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Datasheet for the decision of 14 February 2012

Case Number: T 2236/08 - 3.2.07

Application Number: 02250777.6

Publication Number: 1236812

IPC: C23C 28/00, C23C 4/00, B23P 6/00, B23P 9/00

Language of the proceedings: EN

Title of invention:
Method for refurbishing a coating including a thermally grown oxide

Patentee:
GENERAL ELECTRIC COMPANY

Opponent:
SIEMENS AKTIENGESELLSCHAFT

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (no - obvious modification of prior art)"

Decisions cited:
-

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 2236/08 - 3.2.07

D E C I S I O N
of the Technical Board of Appeal 3.2.07
of 14 February 2012

Appellant: (Opponent)
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Decision under appeal:
Decision of the Opposition Division of the European Patent Office posted 14 November 2008 rejecting the opposition filed against European patent No. 1236812 pursuant to Article 101(2) EPC.

Composition of the Board:

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

Summary of Facts and Submissions

I. The appellant (opponent) lodged an appeal against the decision of the Opposition Division to reject the opposition against European patent EP-B-1 236 812.

II. Independent claim 1 of the patent as granted reads as follows:

"1. A method for refurbishing a service operated metallic coating (12) on a substrate alloy surface (11), the metallic coating (12) including at least within a coating outer surface (16) at least one oxide (14) chemically grown from at least one coating element and chemically bonded with the coating outer surface (16) as a result of thermal exposure during service operation, thereby depleting at least a portion of the coating element from the coating (12), the steps of:

removing the oxide (14) from the coating outer surface (16) while substantially retaining the metallic coating (12) as a retained metallic coating thereby exposing in the coating outer surface (16) at least one surface void (18) that had been occupied by the oxide (16);
mechanically working the retained metallic coating (12), substantially without removal of the retained metallic coating (12), substantially to close the void (18) to provide a treated metallic coating outer surface (20); and,
applying a refurbishing coating (22) over the treated metallic coating outer surface (20)."

III. The following documents of the opposition proceedings are cited in the present decision:

D9 = US-A-5 972 424
D11 = EP-A-0 074 918

IV. The opposition had been filed against the patent in its entirety amongst others under Article 100(a) EPC, for lack of novelty and inventive step.

The Opposition Division admitted only document D9 into the proceedings and stated that documents from the examination proceedings were not automatically part of the opposition proceedings in accordance with the case law while the other ones (except D9) newly cited in the opposition proceedings (among which D11) were also not admitted into the proceedings in accordance with Article 99(1) and Rule 76(2)(c) EPC, since no reasoning had been provided explaining how to link the teachings of these examination proceedings documents and the newly cited ones with an attack on a specific claim, again citing case law. The Opposition Division acknowledged novelty of claim 1 of the patent as granted with respect to the disclosure of D9 and considered that the subject-matter of claim 1 involved inventive step in view of D9. As a result the opposition was rejected.

V. With a communication dated 2 December 2011 and annexed to the summons to oral proceedings the Board presented its preliminary opinion with respect to claims 1-13 of the patent as granted.

The Board remarked amongst others with respect to the issue of novelty that it appeared that novelty of the refurbishing method of claim 1 of the patent in suit had to be acknowledged over the disclosure of D9 since the feature of the mechanically working step "substantially without removal of the retained metallic coating (12)" was **neither** explicitly disclosed in **nor** directly and unambiguously derivable from D9.

With respect to the issue of inventive step the Board remarked amongst others that the appellant considered D9 as the closest prior art and that starting from D9 it could be discussed as to what the person skilled in the art would do if the metallic layer had a rumpled appearance after the removal of the oxide layer, whether or not he would apply a blasting method.

It had to be discussed taking account of the problem-solution approach whether or not the solution to this problem was obvious, particularly in the light of the common general knowledge of the person skilled in the art such as evidenced by D11.

VI. With letter dated 12 January 2012 the respondent submitted as a response to the summons to oral proceedings further arguments concerning novelty and inventive step with respect to the disclosure of D9.

VII. Oral proceedings before the Board were held on 14 February 2012. To start, the appellant declared it did not pursue the novelty attack so that the only issue discussed was inventive step of the subject-matter of process claim 1 in view of D9 and D11.

(a) The appellant requested that the decision under appeal be set aside and that the patent be revoked.

(b) The respondent requested that the appeal be dismissed.

At the end of the oral proceedings the Board announced its decision.

VIII. The appellant argued, insofar as relevant for the present decision, essentially as follows:

With respect to inventive step the subject-matter of claim 1 is rendered obvious by a combination of the teachings of the closest prior art D9 and D11.

D9 discloses a method for repairing gas turbine engine components coated with a thermal barrier coating (TBC) comprising a metallic bond coat 12, an aluminum oxide layer 14 and a ceramic top coat 16 (see column 3, lines 18 to 20, lines 35 to 53 and figure 2). This method according to D9 aims to increase the number of times a part can be repaired, it should be less expensive and time consuming than prior art repair methods and should not lead to the "coat down method phenomenon" noted with prior art repair methods (see column 2, lines 34 to 40). The prior art stripping processes in addition to the removal of the TBC remove a portion of the base metal under the metallic portion thinning the exterior wall of the component (see column 1, lines 57 to 60). The method of D9 removes the ceramic top coating 16 and the aluminum oxide layer 14 from the blade 18 by any conventional method "that does **not** also remove the metallic bond coat 12" (see column 4, lines 6 to 9).

The "autoclave cleaning in KOH" does not remove the metallic bond coat since this treatment is stated to remove **only** the ceramic portion of the TBC coating since the metallic portion of the TBC needs an additional soaking treatment in a heated HCl solution (see column 1, lines 46 to 56).

According to D9 the bond coat 12, after the described removal of the ceramic top coating 16 and the aluminum oxide layer 14, **preferably** will not have a rumpled appearance (see column 4, lines 31 and 32). However, if the bond coat 12 does have a rumpled appearance then the person skilled in the art, in order to maintain the advantage of an increase in the number of times the repairing process can be performed, will have to look how he can treat this rumpled surface. In such a situation the person skilled in the art will turn to the teaching of D11. Thereby he will be taught that shot peening allows to effectively eliminate localized areas of tensile stress, phase transformations, machine and grinding marks, pits, scratches, and the like and at the same time generates a beneficial residual compressive stress in the surface of a metal workpiece (see D11, page 1, lines 10 to 18). The shot peening according to D11 thus allows smoothening surface defects (such as a rumpled surface). Therefore the person skilled in the art would apply the shot peening method according to D11 to react to said rumpled surface. Thereby he would arrive at the repair method of claim 1 of the patent as granted.

Claim 1 of the patent as granted contains no limitation nor definitions with respect to acetic acid (e.g. it could be concentrated acetic acid) or the

aggressiveness of the means used for removing the oxide, it likewise does not exclude any such TBC layer since the bond coat could be an intermediate layer (compare patent in suit, column 1, lines 51 to 55). Claim 1 further has to be interpreted as employing the definition "comprising" for the steps of its method. During the removal of the ceramic top coat the outer surface oxide layer is likewise removed. It is considered that any removal means will slightly remove (to a very limited extent) some of the bond coat. This fact has in any case been acknowledged by the respondent in the definition "substantially retaining …" used in claim 1 which allows such slight removal.

The passage "if there is insufficient bond coat …" (D9, column 4, lines 24 to 28) has to be interpreted that in all other cases the method described in D9 has to be applied. This does not imply that the method of D9 intends to remove said bond coat and to apply a new one. To the contrary, it requires as much as possible of the bond coat to remain "inspected to ensure that sufficient bond coat 12 remains" (column 4, lines 16 to 18). One possible reason that insufficient bond coat is detected during the described inspection of the turbine components after said removal of the ceramic top coating and oxide layer could be that the treated component has already undergone several repairing cycles.

If the surface of the bond coat according to D9 after said removal of the ceramic layer and the oxide layer would be smooth then there would not be any need for inspecting the same (see column 4, lines 28 to 32). If

it is not smooth, i.e. rumpled, then the person skilled in the art would apply the method of D11 to overcome the rumpled appearance.

IX. The respondent argued, insofar as relevant for the present decision, essentially as follows:

Document D9 relates to the repair of TBC coated turbine components (see column 3, lines 18 to 20 and lines 36 to 40 and figure 2) and uses for example an KOH autoclave cleaning process for removing the ceramic layer and the oxide layer and some of the bond coat (see column 4, lines 12 to 15). This is in contrast to process claim 1 of the patent in suit which excludes such a TBC layer and which removes substantially only the thermally grown oxide layer by light grit blasting and/or treatment with a weak acetic acid solution (see column 3, lines 10 to 16). According to claim 1 at least one surface void of this oxide layer will be left. This oxide layer is additionally a soft layer compared to the ceramic top coating layer of D9. Furthermore, due to the definition "removing the oxide from the coating outer surface …" of claim 1 any ceramic top coating is clearly excluded. D9 does not say that the bond coat is unaffected but at least some of it remains after the removal treatment.

According to D9 it has to be checked if sufficient bond coat has remained (see column 4, lines 16 to 19) and if there is insufficient bond coat then the conventional repair method has to be used (see column 4, lines 23 to 28). Consequently, the removal step according to D9 removes at least some of the metallic layer. This is even more so after grinding the surface to remove any

abrasive material. Furthermore, if the surface has a rumpled appearance, D9 does not suggest anything. This can only lead to the conclusion that then the bond coat is replaced by a new one (see column 6, lines 28 to 36), just like when there is insufficient bond coat left. Otherwise the obtained surface is flat. The process according to claim 1 of the patent in suit does not damage turbine parts having no bond coating and is different from that of D9.

Therefore the subject-matter of claim 1 of the contested patent involves inventive step.

Reasons for the Decision

1. *Inventive step (Article 56 EPC)*

1.1 It is clear that claim 1 of the patent as granted has a wording which is not exhaustive, as it reads: "A method … coating (12), the steps of: …". Also the description mentions this aspect clearly (see paragraph [0003]): "Sometimes such coatings including Al are not used as an outer protective coating but have been used as an intermediate or bond coat beneath an outer non-metallic ceramic thermal barrier coating disposed over the coating including Al". Also, according to paragraph [0008]: "The method **comprises** …".

1.1.1 This view is fully supported by the additional process step defined in dependent claim 2: "The method of claim 1 in which, after applying the refurbishing coating (22), the step of mechanically working the refurbishing coating (22) substantially without removal

of the refurbishing coating (22)" - which step is carried out **after** the last process step defined in claim 1 - it is evident that claim 1 of the patent as granted is meant to have the open definition "**comprising**" the method steps.

1.1.2 Furthermore, taking account of the definitions of claim 1: "A method for refurbishing a … metallic coating (12) … the metallic coating (12) including at least within **a coating outer surface** (16) at least one oxide (14) …" and "removing the oxide (14) from **the coating outer surface** (16) … thereby exposing in **the coating outer surface** (16) at least one surface void (18) that had been occupied by the oxide …" (compare point II above) that the term "a coating outer surface" only defines the location of the metallic coating (12) from which the oxide (14) is removed (compare patent in suit, paragraph [0017] together with figures 1 and 2) but does **not** necessarily define exclusively the outermost layer to be removed from the article to be refurbished as argued by the respondent. The respondent's arguments to the contrary therefore cannot hold.

1.1.3 Consequently, the subject-matter of claim 1 of the patent as granted does **not** exclude any additional ceramic coating or any further process steps whether they be performed before or after the claimed steps.

1.2 D9 discloses a method for repairing gas turbine engine parts coated with a thermal barrier coating (TBC) layer comprising a bond coat 12, an aluminum oxide layer 14 and a ceramic top coat 16 (see column 3, lines 18 to 20

and lines 35 to 40 and figure 2). This method comprises the steps of:

(a) removing the ceramic top coat and the aluminum oxide layer from an engine-run gas turbine engine component such that at least about 1 mil of the bond coat remains on the component;

(b) inspecting the component to determine if it meets predetermined minimum standards, including that it does not display any base metal oxidation;

(c) applying a metal flash coat to at least a portion of the component;

(d) forming a new aluminum oxide layer on the flash coat; and

(e) applying a new ceramic top coat over predetermined portions of the component, including the portion to which the metallic flash coat was applied (see claim 1).

1.2.1 Step (a) of this repair method includes removing the ceramic top coating 16 and the aluminum oxide layer 14 from the blade 18 by any conventional method "that does **not** also remove the metallic bond coat 12" (see column 4, lines 6 to 9).

The Board therefore considers that the respondent's arguments to the contrary **cannot** hold since also the method of D9 aims **to retain** said metallic coating 12 for the following reasons.

1.2.2 The Board's view is supported by the fact that neither the more specific "autoclave cleaning in KOH" nor the "grit blasting the ceramic layer and oxidized coating" - which according to D9 are mentioned as possible specific embodiments for the removal of these two

layers (see column 4, lines 9 to 12) - necessarily "substantially" remove the underlying metallic coating.

To the contrary, from D9 it can be clearly derived that stripping the TBC layer requires two separate steps, i.e. an autoclave KOH treatment which removes **only** the ceramic portion of the coating since the metallic portion of the TBC layer requires an additional soaking treatment in a heated HCl solution (see column 1, lines 46 to 56).

1.2.3 Furthermore, D9 mentions the disadvantages combined with said known TBC stripping process (which includes both aforementioned treatment steps) since it results in the removal of a portion of the base metal under the metallic portion (see column 1, lines 57 to 60). D9 thus aims to provide a repair method for TBC coated gas turbine engine parts that increases the number of times a part can be repaired, which should be less expensive and time consuming than prior art repair methods and should not lead to the "coat down method phenomenon" noted with prior art repair methods (see column 2, lines 34 to 40).

1.2.4 Hence step (a) of claim 1 of the repair method of D9 is considered to fulfil the requirements of the first step of method claim 1 of the patent in suit of: "removing the oxide (14) from the coating outer surface (16) while substantially retaining the metallic coating (12) as a retained metallic coating thereby exposing at least one surface void (18) that had been occupied by the oxide (16)".

In this context it is remarked that the used definition "while **substantially** retaining … **thereby exposing** at least one surface void (18) …" allows that, in addition to the removal of the oxide, some of the metallic coating is removed as well during this removing step, which has not necessarily been stopped when said "at least one surface void (18)" has been exposed.

As D9 explicitly mentions the occurrence of a "rumpled surface" this implies the presence of surface voids, as shown in figure 2 of the patent in suit.

1.3 After the removal of the ceramic top coating and the aluminum oxide layer the blade is, according to step (b) of claim 1, inspected to ensure that sufficient bond coat 12 remains to perform the repair of the invention according to D9, but it may be repaired with a conventional procedure if there is insufficient bond coat or if the bond coat is entirely removed from the blade (see column 4, lines 16 to 28).

1.3.1 Since according to the method of D9, as specified in step (a) of its claim 1 (see point 1.2 above), at least 1 mil (= 25.4 µm) of the metallic bond coat is retained the respondent's arguments that D9 does not refer to refurbishing and would teach to apply a brand new bond coat cannot hold (compare also the object underlying D9, see point 1.2.3 above).

1.3.2 The fact that D9 mentions that following inspection any residual abrasive material on the tip 20 may be removed with any conventional method, such as grinding (see column 4, lines 46 to 48; figure 3), after which the tip 20 is restored to predetermined dimensions (see

column 5, lines 9 to 26) does not help the respondent's case either since this is only necessary when grit blasting is used from the ceramic top coat. However, this is not a requirement since it can be removed also by autoclave cleaning in KOH, followed by a HCl treatment of the metallic coat.

1.4 Then, according to step (c), a metallic flash coat should be applied over the bond coat 12 (see column 5, line 59 to column 6, line 28). After depositing the flash coat it may be desirable to peen the flash coat to close porosity or leaders that may have developed during deposition or to perform other mechanical or polishing operations to prepare the flash coat to receive the ceramic top coat 16, e.g. by a gravity assisted shot peening method (see column 6, lines 28 to 36).

1.4.1 Thus according to D9 a flash coat is applied onto the retained metallic bond coat. The Board considers that the step of applying this flash coat is equivalent to the step of applying the refurbishing coating mentioned in claim 1 of the patent in suit as the last step (see point II above).

When asked by the Board at the oral proceedings the respondent could not explain what the difference between a refurbishing coating according to claim 1 and said flash coat according to D9 would be. Actually, both can be made from aluminides and MCrAlY alloys (see D9, column 5, line 66 to column 6, line 13; and patent in suit, column 3, line 58 to column 4, line 6 in combination with column 1, lines 44 to 48).

1.4.2 The described peening step of the flash coat according to D9 - which is considered to represent a mechanical working of a refurbishing coating - is thus carried out **after** said deposition of the refurbishing coat (or flash coat).

1.5 It was undisputed by both parties that the metallic bond coat after the removal of the ceramic top coating and aluminium oxide according to step (a) of the method of D9, **preferably**, will not have a rumpled appearance and will have no bare spots (see column 4, lines 31 and 32).

1.5.1 The respondent's argument that in case that no rumpled surface is established, the surface of the metallic bond coat would be flat and smooth cannot hold, since the autoclave cleaning in KOH - which is comparable to an acid pickling treatment for removing oxides from a steel strip surface - inevitably results in a certain surface roughness of the metallic bond coat. The respondent did not contest this conclusion of the Board at the oral proceedings.

Furthermore, it has also to be considered that the surface roughness of the outer surface of the metallic bond coat on which the oxide layer had been thermally grown according to D9 should be the same as that according to the patent in suit since the latter is not stated to be restricted to specific manufacturing methods.

1.5.2 The appellant argued in this context that the person skilled in the art, in the case that he is confronted with a rumpled appearance of the metallic bond coat, in

order to maintain the increase in the feasible number of repairing processes, will look how he can repair turbine components having such a rumpled surface. Thereby the person skilled in the art would turn to the teaching of D11.

1.5.3 D11 teaches the person skilled in the art that shot peening allows to effectively eliminate localized areas of tensile stress, phase transformations, machine and grinding marks, pits, scratches, and the like (see page 1, lines 10 to 18). The shot peening according to D11 thus allows to heal surface defects such as leaders and voids in coatings on gas turbine parts and to substantially smoothen the coatings and at the same time to produce the desired residual compressive stress (see page 5.1, lines 1 to 19 of D11 and the reply to the appeal, page 2, third paragraph).

The Board therefore considers that the person skilled in the art would apply the shot peening method according to D11 in case he would be confronted with turbine parts having a rumpled surface of the metallic bond coat after step (a) of the method of D9.

The shot peening according to D11 is a method wherein the surface is impacted by particles or shot (see page 1, lines 10 and 11), which is mechanically working the surface in the sense of the method according to patent in suit (compare the patent in suit, column 3, lines 24 to 28).

1.6 Consequently, by applying the shot peening of D11 onto the rumpled metallic bond coat when carrying out the repair method of D9 in order to smoothen the rumpled

surface the person skilled in the art would arrive at the repair method of claim 1 of the patent as granted in an obvious manner. Claim 1 of the single request therefore lacks inventive step and the single request is not allowable.

1.6.1 In this context the Board further remarks that the patent in suit mentions that in case that the surface roughness of the refurbishing coating applied in accordance with method claim 1 is greater than 1.5 µm RA then the mechanical working step is repeated to reduce the surface roughness to the specified or desired range (see patent in suit, paragraph [0023] and claim 2). In that case the claimed method requires two mechanical working steps (one before, one after the refurbishing) to obtain the desired smoothened surface having compressive stress while according to the above described method of D9 only one mechanical working step is necessary to obtain this result.

At the oral proceedings, when questioned by the Board as to why such a double mechanical working step should involve inventive step since no advantages can be seen compared to the single mechanical working treatment, only after the refurbishing, according to D9, the respondent has **not** presented any corresponding arguments, let alone with respect to a specific effect.

1.6.2 The respondent's arguments to the contrary cannot hold for the following reasons.

First of all, the respondent has **not** disputed the above problem-solution approach on the basis of the combination of the teachings of D9 and D11 made by the

appellant at the oral proceedings. Actually the respondent did **not** address the D11 issue at all.

Secondly, it has also **not** disputed that D9 represents the closest prior art with respect to the method of claim 1 of the patent as granted.

The respondent has also **not** addressed the issue that the patent in suit (see column 1, lines 51 to 55) expressly states that the oxide layer need not be the outer protective coating but can be the intermediate layer or bond coat beneath an outer ceramic coating disposed over it.

The argument that the oxide layer is a soft layer compared to a TBC cannot hold, either. Said oxide layer is normally made from aluminum oxide while the ceramic top coating of a TBC is commonly made from yttria-stabilized zirconia which has a comparable hardness as the former. Both materials are also used as abrasive materials, thus can be considered "hard".

The arguments concerning the use of mild acetic acid and/or light grit blasting and that the claimed treatment therefore would not damage turbine parts having no coating cannot be accepted since claim 1 of the patent as granted does **not** comprise the corresponding limiting features.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The patent is revoked.

The Registrar: The Chairman:

G. Nachtigall H. Meinders