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Datasheet for the decision of 4 April 2014

Case Number: T 0479/13 - 3.2.07

Application Number: 02252672.7

Publication Number: 1254967

IPC: C23C4/02

Language of the proceedings: EN

Title of invention:
Improved plasma sprayed thermal bond coat system

Patent Proprietor:
GENERAL ELECTRIC COMPANY

Opponent:
Siemens Aktiengesellschaft

Headword:

Relevant legal provisions:
EPC Art. 100(c), 123(2)

Keyword:
Amendments - inescapable trap (yes)

Decisions cited:

Catchword:

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Case Number: T 0479/13 - 3.2.07

D E C I S I O N
of Technical Board of Appeal 3.2.07
of 4 April 2014

Appellant: (Patent Proprietor)	GENERAL ELECTRIC COMPANY 1 River Road Schenectady, NY 12345 (US)
Representative:	Szary, Anne Catherine GPO Europe GE International Inc. The Ark 201 Talgarth Road Hammersmith London W6 8BJ (GB)
Respondent: (Opponent)	Siemens Aktiengesellschaft Wittelsbacherplatz 2 80333 München (DE)
Representative:	Kaiser, Axel Siemens AG Postfach 22 16 34 80506 München (DE)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted on 11 December 2012 revoking European patent No. 1254967 pursuant to Article 101(3)(b) EPC.**

Composition of the Board:

Chairman:	H. Meinders
Members:	H. Hahn
	E. Kossonakou

Summary of Facts and Submissions

I. The appellant (patent proprietor) lodged an appeal against the decision of the Opposition Division to revoke European patent No. 1 254 967.

With its statement of grounds of appeal the appellant requested that the decision be set aside and the patent be maintained on the basis of the main request, or alternatively on the basis of the auxiliary request or second auxiliary request at present on file, i.e. underlying the impugned decision. In case that the Board should intend to confirm the decision, oral proceedings were requested.

II. Although the opposition had been filed against the patent in its entirety only under Article 100(a) EPC, for lack of novelty and inventive step, the Opposition Division in its summons to oral proceedings, on its own motion (Article 114(1) EPC), raised the (new) ground of opposition under Article 100(c) EPC that the patent extends beyond the content of the application as originally filed.

The Opposition Division at the oral proceedings held that the ground of opposition under Article 100(c) EPC holds against claim 1 of the patent as granted (main request) and that the claims 1 of the auxiliary and the second auxiliary request, respectively, contravene Article 123(2) EPC.

III. Claim 1 of the patent as granted reads as follows:

"1. A process for forming a thermal barrier coating system on a surface of a superalloy component, the process comprising the steps of:

forming a β-NiAl bond coat comprising 15 to 33 weight percent Al and the balance Ni and incidental impurities over the superalloy, the bond coat being formed by first applying a dense sublayer of β-NiAl material, then air plasma spray applying a less dense outer layer of β-NiAl material over the β-NiAl sublayer, the β-NiAl bond coat having an overall thickness of at least 25.4 µm up to 177.8 µm (0.001 up to 0.007 inches); then thermally spraying a ceramic topcoat over the β-NiAl bond coat."

IV. Claim 1 of the auxiliary request dated 26 September 2012 reads (amendments as compared to claim 1 of the main request are in bold; emphasis added by the Board):

"1. A process for forming a thermal barrier coating system on a surface of a superalloy component, the process comprising the steps of:
forming a β-NiAl bond coat comprising 15 to 33 weight percent Al and the balance Ni and incidental impurities over the superalloy, the bond coat being formed by first applying a dense sublayer of β-NiAl material **using an HVOF process**, then air plasma spray applying a less dense outer layer of β-NiAl material over the β-NiAl sublayer, the β-NiAl bond coat having an overall thickness of at least 25.4 µm up to 177.8 µm (0.001 up to 0.007 inches); then thermally spraying a ceramic topcoat over the β-NiAl bond coat."

V. Claim 1 of the second auxiliary request dated 21 November 2012 reads (amendments as compared to claim 1 of the auxiliary request are in bold; emphasis added by the Board):

"1. A process for forming a thermal barrier coating system on a surface of a superalloy component, the

process comprising the steps of:
forming a β-NiAl bond coat comprising 15 to 33 weight percent Al and the balance Ni and incidental impurities over the superalloy, the bond coat being formed by first applying a dense sublayer of β-NiAl material using an HVOF process **employing relatively fine powders**, then air plasma spray applying a less dense outer layer of β-NiAl material **employing relatively coarse powders** over the β-NiAl sublayer, the β-NiAl bond coat having an overall thickness of at least 25.4 µm up to 177.8 µm (0.001 up to 0.007 inches); then thermally spraying a ceramic topcoat over the β-NiAl bond coat."

VI. With a communication dated 21 January 2014 and annexed to the summons to oral proceedings set for 9 April 2014 the Board presented its preliminary opinion with respect to the three requests underlying the impugned decision, i.e. claims 1-4 of the patent as granted (main request) and claims 1-3 of the auxiliary and the second auxiliary request.

It remarked amongst others that the feature "... **the bond coat being formed by first applying a dense sublayer** of β-NiAl material, **then air plasma spray applying a less dense outer layer of β-NiAl material over the β-NiAl sublayer, the β-NiAl bond coat having an overall thickness of at least 25.4 µm up to 177.8 µm** (0.001 up to 0.007 inches); ..." of claim 1 of the main request appeared to be in conflict with the ground of opposition under Article 100(c) EPC and that the same reasoning applied *mutatis mutandis* to the subject-matter of the claims 1 of the auxiliary and the second auxiliary requests which contained the identical wording. The claims 1 of the auxiliary and the second auxiliary requests therefore appeared to contravene Article 123(2) EPC.

Furthermore, it appeared that - since the feature in question cannot be deleted from the subject-matter of claim 1 of the main request in order to overcome the ground of Article 100(c) EPC as that would extend the scope of claim 1 of the patent as granted contrary to the requirements of Article 123(3) EPC - the appellant was caught in the so-called "Article 123(2) and (3) EPC trap".

VII. With letter dated 17 March 2014 the appellant informed the Board that "no representative will be available to attend the Oral Proceedings scheduled for 9 April 2014".

This letter did **not** contain any further arguments concerning the objections raised in the above mentioned Board's communication.

VIII. In the written proceedings the respondent (opponent) has **not** made any substantive submission or submitted any request, let alone requested oral proceedings.

Insofar, the Board is surprised to note the (translated) statement "We withdraw our request for oral proceedings." as submitted by the respondent with its letter dated 25 March 2014.

IX. With communication dated 31 March 2014 the scheduled oral proceedings was cancelled.

X. The appellant argued in the written proceedings, insofar as relevant for the present decision, essentially as follows:

There is an implicit disclosure in the application as filed to support the objected wording. The description at page 6, lines 7 to 15 mentions that HVOF employing relatively fine powders may be used to produce a first sublayer adjacent to the substrate that is dense. The HVOF process produces a smooth and dense sublayer as this technique melts the fine powders without oxidizing them. The sublayer has a surface finish Ra of 125 microinches (3.18 µm) produced with powders finer than 50 microns diameter. The description at page 6, lines 9 to 10 also states that APS employing relatively coarse powders is used to produce a rough, outer surface layer. The surface roughness of the APS layer is given at page 8, lines 23 to 26 which discloses that this layer has a surface roughness Ra of 400 microinches (10.16 µm). The sentence at page 8, lines 26 to 28 further states that the larger particles coupled with the well known air plasma spray parameters make such a relatively rough surface possible. By applying a dense sublayer employing relatively fine particles and subsequently applying an outer layer which employs relatively coarse particles it is inherent that the outer layer will be less dense, having been formed from coarser particles which is further supported by the fact that the sublayer has a relatively smooth surface and the outer layer has a relatively rough surface.

Therefore claim 1 of the main request does not fall due to Article 100(c) EPC and the claims 1 of the auxiliary and second auxiliary request do not comply with Article 123(2) EPC.

Reasons for the Decision

1. The statement of the appellant in its letter dated 17 March 2014 - that **"no representative will be available to attend the Oral proceedings scheduled for 9 April 2014"** (see point VII above), i.e. no one will attend the oral proceedings - is considered by the Board as a withdrawal of its auxiliary request for oral proceedings which further implies, as is constant jurisprudence (see Case Law of the Boards of Appeal, 7th edition 2013, section III.C.2.3) that the appellant relies on its submissions in the written proceedings only.

2. Admissibility of the amendments made in claim 1 (Articles 100(c) and 123(2) EPC)

Main request

2.1 Claim 1 of the patent as granted according to the main request contains the features "... **the bond coat being formed by first applying a dense sublayer** of β-NiAl material, **then air plasma spray applying a less dense outer layer of β-NiAl material over the β-NiAl sublayer, the β-NiAl bond coat having an overall thickness of at lest 25.4 µm up to 177.8 µm** (0.001 up to 0.007 inches); ..." (emphasis added by the Board). These features have no explicit basis in the application as originally filed, as admitted by the appellant who argued that there would be an inherent basis therein. However, these arguments cannot hold for the following reasons (as already explained by the Board in the annex to the summons).

2.1.1 The application as originally filed states "The present invention relates to protective coatings for components exposed to high temperatures, such as components of a gas turbine engine. More particularly, this invention is directed to **a process for forming a thermal barrier coating system utilizing a NiAl bond coat and a ceramic top coat using an air plasma spray method"** (see page 1, first paragraph). This statement - that the bond coat and the ceramic top coat of the TBC are applied by APS - is followed by a description of the prior art of thermal barrier coating (TBC) systems which include the use of EB-PVD and air plasma spray (APS) for the deposition of the ceramic layer thereof. The bond coat of the TBC, among which are MCrAlY that are typically deposited by APS while β-NiAl is typically deposited by use of low pressure plasma spraying (LPPS) or high velocity oxyfuel (HVOF) techniques (see page 1, second paragraph to page 3, first paragraph). LPPS results in smooth coatings while APS due to the formation and entrapping of oxides may not be smooth and continuous, the latter having a higher as-sprayed surface roughness at lower equipment cost and ease of application and masking, but prevents the use of a PVD process for depositing the ceramic layer (see page 3, first paragraph to page 5, second paragraph). The object is then defined as the provision of a process that provides turbine components with greater performance and at lower cost than prior coating processes, by virtue of thinner bond coating than is currently employed by APS MCrAlY and LPPS NiAl bond coatings, without adversely affecting the environmental resistance or spallation resistance of the TBC and should improve component durability and increase the service life of a TBC system (see page 5, third paragraph).

As solution to this aforementioned problem the application discloses in its claim 1 "a process for forming a thermal barrier coating system (20) on a surface of a superalloy component, the process comprising the steps of:

"(a) providing a β-NiAl powder alloy comprising 15 to 33 weight percent aluminium and the balance Ni and incidental impurities;

(b) **air plasma spraying the β-NiAl powder alloy on the surface** of a superalloy component **as a bond coat by air plasma spraying the powder on the surface to produce a thin layer of a continuous β-NiAl** (24); and

(c) thermally spraying a ceramic top coat (26) over the β-NiAl bond coat".

Thus claim 1 as originally filed discloses a process wherein the bond coat is applied **only** by APS as a **continuous layer** ("spraying **the** β-NiAl powder … as a bond coat … to produce …"). The dependent claims 2-13 as originally filed further define the composition of the β-NiAl bond coat (claims 2-10) or that a layer of a diffusion aluminide is applied over the same (claims 11-13).

Claim 1 has, however, **no** clear counterpart in the description (see page 5, fourth paragraph) which states that "The present invention generally provides a method of forming a thermal barrier coating system on an article subjected to a hostile thermal environment, such as the hot path components of a gas turbine engine. The coating system is generally comprised of a ceramic layer and an environmentally resistant beta phase nickel aluminium intermetallic (β-NiAl) bond coat that adheres the ceramic layer to the component surface. A thin aluminium oxide scale forms on the surface of the β-NiAl during heat treatment."

2.1.2 Following this passage an alternative embodiment of the invention is disclosed on page 6, lines 1 to 15 of the application as originally filed which reads:

"In an alternate embodiment of the present invention, an additional layer of diffusion aluminide can be formed on the surface of the article prior to the deposition of the β-NiAl bond coat, or the diffusion aluminide can be formed immediately after the deposition of the β-NiAl bond coat, or both such that the diffusion aluminide adheres the ceramic layer to the component surface. **The β-NiAl bond coat may be deposited by a combination of techniques to satisfy performance requirements. For example, HVOF employing relatively fine powders may be used to produce a first sublayer adjacent to the substrate that are dense, while APS employing relatively coarse powders may be used to produce rough, outer surface layer that may be beneficial in adhesion of the subsequently applied TBC. The HVOF process produces a smooth and dense sublayer as the HVOF technique melts the fine powders without oxidizing them. The sublayer has a surface finish of 125 R_a produced with powders finer than 50 microns**. The size of a powder in microns, as used herein, refers to the diameter of the powder."

This - alternate embodiment - for applying a bond coat of β-NiAl comprises two deposition steps and explicitly requires that the β-NiAl bond coat has a dense sublayer deposited by HVOF and a rough outer surface layer deposited by APS but without specifying what is meant by the unprecise definitions "relatively fine" and "relatively coarse". There exists no explicit disclosure concerning the density of the rough outer surface layer. In the context of the surface finish the HVOF sublayer is stated to be 125 R_a while that of the APS layer should be ≥ 400 R_a which is stated to be the result of larger particles coupled with the well known air plasma spray parameters (see page 8, fourth paragraph); in this context the preferred range of **20-80 µm of the β-NiAl powder for APS** needs to be noted and compared with the one of **"less than 50 µm"** (which e.g. may be 40 µm) mentioned in the context of using HVOF for said sublayer. Hence the HVOF powder is **not** necessarily finer than that for APS spraying.

2.1.3 At page 7, lines 1 to 3 in the application as originally filed it is then stated "According to this invention, **at least a portion of the beta phase nickel aluminum bond coat is deposited using an air plasma spray (APS) process. The thickness of the β-NiAl layer is in the range of about 1 to about 20 mils.** If the β-NiAl layer is thinner than about 1 mils, then the amount of aluminum available from the β-NiAl layer may be insufficient to protect the surface of the article from environmental damage for the expected life of the article". The disclosed thickness range of from about 25.4 to about 500.8 µm seems to relate to the APS process since it is disclosed in that context.

2.1.4 Then the advantages of the APS process are mentioned in comparison to the LPPS process which include less exposure of the substrate to extremely high temperatures, less costs, a thinner coat of β-NiAl, and direct and less costly application of the ceramic top coat by APS (see page 7, second paragraph to page 9, first paragraph; and page 10, third to fifth paragraphs).

Subsequently the alternative embodiment with an optional diffusion aluminide coating is described (see page 9, second paragraph to page 10, second paragraph).

2.1.5 The invention is then described by way of example on the basis of the turbine blade of figures 1 and 2. The TBC system of figure 2 comprises a β-NiAl bond coat which is applied by APS and has a minimum thickness of about 25.4 µm, preferably about 50.8 to about 177.8 µm in order to avoid chipping of the brittle β-NiAl layer (see page 12, second paragraph to page 13, first paragraph). The TBC system may optionally comprise a diffusion aluminide layer either between said β-NiAl layer and the ceramic layer or between the substrate and said β-NiAl layer (see page 13, second paragraph; page 14, second paragraph). The ceramic layer is preferably deposited by plasma spray techniques (see page 13, third paragraph).

2.1.6 Finally, there is the usual statement in the application as originally filed that the scope of the invention is defined by the appended claims (see page 14, third paragraph).

2.1.7 The appellant argued that it would be implied by the indicated techniques and relative powder sizes that the - coarse - outer surface layer is less dense then the dense sublayer.

The Board remarks in this context - likewise as the Opposition Division in its impugned decision - even though it seems plausible that the indicated combination of HVOF and APS techniques **can** be readily employed to make the combined dense/less dense bond coat structure as required by claim 1 of the patent as granted **there is no direct and unambiguous disclosure**

in this regard in the application as originally filed (see points 2.1.1 to 2.1.6 above).

It is **not** conclusive that the quality "coarse" of said β-NiAl layer inherently implies that it must be "less dense" than the so-called "dense" sublayer. In this context it should also be borne in mind that coating layers deposited by HVOF have a certain porosity. Furthermore, it belongs to the common general knowledge that the density of a deposited layer is not only determined by the particle size of the powder used for thermal spraying but additionally can be influenced by many other process parameters including the selected method and process parameters such as the spray angle, the distance between the nozzle and the substrate, the atmosphere, the particle speed, the plasma conditions and the temperatures.

Therefore it is considered to be evident that the teaching of claim 1 of the patent as granted, i.e. that the outer surface layer of the β-NiAl bond coat is less dense than the dense sublayer, goes beyond the content of the application as originally filed and actually represents an intermediate generalisation without any basis, and certainly not the passage at page 6, lines 6 to 14, since the subject matter of claim 1 of the main request does **not** specify either the HVOF deposition process used to apply the β-NiAl sublayer, **or** the use of relatively fine powders for applying the dense sublayer and relatively coarse powders for applying the outer layer, using APS as the only example.

2.1.8 Furthermore, it is doubtful whether or not the preferred thickness range for the APS deposited β-NiAl layer of from 25.4-177.8 µm taken from the example of figure 2 can be combined with said alternative embodiment using two different thermal spraying methods without adding information to the application as originally filed. Since the application as originally filed covered the one step APS deposition of the β-NiAl bond coat layer, there may be a difference in the total coating thickness of this APS layer compared to said two step deposition including a sublayer of unknown thickness when adopting the appellant's argument that there would be a difference of the density between the β-NiAl layer sublayer and the β-NiAl layer outer layer. The density of the layer determines the reservoir of aluminum contained in said β-NiAl layer which is considered to imply that a less dense layer, in order to provide the same reservoir of aluminum, has to be applied in a greater thickness than a more dense β-NiAl sublayer. Therefore the appellant's argument mentioned in the *obiter dictum* - based on page 7, lines 1-3 of the application as originally filed - namely that from that passage it would be unambiguously clear that the application teaches the disclosed thicknesses as indicated in granted claim 1 also for the β-NiAl layer which includes the sublayer ("... at least a portion of the beta phase nickel aluminum bond coat is deposited using an air plasma spray...") may hold true for the general range of about 1 to about 20 mils, i.e. about 25.4 to about 500.8 µm but **not** for the preferred range of from 25.4 to 177.8 µm disclosed in the context of figure 2 and a single step APS spraying of the β-NiAl layer. Thus it cannot be directly and unambiguously derived that the indicated thicknesses also apply to the dense sublayer / less dense outer layer bond coat embodiment defined by claim 1 of the patent as granted.

2.1.9 The ground of opposition under Article 100(c) EPC therefore holds against claim 1 of the patent as granted according to the main request. Therefore the main request is not allowable.

Auxiliary and second auxiliary requests

2.2 The reasoning of points 2.1.7 to 2.1.9 above applies *mutatis mutandis* to the subject matter of claims 1 of the auxiliary request and the second auxiliary request, respectively, which contain the identical wording.

2.2.1 Insofar, the addition of the further feature **"using an HVOF process"** for the sublayer of the β-NiAl bond coat according to claim 1 of the auxiliary request (see point IV above), or **"using an HVOF process employing relatively fine powders"** for the sublayer in combination with **"employing relatively coarse powders"** for the outer layer of the β-NiAl bond coat according to claim 1 of the second auxiliary request (see point V above) - which both have a basis in the application as originally filed (see point 2.1.2 above) - cannot solve this problem.

2.2.2 The claims 1 of the auxiliary request and the second auxiliary request therefore contravene Article 123(2) EPC. The auxiliary request and the second auxiliary request therefore are not allowable either.

2.3 Therefore - since the features in question cannot be deleted from the subject-matter of claim 1 of the main request in order to overcome the objections as that would extend the scope of protection of claim 1 of the patent as granted contrary to the requirements of Article 123(3) EPC - the appellant is caught in the so-called Article 123(2) and (3) EPC trap.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

G. Nachtigall H. Meinders

Decision electronically authenticated