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Datasheet for the decision of 2 July 2013

Case Number: T 1508/10 - 3.2.06

Application Number: 01308666.5

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Language of the proceedings: EN

Title of invention:
Braze repairing process of a gas turbine engine stationary shroud made of Nickel alloys

Patent Proprietor:
GENERAL ELECTRIC COMPANY

Opponent:
Siemens Aktiengesellschaft

Headword:

Relevant legal provisions:
EPC 1973 Art. 56

Keyword:
Inventive step - main request (no) - auxiliary request (yes)

Decisions cited:

Catchword:

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Case Number: T 1508/10 - 3.2.06

D E C I S I O N
of Technical Board of Appeal 3.2.06
of 2 July 2013

Appellant: (Opponent)	Siemens Aktiengesellschaft Wittelsbacherplatz 2 80333 München (DE)
Respondent: (Patent Proprietor)	GENERAL ELECTRIC COMPANY 1 River Road Schenectady, NY 12345 (US)
Representative:	Szary, Anne C. Global Patent Operation - Europe General Electric International, Inc. 15 John Adam Street London WC2N 6LU (GB)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted on 2 June 2010 rejecting the opposition filed against European patent No. 1197290 pursuant to Article 101(2) EPC.**

Composition of the Board:

Chairman: M. Harrison
Members: M. Hannam
R. Menapace

Summary of Facts and Submissions

I. An appeal was filed by the appellant (opponent) against the decision of the opposition division rejecting the opposition to European Patent No. 1 197 290. The appellant requested that the decision of the opposition division be set aside and that the patent be revoked.

II. In response, the respondent (proprietor) requested dismissal of the appeal and, subsidiarily, maintenance of the patent in amended form according to an auxiliary request.

III. The following documents are mentioned in this decision:

D1: US-A-5 705 281
D4: EP-A-1 013 788
D5: WO-A-93/22097

IV. The Board issued a summons to oral proceedings including a communication containing its provisional opinion, in which it indicated *inter alia* that the subject-matter of claim 1 of the main request seemed to lack an inventive step, whereas the subject-matter of claim 2 of that request seemed to involve an inventive step.

V. With its letter dated 30 May 2013 the respondent submitted three auxiliary requests replacing its previous auxiliary request. Of these, the first auxiliary request included a single claim corresponding to independent claim 2 of the main request.

VI. Oral proceedings were held before the Board on 2 July 2013, during which the respondent filed a sole auxiliary request replacing its previous auxiliary

requests, whereby the single claim of the sole auxiliary request was identical to claim 1 of the auxiliary request filed with the letter dated 30 May 2013. The appellant also withdrew its objection of lack of novelty against the subject-matter of claim 1 of the main request.

The appellant requested that the decision under appeal be set aside and the patent be revoked. The respondent requested that the appeal be dismissed or that the decision under appeal be set aside and the patent be maintained according to the sole auxiliary request as filed during the oral proceedings on 2 July 2013.

VII. Claim 1 of the main request (corresponding to claim 1 as granted) reads:

A method of repairing a gas turbine engine stationary shroud (30) of a cobalt base superalloy, comprising the steps of
providing the gas turbine engine stationary shroud (30) having an undersize repair region made of a shroud material, wherein the repair region is an end face (36), or an edge (38, 40), or a back surface (50) not located on a gas flow path surface (32) of the gas turbine engine stationary shroud (30);
repairing the repair region of the gas turbine engine stationary shroud (30) so that the repair region is no longer undersize, the step of repairing including the steps of providing a sufficient mass of a repair material comprising
a first fraction of a first powder of a first alloy component comprising from 25 to 50 weight percent of said mass, and

a second fraction of a second powder of a second alloy component comprising from 75 to 50 weight percent of said mass,
wherein the first alloy component and the second alloy component have different solidus temperatures,
placing the repair material into the repair region,
heating the repair material and the repair region to a brazing temperature sufficient to melt at least a portion of the repair material but not the shroud material of the repair region, so that the repair material flows over the repair region, and thereafter
cooling the melted repair material and the repair region to solidify the repair material, the repair material having a solidus temperature less than that of the shroud material, wherein
the cobalt base superalloy has a composition, in weight percent, comprising about 23.5 percent chromium, about 10 weight percent nickel, about 7 percent tungsten, about 3.5 percent tantalum, about 0.2 percent titanium, about 0.4 percent zirconium, about 0.6 percent carbon, no more than about 2 percent iron, balance cobalt and impurities, and wherein
the first alloy component comprises a prealloyed composition, in weight percent, of from 10 to 25 percent nickel, from 15 to 25 percent chromium, from 5 to 10 percent silicon, from 2 to 6 percent tungsten, from 0.2 to 0.8 percent carbon, from 0.4 to 10 percent boron, balance cobalt and impurities, and
the second alloy component comprises a prealloyed composition, in weight percent of from 5 to 15 percent nickel, from 15 to 30 percent chromium, about 2.0 percent maximum silicon, from 5 to 10 percent tungsten, from 03 to 0.8 percent carbon, about 1.5 percent maximum manganese, about 3 percent maximum iron, about 0.5 percent maximum zirconium, balance cobalt and impurities.

VIII. The sole claim of the auxiliary request (corresponding to claim 2 as granted) reads:

A method of repairing a gas turbine engine stationary shroud (30) of a nickel base superalloy, comprising the steps of
providing the gas turbine engine stationary shroud (30) having an undersize repair region made of a shroud material, wherein the repair region is an end face (36), or an edge (38, 40), or a back surface (50) not located on a gas flow path surface (32) of the gas turbine engine stationary shroud (30);
repairing the repair region of the gas turbine engine stationary shroud (30) so that the repair region is no longer undersize, the step of repairing including the steps of
providing a sufficient mass of a repair material comprising
a first fraction of a first powder of a first alloy component comprising from 55 to 80 weight percent of said mass, and
a second fraction of a second powder of a second alloy component comprising from 45 to 20 weight percent of said mass,
wherein the first alloy component and the second alloy component have different solidus temperatures,
placing the repair material into the repair region,
heating the repair material and the repair region to a brazing temperature sufficient to melt at least a portion of the repair material but not the shroud material of the repair region, so that the repair material flows over the repair region, and thereafter
cooling the melted repair material and the repair region to solidify the repair material, the repair

material having a solidus temperature less than that of the shroud material, wherein
the first alloy component comprises a prealloyed composition, in weight percent, of from 10 to 20 percent cobalt, from 14 to 25 percent chromium, from 2 to 12 percent aluminum, from 0 to 0.2 percent yttrium, balance nickel and impurities, and
the second alloy component comprises a prealloyed composition, in weight percent of from 10 to 20 percent cobalt, from 14 to 25 percent chromium, from 2 to 12 percent aluminum, from 2 to 12 percent silicon, balance nickel and impurities.

IX. The arguments of the appellant may be summarised as follows:

Claim 1 of the main request lacked an inventive step in view of D5 in combination with the general knowledge of the skilled person. D5 failed to disclose features c, d and e of claim 1 such that claim 1 amounted simply to a new use of a repair method already known from D5. Whilst the examples of gas turbine repairs in D5 concerned turbine vanes, not all vanes were subjected to the hottest temperatures, as this depended on the turbine stage involved, and the repair method of D5 was thus equally applicable to a turbine shroud.

Furthermore in claim 1 of the opposed patent, the back surface of the turbine shroud had to be, under steady-state conditions, subjected to similarly high temperatures to the turbine vanes themselves. With the repair method in claim 1 being appropriate for this high temperature region too, it followed that the repair method in D5 was appropriate not only for turbine vanes but also the non gas-flow surfaces of the shroud.

Regarding the auxiliary request, it was first to be noted that the claim wording concerning the gas flow path surface, 'wherein the repair region is an end face, or an edge, or a back surface not located on a gas flow path surface of the gas turbine engine stationary shroud' referred only to the back surface of the shroud not being located on a gas flow path surface; the other surfaces include in the claim could thus be gas flow surfaces. This was therefore not a difference. Furthermore D4 disclosed a method of repairing a gas turbine shroud in a nickel based superalloy. Faced with the problem of providing a suitable material for the repair of such a shroud, the skilled person would have referred to D1 in which the two prealloyed compositions used in the repair according to the claim of the auxiliary request were disclosed for repair of a turbine. It would thus have been obvious for the skilled person to combine the teaching of D1 with the repair method of D4 in order to reach the subject-matter of the sole claim according to the auxiliary request.

X. The arguments of the respondent may be summarised as follows:

D5 failed to disclose features c, d and e of claim 1 of the main request. It was necessary to use the problem-solution approach when analysing the presence of an inventive step. D5 disclosed repairs to the turbine vanes which were subjected to higher temperatures than the claimed repair regions not located on gas flow path surfaces of the turbine shroud.

Regarding the claim of the auxiliary request, contrary to the appellant's view, this concerned only non gas

flow surfaces. D4 used an HVOF method and a single repair material in the repair of the turbine. The skilled person received no incentive to consider using a mixture of two different powder alloys as suggested in D1. Furthermore, D1 concerned repairing the abradable surface of the turbine shroud rather than the non gas-flow surface claimed in the claim.

Reasons for the Decision

1. Main request

1.1 Inventive step

1.1.1 Starting from D5 as the document representing the closest prior art for claim 1 of the main request, the subject-matter of this claim differs from the method of repairing a gas turbine engine stationary shroud known from D5 in that the method comprises the following steps:

b. repairing a gas turbine engine stationary shroud of a cobalt base superalloy;
c. providing the gas turbine engine stationary shroud having an undersize repair region made of a shroud material;
d. whereby the repair region is an end face, or an edge, or a back surface not located on a gas flow path surface of the gas turbine engine stationary shroud; and
e. repairing the repair region of the gas turbine engine stationary shroud.

Although the appellant had stated that features (c) to (e) were the features of the claim which differed over

D5, the Board concludes that also feature (b) above is not known from D5 since there is no explicit mention of a method step of repairing a gas turbine stationary shroud, nor is such a method step implicit. The parties also did not provide any argument in regard to the lack or presence of feature (b) of the claim.

1.1.2 In view of the above identified differing features of the claim over D5, the Board finds an appropriate objective technical problem to be 'how to repair other parts of a gas turbine engine not being a vane'.

1.1.3 The Board notes that page 1, lines 5-7 of D5 states that the 'invention relates to a process for repairing defects in cobalt-based superalloy gas turbine engine components'. The Board thus finds that D5 provides guidance to the skilled person to apply the repair method to all parts of a gas turbine engine, not just a vane, therefore implicitly including also the surfaces of the shroud not located on the gas flow path.

1.1.4 The respondent argued that the examples presented in D5 concerned repairs to turbine vanes and that these parts of a gas turbine would be the portions exposed to the highest temperatures within the turbine. In contrast the surfaces being repaired in the claim not located on a gas flow path surface of the shroud were not subjected to such extremes of temperature, such surfaces therefore not being considered by the skilled person as suited to the repair method of D5.

In this respect the Board notes that whilst examples II - IV of D5 do indeed concern repair to turbine vanes, the above identified statement of the field of application of the invention according to D5 (see point 1.1.3) is much more general. Furthermore,

example V concerns the filling of a gap between two cobalt-based superalloy plates, which may be regarded as a very general application of the repair method and not necessarily related to turbine vane repairs. The skilled person would thus see the repair method of D5 as equally applicable to surfaces not located on the gas flow path of the turbine.

The Board furthermore notes, as argued by the appellant and notably not counter-argued by the respondent, that the turbine, once having reached steady state operating conditions, would be expected to have relatively similar temperature conditions for both the turbine vanes and the shroud, each being in direct contact with the same combustion gases. Even the shroud surfaces not located on the gas flow path would be expected to be exposed to essentially similar temperatures to those on the gas flow surfaces absenting any active cooling of the non gas flow surfaces. The skilled person would thus immediately understand that the repair method known from D5 is appropriate also for repairs to surfaces not located on the gas flow path of the turbine. The skilled person would thus, without exercising inventive skill, apply the repair method of D5 to further components of the gas turbine, including those not located on a gas flow path surface of the turbine, thereby solving the objective technical problem and reaching the subject matter of the claim.

1.1.5 Absent any further arguments from the respondent in support of an inventive step, the Board concludes that the subject-matter of claim 1 of the main request lacks an inventive step when starting from D5 as the closest prior art and combining this with the general knowledge of the skilled person when considering the further

teaching in D5 as to the general applicability of the method therein.

1.1.6 The main request is thus not allowable.

2. Auxiliary request

2.1 Inventive step

2.1.1 Starting from D4 as the closest prior art document for considering inventive step of the subject-matter of the sole claim of the auxiliary request, this claim differs from the method of repairing a gas turbine engine stationary shroud known from D4 in that the method comprises the following steps:

- providing a first fraction of the first powder of the first alloy component comprising from 55-80 weight percent of the repair material mass;
- providing a second fraction of a second powder of a second alloy component comprising from 45 to 20 weight percent of the repair material mass;
- the first and second alloy components having different solidus temperatures; and
- the second alloy component comprising a prealloyed composition, in weight percent of from 10 to 20 percent cobalt, from 14 to 25 percent chromium, from 2 to 12 percent aluminium, from 2 to 12 percent silicon, balance nickel and impurities.

The parties did not dispute that these features were the features of the claim which differed with respect to D4.

Based on the above identified differing features, the objective technical problem to be solved when starting

from D4 may be regarded as 'providing an alternative material for the repair of shrouds in an HVOF repair process'. The appellant had formulated the objective technical problem similarly, however demanding 'an appropriate material' rather than 'an alternative material', which however is regarded as being analogous in the context of the present inventive step discussion.

2.1.2 The combination of D4 with the teaching of D1, which was the appellant's only line of attack against the presence of an inventive step in the subject-matter of the sole claim of the auxiliary request, however fails to deprive it of an inventive step for the following reasons:

D1 concerns the repair of an abradable coating on a gas turbine engine shroud (see col.1, lines 10-37) The teaching of D1 is thus that this repair material is suitable for gas flow path surfaces which present a sacrificial surface in order to protect the base material from damage through contact with the rotating turbine vanes. D1 presents no hint to the skilled person suggesting the use of the disclosed repair material in other regions of a gas turbine engine shroud i.e. where no abrasion is present, let alone as in the claim, on surfaces not in the gas flow path. To this reason, included in the Board's preliminary opinion annexed to the summons to oral proceedings, the appellant presented no counter-argument either in writing or during the oral proceedings.

2.1.3 The appellant argued that the wording of the claim concerning the gas flow path surface, 'wherein the repair region is an end face, or an edge, or a back surface not located on a gas flow path surface of the

gas turbine engine stationary shroud' referred only to the back surface of the shroud not being located on a gas flow path surface; the end face and an edge were not so restricted and could be located in a gas flow path surface of the shroud.

The Board cannot concur with this reading of the claim, finding that the commas placed between the features of 'the end face', 'an edge' and 'a back surface' indicate that the adjective phrase 'not located on a gas flow path...' refers to all of the aforementioned features separated by commas. Therefore the Board finds that the claimed repair regions 'an end face, or an edge or a back surface' are all not located on a gas flow path surface of the gas turbine engine stationary shroud. The appellant's argument that D1, which discloses repairs to abradable regions in the turbine gas flow, and therefore provides a repair material for use in the repair method of D4, is thus not found convincing by the Board.

2.1.4 It is furthermore noted that the repair methods disclosed in D4 and D1 are different. Material repairs in D4 are disclosed using a HVOF process in which the repair material is applied to the repair area in a high temperature fluid stream. Conversely in D1, the repair material is applied to a surface of the repair region before being subsequently heated. These different repair methods would thus be a further disincentive for the skilled person to consider the repair material of D1 when starting from a method such as that disclosed in D4 and searching for a solution to the objective problem posed starting from D4.

2.1.5 It follows that the skilled person would not consider D1 as providing a solution to the objective technical

problem when starting from the repair method known from D4, unless inventive skill were used.

With no further arguments having been presented by the appellant contesting the presence of an inventive step in the subject-matter of the claim, the Board finds that the sole claim of the auxiliary request involves an inventive step over the cited art.

3. The description and title of the patent were adapted to the amended claims. To these, the appellant had no objections.

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 with the order to maintain the patent with the description (columns 1 to 7) and (sole) claim 1 as filed during the oral proceedings before the Board and Figures 1-3 as granted.

The Registrar: The Chairman:

M. H. A. Patin M. Harrison

Decision electronically authenticated