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Datasheet for the decision of 29 February 2012

Case Number: T 0522/10 - 3.2.07

Application Number: 06253302.1

Publication Number: 1739203

IPC: C23C 8/20

Language of the proceedings: EN

Title of invention:
Titanium treatment to minimize fretting

Applicant:
GENERAL ELECTRIC COMPANY

Headword:
-

Relevant legal provisions:
EPC Art. 54, 56

Keyword:
"Novelty (main request - no)"
"Inventive step (auxiliary request - no)"

Decisions cited:
-

Catchword:
-

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Case Number: T 0522/10 - 3.2.07

D E C I S I O N
of the Technical Board of Appeal 3.2.07
of 29 February 2012

Appellant: (Applicant)
GENERAL ELECTRIC COMPANY
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Schenectady, NY 12345 (US)

Representative:
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Decision under appeal:
Decision of the Examining Division of the European Patent Office posted 23 October 2009 refusing European patent application No. 06253302.1 pursuant to Article 97(2) EPC.

Composition of the Board:

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

Summary of Facts and Submissions

I. The applicant lodged an appeal against the decision of the Examining Division to refuse the European patent application No. 06 253 302.1.

II. In this decision the following documents are cited:

D1 = JP 07 090541 A (and English machine translation provided by the Japanese Patent Office [JPO]; and Patent Abstracts of Japan, abstract)
D2 = JP 2002 371348 A (and English machine translation provided by the JPO)
D3 = JP 2003 041359 A (and English machine translation provided by the JPO)
D4 = US-A-5 891 267
D5 = GB-A-2 053 744

III. The Examining Division held that the subject-matter of claim 1 of the single request dated 6 August 2009 lacked novelty over each of D1 and D2.

IV. With its grounds of appeal dated 30 November 2009 the appellant requested to set aside the decision and to grant a patent on the basis of claims 1-10 of the request filed with letter of 6 August 2009. In case that the Board should consider a decision other than according to the aforementioned requests, oral proceedings were requested.

V. Independent claim 1 of this (main) request reads as follows:

"1. A method for surface treating a titanium or titanium alloy substrate comprising:

providing the titanium or titanium alloy substrate;
heating the substrate to a temperature sufficient to diffuse carbon into the titanium and less than 538°C (1000°F); and
contacting the surface with a carbon-containing gas for a period of time sufficient to diffuse carbon into the substrate to form a surface layer comprising one or more of carbides and interstitial carbon."

VI. With a communication dated 16 December 2011 and annexed to the summons for oral proceedings the Board presented its preliminary opinion with respect to claim 1 of the request filed with letter of 6 August 2009.

The Board stated amongst others that it appeared that the subject-matter of claim 1 lacked novelty over each of the disclosures of D1 to D3.

VII. With letter dated 24 February 2012 faxed on the same date the appellant submitted a declaration by the inventor Mr. Bruce filed in connection with the corresponding US application and stated that "the present invention is concerned with a method using a gas carburization method and not a plasma carburization process".

VIII. Oral proceedings were held on 29 February 2012. At the start the appellant filed an auxiliary request. Thereafter novelty of the subject-matter of claim 1 of the main request was discussed in view of D2. This was followed by a discussion of the admissibility and of

inventive step of the subject-matter of claim 1 of this auxiliary request, particularly with respect to the teaching of D2 and the common general knowledge of the person skilled in the art.

The appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of the main request, filed with letter dated 6 August 2009 or, in the alternative, on the basis of the auxiliary request filed during the oral proceedings (with claim 10 of the main request).

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

IX. Method claim 1 of the auxiliary request differs from that of the main request (see point V above) in that the feature "**by gas carburization**" has been inserted between the terms "… titanium or titanium alloy substrate" and "comprising: …".

X. The appellant argued essentially as follows:

It is implicit from the description of the present application that no plasma is used. The feature "contacting the surface with a carbon-containing gas for a period of time …" excludes any plasma treatment so that the process of D2 is not novelty destroying for the subject-matter of claim 1 of the main request.

Claim 1 of the auxiliary request has been restricted to "a method … by gas carburization". It was only at the time when the declaration of the inventor was obtained that this distinction between the prior art's known

plasma carburization and gas carburization became manifest (see point 8 of the declaration of Mr. Bruce). Therefore this auxiliary request should be admitted into the proceedings.

The claimed gas carburization process according to the auxiliary request is a more economical process than the conventional carburization at the high temperatures as e.g. known from D4 (900-1200°C) or D5 (750-950°C), it is not rendered obvious by the prior art D1 to D3 and solves the fretting fatigue and wear problems of titanium parts (see page 2, third and fourth paragraphs).

The plasma carburized parts obtained by the method of D2 have a rough surface and need to be shot-peened (see paragraph [0054]). According to the present application shot-peening of the carburized parts is to be avoided (see page 1, fourth paragraph to page 2, first paragraph). Furthermore, D2 cannot suggest the claimed gas carburization method without any plasma.

It is admitted that no evidence has been provided which shows that carburizing at a lower temperature results in a different carburized zone than that obtained at a temperature greater than about 538°C.

Reasons for the Decision

1. *Allowability of amendments (Article 123(2) EPC)*

Since the Board comes to the conclusion that the subject-matter of claim 1 of the main request lacks

novelty (see point 2 below) while the subject-matter of claim 1 of the auxiliary request lacks inventive step (see point 3 below) there is no need to verify whether or not the claims of these requests or the amendments made therein comply with Article 123(2) EPC.

Main request

2. *Novelty (Article 54 EPC)*

2.1 Document D2 discloses a process for improving the fatigue property, particularly reducing the coefficient of friction, of a titanium alloy component, such as airplane parts including a turbine blade for power generation, which includes shot-peening of the plasma carburised articles (see English machine translation provided by the JPO, abstract; claims 1-7; paragraphs [0001] to [0003] and [0054] to [0055]). The process of D2 is applicable to beta type and semi-alpha type titanium alloys and comprises a solution and aging treatment of the articles before the plasma carburising step at a gas temperature between 350°C and 950°C and a gas pressure of 10-2000 Pa (see D2, English machine translation, paragraphs [0012] to [0021]).

2.2 According to the example Ti-6Al-4V was used as a typical beta type alloy which was plasma carburised in a processing chamber (the top thermal insulation in this chamber is connected to the cathode of DC power supply while the mounting base of the processed material is connected to the anode of this DC power supply to generate a glow discharge for ionizing the gas for carburisation; see D2, English machine translation, paragraph [0032]) with propane at a

temperature between 350-950°C and a pressure of 10-2000 Pa. The carbon in propane is ionized by said glow discharge and this activated carbon ion collides with the surface of said titanium alloy article whereby a carburization layer including TiC is formed (see D2, English machine translation, paragraphs [0031] to [0037]).

2.3 The carburizing process of claim 1 of the main request does **not** exclude any plasma treatment and can be performed in any furnace suitable for carburization (see the application as originally filed, page 12, third paragraph).

2.4 It is held that the skilled person, when executing the teaching of D2, will seriously contemplate working in the overlapping temperature range of 350°C to less than 538°C for plasma carburizing the titanium alloy substrate, because a lower heating temperature reduces the costs attributed to the energy loss of the heating furnace (see in this respect the Case Law of the Boards of Appeal of the European Patent Office, 6th edition, 2010, I.C.4.2.2).

2.5 A pretreatment step before the heating and carburizing step which may include a possible grit blasting or chemical etching is also disclosed in the present application (see the application as originally filed, page 11, third paragraph).

2.6 The plasma carburizing process of D2 is therefore considered to meet all the requirements of the subject-matter of claim 1 of the main request. This subject-

matter thus lacks novelty over D2. Consequently, the main request is not allowable.

The Board thus principally confirms the Examining Division's decision concerning lack of novelty of the subject-matter of claim 1 of the then single request.

2.7 The appellant's arguments to the contrary cannot hold for the following reasons.

2.7.1 First of all, the fact that the present application does not mention any plasma treatment does **not** mean that it is actually excluded from the subject-matter of claim 1.

2.7.2 Secondly, the feature "contacting the surface with a carbon-containing gas …" of claim 1 is likewise considered **not** to exclude such a plasma treatment since the carbon-containing gas according to D2, i.e. propane (see point 2.2 above) will still be in the gaseous state after having been ionized by the described DC glow discharge. The appellant could not make plausible why this generated reactive species would not be in the gaseous state. In this context it has to be considered that a reduced pressure of 10-2000 Pa is used during the carburization and that the formation of soot from said carbon-containing gas is to be avoided as it increases the materials costs (see D2, English machine translation, paragraphs [0019] and [0020]).

2.7.3 Thirdly, the declaration of the inventor Mr. Bruce filed in connection with the corresponding US application of the present application is not considered to be relevant at all. It does not contain

any statement concerning D1-D3 cited in the examination procedure of the present application but only concerns two totally different US documents (see declaration, points 6 and 10). Secondly, the statement "**Plasma carburization is a fundamentally different process method from gas carburization requiring different energy input, different materials, and significantly different process conditions**" (see declaration, point 8) does not explain in detail what these alleged fundamental differences are or should be.

For example, the titanium alloy material Ti-Al6-4V of D2 which is plasma carburized by using a gas mixture of propane and hydrogen (see e.g. English machine translation of D2, paragraphs [0040] and [0045]) is among the preferred materials according to the present application (see claim 2 as originally filed). Propane is among the preferred carbon-containing gases according to the present application while hydrogen is among the preferred non-reactive gases additionally comprised in the carbon-containing gas (see claims 4 and 5 as originally filed). Therefore, if it is assumed that method claim 1 of the main request would relate to a gas carburization method which is carried out at a temperature of e.g. 400°C with the aforementioned preferred materials then the only difference with respect to the plasma carburizing process according to D2 carried out at an identical temperature of 400°C would reside in the omitted glow discharge and much longer treatment periods. It is, however, clear that the glow discharge plasma according to D2 significantly shortens the treatment period necessary for obtaining the same result as with a conventional gas

carburization at an identical temperature. Other differences are, however, not visible.

Auxiliary request

3. *Inventive step (Article 56 EPC)*

The auxiliary request was filed by the appellant at the oral proceedings before the Board in order to establish novelty of the subject-matter of its claim 1. In the present case there is no need to deal with the aspects of its admissibility due to its late filing since the subject-matter of claim 1 thereof does not comply with Article 56 EPC for the reasons that follow.

3.1 The method according to the present application aims to provide an inexpensive, low temperature treatment that reduces the fretting wear and fatigue problem of titanium and titanium alloy parts, particularly of gas turbine engine components, since high-temperature thermal treatments of blade dovetails and disks preclude the use of conventional carburizing methods which normally take place at high temperatures, including temperatures of greater than about 927°C (see page 1, first paragraph to page 2, fourth paragraph of the application as originally filed).

3.1.1 Such carburizing methods of the prior art take place at a temperature of e.g. 900-1200°C for about 1-4 hours for superalloy substrates (see D4, column 4, lines 20 to 39 and column 5, lines 35 to 50) or at 750-950°C for between 1-10 hours for titanium-base alloy blades (see D5, claims 2 and 4).

3.1.2 An advantage of the low temperature carburization method below 538°C is the reduced cost of equipment required to produce the carburized zone (see page 4, third paragraph of the application as originally filed).

3.1.3 The appellant's arguments concerning a different amount of carbon present in the carburized zone, which would be greater than the amount present in a conventional carburized surface which has been carburized at a temperature greater than that according to the present application, cannot be accepted since no evidence in support of this allegation has been submitted. This fact has been admitted by the appellant at the oral proceedings when asked by the Board.

3.2 The carburizing process of D2 similarly aims to improve the fatigue property and wear of titanium alloy components, particularly reducing the coefficient of friction of these titanium alloy parts by plasma carburization in the temperature range of 350-950°C (see point 2.1 above). It teaches that a too high carburization temperature results in a rough surface (see English machine translation, paragraph [0019]) so that the person skilled in the art would select an appropriate temperature for plasma carburization which would also take account of other constraints such as said high-temperature thermal treatments of blade dovetails and disks.

3.3 As already considered in point 2.7.3 above, in case that the same Ti-6Al-4V material is carburized by using a mixture of propane and hydrogen then the only difference between the (conventional) gas carburization method of claim 1 of the auxiliary request and the

plasma carburization process according to D2 in the overlapping temperature range of from 350°C to less than 538°C resides in the omission of the plasma.

The plasma of the generated glow discharge is responsible that the carburization according to D2 takes place in a much shorter treatment period than according to the present application which latter mentions treatment times of up to 1500 hours (see claim 9 as originally filed).

It is clear to the person skilled in the art that an apparatus of a given size for carburization including plasma generating means is much more expensive than a simple gas carburization furnace of the same size for low temperature carburization without such plasma means. However, the throughput through said plasma carburizing apparatus is much higher due to the much shorter treatment time.

3.4 As concurred with by the appellant at the oral proceedings the carburization depth is dependent on temperature, time and concentration and is governed in particular by Fick's first and second law of diffusion which belongs to the common general knowledge of the person skilled in the art (compare also page 13, lines 13 to 15 and lines 24 to 31 of the application as originally filed). This means in simple words - assuming that a conventional gas carburization method with a single concentration of the carbon-containing gas is used - that a high carburization temperature results in a short treatment time whereas a low carburization temperature requires a long treatment time. The throughput of such a gas carburizing furnace

of a given size is therefore determined by the treatment time which is dependent upon the applied temperature.

3.4.1 On the other hand it is clear to the person skilled in the art that, provided that sufficient time is available for a long treatment time at low temperature, only a small investment in a simple gas carburization furnace is necessary in order to obtain the same result of a carburized titanium part.

3.4.2 The Board therefore holds that it is obvious that the person skilled in the art starting from the carburizing process of D2 by applying his common general knowledge would omit the plasma discharge for economic reasons in order to use a cheaper and simplified carburizing apparatus.

Thereby the person skilled in the art would arrive at the method of claim 1 of the auxiliary request without inventive skills. The subject-matter of claim 1 of the auxiliary request therefore lacks inventive step (Article 56 EPC). Consequently, the auxiliary request is not allowable.

3.5 The appellant's arguments to the contrary cannot hold for the following reasons.

Although the present application states that shot-peening should be avoided (see page 1, fourth paragraph to page 2, first paragraph of the application as originally filed) method claim 1 of the auxiliary request, due to the used wording "comprising", does **not** exclude any further process steps such as the shot-

peening described in D2 which has to be carried out after the carburizing step in order to smoothen the surface and to create compressive stress therein (see D2, English machine translation, paragraph [0054]).

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

G. Nachtigall H. Meinders