profile being created. A stress profile required a determination of an amount of stress in the profile. D5 disclosed mechanical stresses in general but did not indicate what stresses were involved let alone that these individual stresses were used to form a profile. The term "considers" in the feature "the stress profile

considers...stresses" would be understood by a skilled person to involve a quantification of the individual stresses, not merely a recognition that they might or might not be present. Steady state stresses were not mentioned and no centrifugal forces giving rise to such stresses would be present since D5 related to a stator. Further, the term "residual stresses" in claim 1 had been consistently referred to in the patent as the stresses created when bonding a patch on to the patch line and not other stresses mentioned by the appellant. In as far as D5 disclosed residual stresses at all on page 11, it was stated that a non-fusion process should be used so that residual stresses would not be present, and thus not considered, when creating the stress profile.

Auxiliary request

The amendments made in claim 1 were based on paragraphs [0027] and [0028] of the patent and Figures 3 to 6, as well as claim 3 as granted. No contravention of Article 123(2) EPC had occurred. In particular, the disclosure was not restricted to rotor blades, but disclosed airfoils in general; two straight patch lines were shown in the Figures extending from the leading and trailing edges to the tip respectively, whereby the abbreviations T.E. and L.E. were, for a skilled person, unmistakeable references to trailing edge and leading edge; the terminology "collectively mapped stress" instead of "expected collective stress" was used merely for consistency with previous wording in the claim, such that use of different wording did not result in an unallowable amendment as the meaning was not changed when read in context; the term "unacceptably" was

introduced to add clarity to the term "high stress region" as compared to the acceptable stress regions through which the patch line passed once it was determined; the "repeated process" mentioned in the description evidently referred to the stress comparison and evaluation steps, since only in this way would the repeated process produce the defined result. It was also clear for a skilled person exactly which steps were involved in the stress comparison and evaluation.

The requirements of Article 83 EPC were met. It was well known by a skilled person how to determine the expected residual stresses, for example by finite element analysis or by practical tests. Stress determination and mapping techniques were well known to the skilled person. No objection to possible remittal arose.

Reasons for the Decision

1. *Main request*

1.1 Using the wording of claim 1 and references from D5 and brief comments in parentheses, D5 discloses a method of repairing an airfoil (see e.g. page 4, first paragraph), comprising the steps of: determining one or more regions of said airfoil that are likely to be damaged during a period of operation (see e.g. paragraph bridging pages 6 and 7 disclosing front edge and main plane damage areas); creating a stress profile for said airfoil - (see comments below); selecting a patch line (26 - see page 7, last five lines of first paragraph and Figure 1) using said stress profile and said

determination of said one or more regions likely to be damaged during a period of operation; providing an airfoil replacement section (24) with a predetermined shape (part 24 is adapted to fit the predetermined path 26) having a bond surface (30) that substantially mates with said patch line (26) - (see e.g. Figure 1 and page 7, second paragraph); removing a damaged portion of said airfoil up to said patch line (26) - (see page 7, first paragraph last two lines); bonding said airfoil replacement section (24) to said airfoil along said patch line (26 - see e.g. page 5, lines 17 to 19); and shaping said airfoil (shaping operations are always required in some manner; the disclosure of this feature in D5 was also not disputed by the respondent), characterized in that said stress profile considers dynamic, steady-state, and residual stresses - (see comments below).

1.2 The feature "creating a stress profile for said airfoil" is found by the Board to merely require a determination of the stresses that the airfoil will likely experience during operation. This is also confirmed by the patent in column 3, lines 38 to 42. In D5 (see e.g. page 5, lines 5 to 10 and page 8, lines 1 to 8) it is disclosed that the patch line (26) is placed in an area where relatively low mechanical stresses will be present. In order for such placement to occur, an area of low stress must first be identified and thus it is self-evident that the skilled person has made a determination of where low stresses are likely to occur, be this correct or incorrect. Contrary to the submissions of the respondent, nothing in the claim limits the creation of a stress profile to something requiring a quantification of stress values.

It is thus sufficient for the creation of a stress profile to determine regions where low mechanical stresses are expected to occur.

Although the respondent argued that a quantification of specific stress values was implicit for a skilled person when creating a stress profile, the disclosure in the patent does not support this submission. Additionally, no evidence has been filed which would suggest that a skilled person must understand creation of a stress profile in this manner. Further, even if quantification were required, the fact that D5 uses a patch line 26 which is placed within areas of low mechanical stress is in itself a quantification of the stresses as being "low".

1.3 With regard to the feature whereby the "stress profile considers dynamic, steady-state, and residual stresses", the term "considers" in this terminology is found by the Board not to put any limitation on the particular way in which the individually listed stresses are considered.

Since D5 places the patch line in an area of low mechanical stress, it is implicit that particular stresses have been "considered" in arriving at the stress profile. In regard to the particular stresses defined in claim 1, a dynamic stress is disclosed in D5, on page 6, e.g. last four lines, which discloses the presence of bending stresses during operation. It is also known by a skilled person, not least from general mechanical principles, that a gas flow loading on an airfoil, whether this is a stator or a rotor, produces both dynamic stresses and steady state stresses. Such a

gas flow loading, which inherently involves not only dynamic loadings (e.g. from buffeting and changed loading conditions) but also a gas pressure loading (which is defined as being a steady-state stress in the patent in paragraph [0014]), is explicitly mentioned in D5 (see page 7, last paragraph) in the context that this loading has to be transferred from the airfoil into the supporting structure when considering the repair.

The final stress type, residual stresses, are also found by the Board to be considered in D5 in creating the stress profile. On page 11, last paragraph, D5 explains the stress effects of fusion bonding and non-fusion bonding processes, whereby D5 specifically uses non-fusion bonding processes. In this way, D5 discloses that in the stress profile of D5 it has been considered that the residual stresses will be negligible. The respondent argued that using a bonding process in D5 that is specifically intended to exclude such stresses meant that the residual stresses are not considered. The Board is however unconvinced by this submission, since in arriving at the decision to use a non-fusion bonding process, the skilled person has already considered that the stress profile will be relatively unaffected thereby. Thus, when creating the stress profile, the skilled person considers the bonding method and considers to what extent this would affect the stress profile; the mere fact that the skilled person may then consider that residual stresses are negligible as a result of the bonding method chosen does not alter the fact that the residual stresses have indeed been "considered" in creating the profile.

1.4 The question as to whether the opposition division correctly exercised its discretion by not admitting the late-filed ground of lack of novelty into proceedings following its analysis of D5, can be left undecided because a claim lacking any feature distinguishing it from the closest prior art also lacks any feature which can make its subject matter inventive (see e.g. Enlarged Board of Appeal decisions G 1/95 and G 7/95, Reasons 7.2).

Since the subject matter of claim 1 is disclosed in D5, it lacks novelty. Therefore claim 1 does not meet the requirements of at least Article 56 EPC, since its subject matter, due to a lack of novelty, also lacks inventive step.

The main request is therefore not allowable.

2. *First auxiliary request*

2.1 *Admittance of the request into proceedings*

This request was first filed during the oral proceedings, and although the appellant argued that sufficient time had been available in the written proceedings to file the request then, it should be noted that the respondent had already filed two auxiliary requests with its response of 28 May 2009 which were aimed specifically at dealing with objections first raised by the Board in the annex to the summons concerning the way in which claim 1 was interpreted, in particular regarding the way in which the three stress types were considered in creating the stress profile with respect to the disclosure in D5.

Furthermore, during the oral proceedings, the Board and the appellant each raised objections to aspects of the amendments made in those requests, and the single auxiliary request was filed to meet those new objections. The Board also took account of the fact that the request presented a fully convergent and procedurally efficient approach in dealing with the objections. The Board further finds (see below) the amendments to be acceptable in view of at least Article 84 EPC 1973 and Article 123 EPC and, with regard to D5 and all other documents in the appeal proceedings, that the subject matter of claim 1 is novel.

The Board thus exercised its discretion under Article 13(1) of the Rules of Procedure of the Boards of Appeal (RPBA) to allow the respondent to amend its case by filing the auxiliary request.

2.2 *Article 123 EPC*

2.2.1 The protection conferred by claim 1 of the auxiliary request has been limited compared to that of granted claim 1, due to the introduction of features which further limit the way in which the stress profile is considered when deciding upon the location of the patch line. The requirement of Article 123(3) EPC is thus met.

2.2.2 In regard to Article 123(2) EPC, the amendments introduced are disclosed, albeit somewhat reformulated for reasons of consistency, in e.g. paragraphs [0026, 0027 and 0028], Figures 3 to 5 and in claim 3 of the granted patent, which correspond to paragraphs [0029, 0030 and 0031], Figures 3 to 5 and e.g. claim 10 of the

published version of the application as filed. The subject matter of claim 1 therefore does not extend beyond the content of the application as filed and the requirement of Article 123(2) EPC is thus met.

2.2.3 The appellant's objections to the amendments are found unconvincing, as explained below:

(a) the appellant argued that the embodiment which was described in paragraphs [0026] to [0028] of the patent and which was shown in the Figures was disclosed in respect of a rotor blade only, not any type of airfoil. Since the amendment was based on this disclosure, the appellant argued that the claim should be limited to only rotor blades. However, the Board finds otherwise. First, the claims as granted were not limited to an airfoil of a particular type. Then, in paragraph [0029] of the published application (paragraph [0025] of the patent) the steps in the method of repairing "an airfoil" are described, without specifying or requiring any particular type of airfoil. In the following paragraph, reference is again made to an airfoil, albeit then with particular reference being made to the type of damage which may be encountered by "a rotor blade in a particular application". Thus, whilst paragraph [0030] of the description does mention a rotor blade, and whilst Figures 3 and 4 are stress plots for a rotor blade, the description (particularly in paragraph [0029] read together with paragraph [0030] and taking account of the subject matter of the claims originally directed to airfoils and the understanding by a skilled person) provides a more

general disclosure concerning the repair of an airfoil rather than only repair of a rotor blade by the method now in claim 1. The inconsistency of several parts of the description (see e.g. paragraph [0001] of the patent and published application) which mention rotor blades rather than just airfoils does not alter this conclusion, since the claims as filed were also directed more generally to an airfoil repair method and were thus already inconsistent with those parts of the description.

(b) the appellant's objection that no disclosure is present of a straight patch line extending from a leading or trailing edge of the airfoil to its tip, is not found convincing by the Board. Figures 3 to 5 each depict airfoils and are each labelled with the terms "airfoil base", "airfoil tip", "L.E." and "T.E". It is thus self-evident to a skilled person in the art of airfoils that L.E. and T.E. are abbreviations for "leading edge" and "trailing edge"; as is known (and also shown in the Figures) these edges extend between the base and the tip of the airfoil. It is thus unambiguously disclosed that the Figures represent airfoils with leading and trailing edges having patch lines 42 depicted thereon. The patch lines 42 in Figure 5 are also straight and extend from the trailing edge and the leading edge respectively to the tip. The appellant's argument that the expressions "leading edge" and "trailing edge" do not appear as such in the application does not change this conclusion, since the amendment is based on the unambiguous disclosure in the content of the filed application

when read by a skilled person. In the present case, the skilled person would have no doubt that the patch lines shown are patch lines extending from leading and trailing edges, even without the presence of the abbreviations L.E. and T.E.

(c) although the appellant objected that there was no disclosure in the description of "comparing the collectively mapped stress at any given point" but instead only a disclosure of "comparing the expected collective stress at any given point", the difference in wording used in claim 1 from that in the description results entirely from the need for consistency with the antecedent terminology in the claim, namely "...by said dynamic stresses, steady state stresses, and residual stresses expected to be created in said bonding process being individually determined and collectively mapped for the airfoil". Indeed, the terminology "comparing the expected collective stress at any given point" as used in the description follows in the next paragraph of the description mentioning the individual determination and collective mapping of the stresses, and thus can only be interpreted in the manner now defined in the claim. The appellant's further argument that use of a novelty test would produce a different result is simply ill-founded, since a comparison must be made between a defined feature and a disclosure in the application, and not simply by a comparison of the wording; as explained *supra* the disclosure of "expected collective stress at any given point" can only be

read as meaning "the collectively mapped stress at any given point" in the context described.

(d) although the terminology "altering the patch line to avoid the unacceptably high stress region" was not disclosed explicitly, this only relates to choice of wording, since the regions of high stress referred to are those areas which are unacceptable compared to the regions of stress which the patch line will pass, once these have been determined, whereby these regions are defined in claim 1 and disclosed in the application as filed as being "regions of acceptable stress". Thus the appellant's objection to the terminology "unacceptably high stress region" is unconvincing.

(e) the terminology "repeating the stress comparison and evaluation" was objected to by the appellant under Article 123(2) EPC. However, the terminology used in the claim is disclosed in the filed application, because the terminology "the process repeats itself until a patch line 42 is determined that extends through regions of acceptable stress" is explicitly used in the description (paragraph [0032] of the published application), and this follows directly after the description of the iterative method involving the selection of a potential patch line followed by an evaluation involving use of the stress profile which provides a collectively mapped stress at any given point along the potential patch line, followed by moving the (potential) patch line until the patch line no longer extends through regions having unacceptably high stress. The repeating process is thus

unambiguously referring to the iterative process involving stress comparison and evaluation as now defined in the claim.

2.3 *Article 84 EPC 1973*

The appellant also raised an objection of lack of clarity of the claim regarding the process step "repeating the stress comparison and evaluation". However, the Board finds that this step is perfectly clear since the claim defines what is compared and evaluated, namely that a comparison of the collectively mapped stress at any given point on the line is made with a predetermined stress value or a predetermined percentage of it and then an evaluation is performed for each point to determine whether this collectively mapped stress is above or below that value in order to determine whether the potential patch line must be altered or not.

Since no further objections were made under Article 84 EPC 1973 concerning claim 1 and since the Board also finds no reason to raise any such objections, the Board concludes that claim 1 fulfils the requirements of Article 84 EPC 1973.

2.4 *Article 54 EPC*

The Board finds that the subject matter of claim 1 is novel with respect to D5, at least in regard to all the features of claim 1 starting from "by said dynamic, stead state stresses, and residual stresses expected to be created in said bonding process being individually determined..." up to the end of claim 1.

No other documents in the appeal proceedings have been cited by the appellant in regard to the objection of lack of novelty, nor indeed has the appellant raised a novelty objection. The Board also finds no basis for such an objection.

Thus, the subject matter of claim 1 is novel with regard to the documents cited in the appeal proceedings and the requirements of Article 54 EPC are thus fulfilled with respect to those documents.

2.5 *Remittal*

2.5.1 Claim 1 of the auxiliary request, the only independent claim, has been amended to such an extent that its subject matter differs significantly to the claims considered by the opposition division. For this reason, and since the appellant also raised an objection under Article 83 EPC 1973 and required a further opportunity to present its case on this matter, the Board finds that remittal of the case to the department of first instance for further examination of the opposition is appropriate.

Neither the appellant nor the respondent raised any objection concerning possible remittal of the case for further examination based on the new auxiliary request.

2.5.2 For the avoidance of doubt, the Board has not considered the subject matter of claim 1 with regard to e.g. Article 83 EPC 1973 nor with respect to Article 56 EPC 1973, but only with regard to Article 123 EPC,

Article 84 EPC 1973, and in respect of novelty with regard to the documents cited in the appeal proceedings.

Further, it should be remarked that only claim 1 of the auxiliary request has been considered in regard to the foregoing matters, and not the dependent claims.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the opposition division for further prosecution.

The Registrar: The Chairman:

M. Patin P. Alting van Geusau