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Datasheet for the decision of 6 November 2018

Case Number: T 0014/16 - 3.2.08

Application Number: 05253365.0

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IPC: B23P6/00, C21D9/50

Language of the proceedings: EN

Title of invention:
Methods for repairing gas turbine engine components

Patent Proprietor:
United Technologies Corporation

Opponent:
Siemens Aktiengesellschaft

Headword:

Relevant legal provisions:
EPC Art. 54, 56

Keyword:
Novelty
Inventive step

Decisions cited:
T 0085/93

Catchword:

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Case Number: T 0014/16 - 3.2.08

D E C I S I O N
of Technical Board of Appeal 3.2.08
of 6 November 2018

Appellant: (Opponent)	Siemens Aktiengesellschaft Werner-von-Siemens-Straße 1 80333 München (DE)
Representative:	Siemens AG Postfach 22 16 34 80506 München (DE)
Respondent: (Patent Proprietor)	United Technologies Corporation 10 Farm Springs Road Farmington, CT 06032 (US)
Representative:	Dehns St. Brides House 10 Salisbury Square London EC4Y 8JD (GB)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted on 7 December 2015 rejecting the opposition filed against European patent No. 1602442 pursuant to Article 101(2) EPC.**

Composition of the Board:

Chairwoman	P. Acton
Members:	M. Alvazzi Delfrate
	Y. Podbielski

Summary of Facts and Submissions

I. By its decision posted on 7 December 2015 the opposition division rejected the opposition against the European patent No. 1 602 442.

II. The appellant (opponent) lodged an appeal against this decision in the prescribed form and within the prescribed time limits.

III. Oral proceedings before the Board of appeal were held on 6 November 2018.

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

The respondent (patent proprietor) requested that the appeal be dismissed and the patent be maintained as granted or, as an auxiliary measure, that the patent be maintained in amended form according to one of auxiliary requests 1-3 filed on 6 July 2016 with the reply to the grounds of appeal.

IV. Claim 1 of the **main request** reads as follows:

"1. A method for minimizing post-weld residual stresses in a weld repaired component, comprising:

solution heat treating the weld repaired component by heating the weld repaired component to 2000°F ± 25°F (1090°C ± 14°C), holding the weld repaired component at 2000°F ± 25°F (1090°C ± 14°C) for about one hour; and cooling the weld repaired component to below 700°F (370°C) at a rate equivalent to cooling in air; and

precipitation heat treating the weld repaired component by heating the weld repaired component to 1325°F ± 25°F (720°C ± 14°C), holding the weld repaired component at 1325°F ± 25°F (720°C ± 14°C) for about 8 hours, cooling the weld repaired component to 1150°F ± 25°F 620°C ± 14°C) at a maximum rate of 100°F/hour (56°C/hour), holding the weld repaired component at 1150°F ± 25°F (620°C ± 14°C) for about 8 hours, and cooling the weld repaired component to room temperature

wherein the weld repaired component is made of an iron-nickel-cobalt-based superalloy."

Claim 1 of **auxiliary request 1** differs from claim 1 of the main request by the addition of the wording

"and wherein dimensions of the component are maintained during solution heat treating and precipitation heat treating via a furnace tool."

V. The following documents played a role for the present decision:

D7: Wanner et al. "Development of a new controlled thermal expansion superalloy with improved oxidation resistance", Superalloys 1992, pages 237-246;
D12: WO -A- 99/21681;
D18: "Super-Alloys - a Technical Guide", 2nd edition, Matthew and Steven Donachie, January 2002, pages 144-145;
D20: "Super-Alloys - a Technical Guide", 2nd edition, Matthew and Steven Donachie, January 2002, page 165.

VI. The arguments of the appellant can be summarised as follows:

Admission of D20 into the proceedings

Document D20 was evidence of common general knowledge filed with the statement of grounds of appeal, i.e. at the earliest possible stage of the appeal proceedings. Therefore, it should be admitted into the proceedings.

Main request

The subject-matter of claim 1 was not novel in view of D7 or at least not inventive in view of said document and the common general knowledge of the person skilled in the art as detailed in D20.

D7 concerned the Thermo-Span® alloy to which the patent in suit related. On page 241, this document described the standard heat treatment for this type of precipitation hardened iron-nickel-cobalt-based superalloy. As acknowledged in paragraph [0028] of the patent in suit, this was the same treatment as in claim 1. It was true that D7 did not explicitly disclose that the cooling after solution heat treatment was carried out to a temperature below 370°C. However, this was implicit in the wording "Air cool". As to the fact that some stress relief was obtained, this was an inherent result of the solution heat treatment.

In respect of the application of the process to weld repaired components, D7 disclosed the manufacture of welded dual-alloy components.

Even acknowledging the latter feature as distinguishing feature would not justify an inventive step because, as

shown in D20, it was known to apply solution treatment and aging to welded precipitation hardened alloys. It was thus obvious to apply this type of treatment to a weld repaired component made from the alloy of D7. The choice of the standard treatment to do so was the most obvious one for the person skilled in the art.

Hence, no novelty or at least no inventive step could be acknowledged.

Auxiliary request 1

The feature added in auxiliary request 1 was rendered obvious by D12 or D18.

D12 disclosed on page 24, lines 25-27, the use of fixturing to maintain stress across a bond surface as two parts heated up in a furnace.

D18 had a whole section on page 145 relating to fixturing during heat treating. It was true that this document taught that for alloys that must be cooled rapidly from the solution treating temperature the best practice was to employ minimum fixturing during solution treating and quenching and to control dimensional relations by the use of restraining fixtures during aging. However, "minimum fixturing" still involved some fixturing and thus the use of tools in accordance with claim 1 not only during aging but also solution treatment.

Therefore, the subject-matter of claim 1 did not involve an inventive step.

VII. The arguments of the respondent can be summarised as follows:

Admission of D20 into the proceedings

Document D20 could have been submitted at an earlier stage because it was an extract from the same textbook as D18. Hence, there was no justification for the delay in its submission.

Moreover, it was not *prima facie* relevant because it did not relate to repair welding.

Finally, the fact that it related to common general knowledge was no reason for admitting it into the proceedings either, since as established in T 85/93 evidence of common general knowledge should be submitted at the earliest possible stage in opposition proceedings.

Therefore, D20 should not be admitted into the proceedings.

Main request

D7 could not take away the novelty from claim 1. This document described a standard heat treatment for a Thermo-Span® alloy, which was performed during the manufacture of the alloy. It did neither disclose that the treatment provided stress relief of a welded component nor that the cooling after the solution treatment was to a temperature below 370°C. Finally and most importantly, D7 did not disclose repair welding.

It was also not obvious to apply the treatment of D7 to relieve the stress of weld-repaired components. Stress relief was not usually performed by treating the weld-repaired component at temperatures as high as solution

treatment. Nor could D20 provide a hint in this direction. D20 did neither refer to the specific alloy of D7 nor to weld repaired components. Moreover, it did not provide any details as to the specific solution treatment and aging conditions, so that the person skilled in the art would have had no reason to apply the same treatment that was applied in the manufacture of the component according to D7. Finally, even doing so he would have not arrived at the claimed process since, as already explained, the treatment of D7 did not comprise all the steps stipulated by claim 1.

Thus, the subject-matter of claim 1 involved an inventive step.

Auxiliary request 1

The feature added by auxiliary request 1 prevented distortion of the repaired component. Neither D12 nor D18 rendered it obvious to achieve it in accordance with claim 1. The fixturing disclosed on page 24 of D12 was performed during bonding and not during the heat treatments that followed, as made clear on page 25 of the same document. As to D18, it taught away from the claimed solution because it stated that for alloys which must be cooled rapidly from the solution treating temperature, like in the treatment of D7 wherein air cooling was applied, the best practice was to employ minimum fixturing during solution treating and quenching and to control dimensional relations by the use of restraining fixtures during aging. Thus, in the solution treatment phase only supporting means and no tool maintaining the dimensions of the component was used. Consequently, the subject-matter of claim 1 involved an inventive step.

Reasons for the Decision

1. Admission of D20 into the proceedings

Document D20 is evidence of common general knowledge and has been filed for the first time with the statement of grounds of appeal. Therefore, its admission into the proceedings is subject to the discretionary power of the Board (Article 12(4) RPBA).

In decision T 85/93, cited by the respondent, the Board found that evidence of common general knowledge may be rejected as inadmissible in the Board's discretion, if filed for the first time during appeal proceedings (point 1.1 of the reasons). In other words it found that the admission of said late-filed evidence is, as already explained above, at the discretion of the Board. However, it did not find that it should not be admitted in principle (indeed in point 1.2 of decision T 85/93 the Board eventually decided to admit the late-filed evidence).

In the present case D20 concerns the applicability of solution treatment and aging to welded products. Since this is a crucial issue for assessing inventive step starting from D7, D20 is *prima facie* highly relevant.

It is true that D20, which is an extract from the same textbook as D18, could have been submitted at an earlier stage. However, this document represents common general knowledge, is to be considered as a reaction to the understanding of said common general knowledge by the opposition division, is fairly short (one page) and has been submitted at the earliest possible phase of

the appeal proceedings. Hence, its introduction into the proceedings does not cause any difficulty or delay.

Under these circumstances the Board decided to admit document D20 into the proceedings.

2. Main request

2.1 The present invention relates to the repair of superalloy components, in particular gas turbine components made of Thermo-Span® alloy (paragraph [0001]). This type of precipitation hardened iron-nickel-cobalt-based superalloy is disclosed for instance in D7 (abstract), which mentions also its use for the production of gas turbine components (first paragraph on page 238). D7 further describes on page 241 ("Characterization of Thermo-Span Alloy") the standard heat treatment, comprising a specific solution treatment and aging, which is performed during the manufacture of the alloy to obtain the desired microstructure. However, D7, albeit mentioning the manufacture of welded dual-alloy components on page 245, does not disclose a process involving weld repair. Hence, it cannot deprive the claimed process of novelty.

2.2 Gas turbine engine components are routinely weld repaired to return critical and/or expensive components to useful service. Welding generates very high residual stresses in the repaired component due to the solidification reaction in the weld. Since these residual stresses can negatively impact a variety of properties, reducing them is a key engineering consideration for an acceptable repair. The typical approach to reducing weld-related stresses in a part is

to stress relieve the part after a weld repair is made (paragraphs [0023]-[0024] of the patent in suit).

The question to be considered to assess inventive step is thus whether it was obvious to apply the treatment of claim 1 on a weld-repaired component made of the alloy of D7.

2.3 As evidenced by D20, first full paragraph of the right-hand column, in the case of precipitation hardenable alloys it was common general knowledge to submit the welded components to a solution heat treatment after welding to relieve residual stresses and then perform hardening by aging heat treatment. Hence, for these type of alloys stress relieving was performed at the solution treatment temperature, followed by an aging treatment.

Although the passage of D20 does not refer to the specific alloy of D7, the fact that no particular alloy is specified means that the measures described in D20 are applicable to any precipitation hardenable alloy, comprising the Thermo-Span® alloy described in D7.

It is true that D20 does not explicitly refer to weld repaired components. It is however clear for the person skilled in the art that the residual stresses are the same in any welding process, irrespective of whether the welding is used to repair a component or to join two components together. Thus, it was obvious to apply the combination of solution heat treatment and aging described in D20 to a weld repaired component made of the alloy of D7.

Since D20 does not give any specific indication in respect of the solution treatment and aging conditions

an obvious possibility to try would have been the standard treatment conditions already known for the fabrication of the components, i.e. the standard treatment described in D7.

As already mentioned above, the standard treatment is described in D7 on page 241 ("Characterization of Thermo-Span Alloy"). It comprises solution heat treating the component by heating the weld repaired component to a temperature in the range 2000°F ± 25°F (1090°C ± 14°C), holding the component at a temperature in the range 2000°F ± 25°F (1090°C ± 14°C) for about one hour; air cooling the component; and precipitation heat treating the component by heating the component to a temperature in the range 1325°F ± 25°F (720°C ± 14°C), holding the component at a temperature in the range 1325°F ± 25°F (720°C ± 14°C) for about 8 hours, cooling the component to a temperature in the range 1150°F ± 25°F (620°C ± 14°C) at a maximum rate of 100°F/hour (56°C/hour), holding the component at a temperature in the range 1150°F ± 25°F (620°C ± 14°C) for about 8 hours, and cooling the component to room temperature.

The fact that some stress relief is obtained is, although not explicitly disclosed in D7, an inherent result of the solution heat treatment described in this document (see D20, cited passage as well as the patent in suit, paragraph [0028]).

D7, which describes the standard precipitation heat treatment for Thermo-Span® alloys, does not explicitly disclose that the cooling after solution heat treatment is carried out to a temperature below 370°C. However, the wording "Air cool", without any further indication of an end cooling temperature, in the cited passage of

D7 implies for the person skilled in the art that the cooling is carried out to a temperature about room temperature, i. e. well below 370°C. This is in agreement with the statement in the patent in suit, paragraph [0028], that the standard precipitation heat treatment comprises cooling after solution heat treatment to a temperature below 370°C. Accordingly, the treatment of D7 has a thermal cycle in accordance with claim 1.

2.4 Therefore, it was obvious to treat a weld-repaired component made of Thermo Span® alloy with the treatment of present claim 1. As a consequence, the subject-matter of claim 1 of the main request does not involve an inventive step.

3. Auxiliary request 1

Auxiliary request 1 adds the feature according to which dimensions of the component are maintained during solution heat treating and precipitation heat treating via a furnace tool. In this way distortion of the repaired component, which is not intended to be submitted to further machining, is prevented.

None of the prior art documents renders it obvious to adopt said measure for this purpose.

D12 discloses on page 24, lines 25-27 that "in order to maintain the parts fit up during bonding, fixturing may be needed which will maintain stress across the bond surface as the parts heat up in the furnace". However, the fixturing is not applied during solution heat treating or precipitation heat treating but during the bonding that precedes them and is removed before said

treatments (see page 25, lines 27-32). Hence, D12 does not disclose the claimed solution.

D18 has a section on page 145 relating to fixturing during heat treating. D18 teaches that for alloys that must be cooled rapidly from the solution treating temperature the best practice is to employ "minimum fixturing" during solution treating and quenching and to control dimensional relations by the use of "restraining fixtures" during aging (second sentence of the first paragraph of the section "Fixturing"). The fixtures described in D18 can be either of the restrain type, i.e. furnace tools which maintain the dimensions of the component as in claim 1 of auxiliary request 1, or of the support type, to be used when restraint is not required (first two paragraphs of the section "Fixturing"). It is clear that the "minimum fixturing" described in D18, as opposed to "restraining fixtures", involves support type fixtures. Thus, D18 teaches that for alloys that must be cooled rapidly from the solution treating temperature a furnace tool in accordance with present claim 1 is to be used only during aging and not during solution treatment. In the standard treatment according D7 the components are air cooled after solution treatment, i.e. subjected to a rapid cooling. Therefore, for said treatment D18 teaches away from claim 1, which stipulates the use of a furnace tool which maintains the dimensions of the component during both solution heat treating and precipitation heat treating.

Hence the subject-matter of claim 1 of auxiliary request 1 involves an inventive step.

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 as amended in the following version:

   - Claims 1-13 of auxiliary request 1 filed with letter dated 6 July 2016;

   - the description and drawings of the patent specification.

The Registrar: The Chairwoman:

C. Moser P. Acton

Decision electronically authenticated