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Datasheet for the decision of 10 July 2014

Case Number: T 1409/12 - 3.2.08

Application Number: 06001713.4

Publication Number: 1666618

IPC: C22C19/05, C22C1/04

Language of the proceedings: EN

Title of invention:
Ni based superalloy and its use as gas turbine disks, shafts and impellers

Patent Proprietor:
GENERAL ELECTRIC COMPANY

Opponent:
Siemens Aktiengesellschaft

Headword:

Relevant legal provisions:
EPC Art. 54, 56

Keyword:
Novelty - selection invention (yes)
Inventive step - (yes)

Decisions cited:
T 0198/84

Catchword:

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Case Number: T 1409/12 - 3.2.08

D E C I S I O N
of Technical Board of Appeal 3.2.08
of 10 July 2014

Appellant: (Opponent)	Siemens Aktiengesellschaft Wittelsbacherplatz 2 80333 München (DE)
Representative:	Kaiser, Axel Siemens AG Postfach 22 16 34 80506 München (DE)
Respondent: (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)
Decision under appeal:	**Interlocutory decision of the Opposition Division of the European Patent Office posted on 29 May 2012 concerning maintenance of the European Patent No. 1666618 in amended form.**

Composition of the Board:

Chairman	T. Kriner
Members:	C. Herberhold
	D. T. Keeling

Summary of Facts and Submissions

I. By its decision dispatched on 29 May 2012 the Opposition Division decided that the European patent No. 1 666 618 in amended form according to the Main Request then on file and the invention to which it related met the requirements of the EPC.

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

III. Oral proceedings before the Board of Appeal were held on 10 July 2014.

IV. At the end of the oral proceedings the requests of the parties were as follows:

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

The respondent (patent proprietor) requested that the appeal be dismissed.

V. Claims 1, 5 and 10 of the amended patent (as maintained by the Opposition Division) read as follows:

Claim 1:
"A composition of matter consisting of, in weight percent, from 16 percent to 20 percent cobalt, from 11 percent to 15 percent chromium, from 2 percent to 4 percent tantalum, from 0.5 to 3 percent tungsten, from 3 to 5 percent molybdenum, from 0.015 to 0.15 percent zirconium, from 1 to 3 percent niobium, from 2.6 to 4.6 percent titanium, from 2.6 to 4.6 percent aluminum,

from 0 to 2.5 percent rhenium, from 0 to 2 percent vanadium, from 0 to 2 percent iron, from 0 to 2 percent hafnium, from 0 to 0.1 percent magnesium from 0.015 to 0.1 percent carbon, from 0.015 percent to 0.045 percent boron, balance nickel and impurities; wherein the ratio (percent zirconium + percent boron)/percent carbon is greater than 1."

Claim 5:
"An article having a composition according to claim 1."

Claim 10:
"A method for preparing an article, comprising the steps of furnishing a mass of compacted powders having a composition consisting of, in weight percent, from 16 percent to 20 percent cobalt, from 11 percent to 15 percent chromium, from 2 percent to 4 percent tantalum, from 0.5 to 3 percent tungsten, from 3 to 5 percent molybdenum, from 0.015 to 0.15 percent zirconium, from 1 to 3 percent niobium, from 2.6 to 4.6 percent titanium, from 2.6 to 4.6 percent aluminum, from 0 to 2.5 percent rhenium, from 0 to 2 percent vanadium, from 0 to 2 percent iron, from 0 to 2 percent hafnium, from 0 to 0.1 percent magnesium from 0.015 to 0.1 percent carbon, from 0.015 percent to 0.045 percent boron, balance nickel and impurities; wherein the ratio (percent zirconium + percent boron)/percent carbon is greater than 1;
heat treating the mass by the steps of solution treating the mass at a solution-treating temperature above its solvus temperature, and
cooling the solution treated mass to a temperature below its solvus temperature."

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

D2: EP-A-0 849 370;
D5: DE-A-1 810 246;
D7: DE-A-1 608 242;
D8: US-A-5,328,659;
D9: EP-A-0 403 682.

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

Novelty

Document D5 disclosed an alloy composition with elemental ranges only minimally different from the ones claimed in the amended patent. Furthermore, the additional restriction due to the formula (percent zirconium + percent boron)/percent carbon > 1 had only a minor limiting effect and also could not be seen as a purposive selection. Indeed, Figure 5 of the patent only disclosed 6 data points, which was insufficient to support the alleged causal relationship between the criterion defined in the formula and the improvement in the crack growth rate. Moreover - even if one accepted the experimental data - the formula comprised three free parameters and it was well possible that the improvement in crack growth rate observed was only due to e.g. a lower carbon content, with the fulfilment of the formula being a simple consequence thereof. Although it was true that only example 1 of D5 fulfilled the criterion of the formula and that none of the examples described in that document comprised all three of the elements Ta, Mo and Nb in combination, the broad alloy composition defined in claim 1 of D5 provided the beneficial effect throughout its full range. There was nothing in D5 which would restrict the teaching of D5 to the particular examples or which

would discourage the skilled person from the use of all three elements Ta, Mo, and Nb in the disclosed alloy. To the contrary, on page 12, lines 19-22 it was disclosed to be advantageous for the alloy to comprise Mo as well as at least ca. 1% of the metals from the group consisting of Ta and Nb. Moreover, D5 explicitly required the sum of these elements' percentages to be at least 3%, which also taught the person skilled in the art to add all 3 of these elements.

Consequently, the sub-range defined in claim 1 of the amended patent qualified neither as a narrow selection nor as a purposive selection. In accordance with the criteria developed in T198/84, claim 1 was thus not novel over prior art D5.

Inventive step

Starting from D5 as closest prior art, the only difference which could at best be identified, was in the requirement of the ratio (percent zirconium + percent boron)/percent carbon being greater than 1. Firstly, as discussed above, there was no sufficient evidence that said ratio had indeed any technical effect. The feature should thus be ignored. Secondly, even if one accepted the ratio to have a technical effect, the restriction to particular values thereof was not inventive for the following reasons: According to the patent, the technical effect of the feature was to keep the dwell fatigue crack growth rate in acceptable limits, i.e. to improve fatigue strength. It was however known from D2, column 5, line 26-34 that low cycle fatigue failures are linked to the presence of carbide stringers, which could be controlled by controlling the amount of molybdenum and carbon such that discrete carbides form rather than the detrimental

carbide stringers. Starting from the D5 alloy, the person skilled in the art would thus lower the carbon content in order to improve the fatigue failure properties and thus arrive at an alloy fulfilling the requirement (percent zirconium + percent boron)/percent carbon > 1. Even if the suggested preferable carbon amount in the superalloy only partly overlapped with the carbon range defined in claim 1 of the amended patent, the person skilled in the art would chose a value somewhere between the disclosed upper and lower limit, if necessary with the aid of experiments. While it was true that the Ta content of the D2 alloy was between 0 and 1 wt% and thus lower than required by claim 1 of the amended patent, the person skilled in the art knew that Ta did not interfere with carbon stringer formation and thus would keep the Ta content in the 5% range explicitly disclosed as particularly resistant to oxidation and sulfidation in D5, page 14, lines 3-6.
Therefore, the subject-matter of claim 1 did not qualify as inventive over the combination of documents D5 and D2.

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

Novelty

While it was true that there was some overlap between the disclosure of D5 and the claimed alloy's elemental composition, the invention defined a considerably reduced sub-range for basically every element, giving detailed reasons for the particular selection of each elemental range. With respect to the three elements Ta, Mo, and Nb, these were each disclosed as optional in D5, with the presence of only two of them being

required. Accordingly, D5 comprised not a single example of an alloy which had all three of these elements. The amended patent, on the other hand, required the presence of all three of these elements in specific concentrations, thus qualifying as a narrow selection.
Furthermore, Figure 5 of the amended patent clearly showed the effect of the ratio (percent zirconium + percent boron)/percent carbon on the crack growth rate and thus proved the purposive selection of the claimed ratio.
Consequently, claim 1 of the amended patent was new over D5.

Inventive step

Firstly, as already discussed under novelty, D5 only disclosed the use of two of the three elements Ta, Mo, Nb and did not include any motivation towards including all three of them. For this reason alone, even a combination of the teachings of D5 and D2 would not result in the subject-matter claimed in the amended patent.
Secondly, the technical effect of the ratio (percent zirconium + percent boron)/percent carbon had been clearly supported by the experimental data provided in Figure 5 of the patent. D2 provided no motivation to said ratio being of significance, but appeared to focus more on preventing the formation of Mo-containing carbides.

Therefore, the subject-matter of claim 1 of the amended patent was inventive over the combination of D5 with D2.

Reasons for the Decision

1. The appeal is admissible.

2. Novelty

2.1 Document D5:

2.1.1 In the following table, the superalloy composition claimed in the amended patent is compared with the disclosure of D5 (all concentrations - also in the following text - are in wt% unless explicitly referred to as atomic percent):

	Patent cl1	D5 cl1	A	B	ex1	ex2	ex3	ex4
Co	16 -20	15-25	19,7	19,7	20,0	19,7	19,7	19,8
Cr	11 -15	13-18	15,5	15,5	15,4	15,3	15,5	15,4
Ta	2-4	0-5	-	2,0	2,0	-	3,8	-
W	0,5-3	0,25-5	3,1	3,1	2,94	3,1	3,1	3,39
Mo	3-5	0-4	2,0	-	-	1,98	2,0	1,98
Zr	0,015-0,15	0,01-0,2	0,06	0,06	0,14	0,06	0,06	0,06
Nb	1-3	0-2,5	2,0	2,0	1,95	1,99	-	2,07
Ti	2,6-4,6	< 5	4,2	4,2	4,48	4,15	4,2	3,11
Al	2,6-4,6	> 2,5	2,8	2,8	2,87	2,79	2,8	3,45
C	0,015-0,1	0,03-0,2	0,15	0,15	0,15	0,11	0,15	0,12
B	0,015-0,045	0,005-0,05	0,015	0,015	0,016	0,015	0,015	0,017
Ni	Bal.	Bal.	Bal.	Bal.	Bal.	Bal.	Bal.	Bal.
Ratio	+	(+/-)	-	-	+	-	-	-

The column "Patent cl1" indicates the concentrations claimed in claim 1 of the amended patent, column "D5 cl1" indicates the broadest disclosure in D5 (as given in claim 1 or on page 2, second paragraph of said document), "A" and "B" indicate the elemental

concentrations in alloys A and B (p. 13, Table I), and "ex1" to "ex4" indicate the examples 1 to 4 (pages 17, 20 and 22 respectively).
If the criterion "(percent zirconium + percent boron)/ percent carbon is greater than 1" (referred to as the "ratio criterion" in the following) is fulfilled, this has been marked by a "+" in the row "Ratio". If the criterion is not fulfilled a "-" has been inserted.

Further to the elemental ranges given above, D5 requires the following criteria to be fulfilled:
- the alloy comprises at least two elements of the group consisting of Mo, Ta, and Nb, the sum of Mo, Ta and Nb being at least 3%;
- the amounts of Al and Ti are such that the ratio of the atomic percent Al to the atomic percent Ti is between 1 and 2 and the total of the atomic percent Ti and the atomic percent Al is less than 12 atomic percent;
- the elements in the alloy are correlated such that the sum of the atomic percentages of Mo, W, Ta and Nb is less than about 4,8 atomic percent.

As can be seen from the above table the most relevant differences (marked by a light grey background colour) are in the content of the elements Ta, Mo and Nb and in the ratio criterion.

2.1.2 The table reveals an overlap between the alloy composition disclosed in D5 and the one claimed in the amended patent. Hence, the alloy composition claimed is a selection from the disclosure of D5. It therefore has to be examined whether the claimed method satisfies the three criteria for a "novel selection", i.e. (i) the overlap must be small; (ii) the examples disclosed in the prior art must be sufficiently far removed from the

claimed range; (iii) the selection is not arbitrary as e.g. inferable by a technical effect obtained by the selected range. Also, it has to be examined whether the skilled person taking into account the technical disclosure of document D5, would seriously contemplate working in the range of overlap.

2.1.3 As to the elements Ta, Mo and Nb, claim 1 of the amended patent requires the presence of a considerable minimal amount of all three of them (at least 2, 3 and 1% respectively), whereas D5 only demands the presence of two of these elements, i.e. one of the elements being fully optional. Of the other two, one element may be dominating with the other one close to the impurities level (e.g. with a Ta content of >3%, the second element may be missing completely, with the third element being present only in a minimal concentration). Additionally, the claimed range is further restricted by the ratio criterion. The selection claimed in claim 1 of the amended patent thus qualifies as a narrow selection (criterion (i)).

2.1.4 Said selection is also sufficiently far removed from the examples disclosed in the prior art (criterion (ii)), because none of the examples shows the required simultaneous presence of all three elements Ta, Mo, and Nb (see ex1 - ex 4 in the above Table).

2.1.5 As correctly pointed out by the respondent, the patent gives detailed reasons for each of the elemental ranges specified, motivating the selection of the respective lower as well as upper limits. For Ta, Mo and Nb these reasons are discussed in paragraphs [0021]-[0023], and [0025]-[0026] of the amended patent. In view of the arguments provided therein, the selection of these elements aims at specific technical effects and thus is

not arbitrary. With respect to the ratio criterion, Figure 5 of the patent further demonstrates the decrease of the dwell fatigue crack growth rate with the increase in the ratio. In view of these data, a lower limit for the ratio has a technical effect and cannot be considered arbitrary. The appellant was of the opinion that due to the three free parameters in the ratio and because of the low number of data points, the experimental evidence was insufficient to prove a technical effect. However, in view of the measurement data provided in the patent, the burden of proof for such an alleged lack of technical effect is on the appellant. Without any experimental evidence, the appellant's objection remains a pure allegation. Thus, the Board accepts the lower limit for the ratio as well as the selection of the ranges of Mo, Ta and Nb to be a purposive selection (criterion (iii)).

2.1.6 It remains to be examined whether the skilled person would seriously contemplate working in the range of overlap. The appellant has pointed to D5, page 12, line 19-22 which discloses that it was advantageous for the alloy to comprise Mo as well as at least ca. 1% of the metals from the group consisting of Ta and Nb. However, firstly this passage does not require both of Ta and Nb to be present and, secondly, a Ta content of 1% is still outside the claimed range (2-4%), such that said disclosure does not clearly and unambiguously disclose that the person skilled in the art would seriously contemplate to work in the ranges claimed for the elements Ta, Mo and Nb. Moreover, also the D5 examples can give no indication to work in the claimed range because none comprises all three elements. Furthermore, the teaching on page 20, last two lines - page 21, line 4 suggests to replace the 2% Ta content against 2% Mo in order to provide a cheaper alloy, thus further

supporting the teaching of the examples i.e. that Mo and Ta are indeed rather alternate ingredients of the alloy composition than synergistically providing a technical effect. It is further consistent with this analysis that also all of the comparative alloys shown in Table V of D5 lack at least one of the elements Mo, Nb and Ta. With respect to the ratio criterion, only example 1 of D5 fulfils said criterion. However, according to page 17, lines 2-4, it had been intended to produce an alloy having the composition "B", i.e. a composition which does not fulfil the ratio criterion, such that fulfilling the ratio criterion appears to be more a coincidence caused by an unintentional high Zr content in example 1 rather than a deliberate teaching. Consequently, in view of the teaching in D5, the person skilled in the art would not seriously contemplate to work in the sub-range defined in claim 1 of the amended patent.

Because all of the three criteria for novelty are fulfilled and because the person skilled in the art would not seriously contemplate working in the claimed sub-range, the subject-matter of claim 1 of the amended patent is novel over prior art D5.

2.2 Documents D7, D8, D9:

These documents have been cited in the written proceedings as novelty destroying. However, the appellant did not present any further arguments with respect to documents D7, D8 and D9 during the oral proceedings.

D7 and D9 have a one point overlap with the claimed alloy (D7: Mo 0,5-3% in claim 1 of D7 vs. 3-5% claimed in the amended patent; D9: Ta 1-2% in claim 1 of D9 vs.

2-4% claimed in the amended patent), the claimed sub-range thus being narrow. Moreover, none of the examples falls under the scope of claim 1 of the amended patent: In D7 among others the Co content (10%) as well as the C content (0,15%) in the examples is clearly out of the claimed range (16-20% and 0,015-0,1% respectively). In the D9 example (HK79), the Ta content (1,5%) as well as the Nb content (4%) are outside the claimed ranges (2-4% and 1-3% respectively). Thus, criteria (i) and (ii) are fulfilled. With respect to criterion (iii) the arguments in item 2.1.5 above apply, the claimed subject-matter thus being novel over the disclosure in documents D7 and D9.

D8 discloses a broad superalloy composition wherein numerous elements are optional (e.g. Ta, W, Zr, Nb), the claimed sub-range with all these elements being mandatory thus being narrow. Again, none of the examples (see D8, Table I) falls under the definition of claim 1 of the amended patent. Thus, and for the reasons already discussed above, the claimed sub-range is novel.

3. Inventive step:

The appellant has put inventiveness of the subject-matter claimed into doubt based on D5 as closest prior art. Like the patent in suit, D5 relates to a superalloy with high creep resistance (D5, page 4, second paragraph). As discussed in item 2.1.1 above, the subject-matter claimed differs from the disclosure of D5 in the selected composition in Mo, Ta and Nb and in the ratio criterion. These differences solve the technical problem to improve creep resistance and fatigue crack growth resistance (see the patent, paragraphs [0021]-[0023], [0025]-[0026] and [0032]).

With respect to the mandatory presence of Mo, Ta and Nb, the appellant was of the opinion that the general disclosure of D5 allowed the presence of all three elements and that - with the content of Mo, Ta and Nb being at least 3% and with the Ta content being preferably around 5% for a Cr content of 13-14,5% (D5, page 14, first paragraph) - the person skilled in the art would be prompted to provide the alloy with all three elements Mo, Ta and Nb. However, this reasoning cannot be followed by the Board. Even with a Ta content of 5%, the presence of one of the elements Mo and Nb remains fully optional and the other may also be just above the impurity level. There is no indication to provide the alloy having a Ta content of 5% with all three of the elements, let alone in the specific respective parameter ranges. In particular, a Ta content of 5% is by itself outside the claimed Ta range (2-4%). As discussed before, the patent gives specific beneficial technical effects with respect to the problem the invention intends to solve, i.e. with respect to the optimization of creep resistance and fatigue crack growth resistance at which the selections of the respective ranges are aimed (patent paragraphs [0021]-[0023], and [0025]-[0026]). The appellant has indicated no hint in a prior art document or in the knowledge of the person skilled in the art which would lead the skilled person to choosing contents of Mo, Ta, Nb within the claimed ranges in order to solve the problem posed.

With respect to the ratio criterion, the appellant argued that in order to improve fatigue failure, the skilled person would learn from D2, column 5, lines 26-34 to reduce the amount of detrimental carbide stringers by controlling the carbon content to between

0,010 and 0,020%. Applying this teaching to the D5 alloys would result in a lower carbon content and consequently in the ratio criterion being fulfilled. Firstly, the alloy discussed in D2 has a low Ta content of 0-1%. With D5 explicitly disclosing examples of low or no Ta content, it is natural to apply the teaching of D2 in the range of overlap. This would however result in an alloy having a Ta content of 0 to 1%, which is outside the range claimed in the amended patent. The appellant argued that D5, page 14, lines 3-6 taught the person skilled in the art to employ a Ta content of 5% in order to reach a preferable oxidation and sulfidation resistance. As it was known that Ta did not influence carbide stringer formation, the person skilled in the art would keep the Ta content of the alloy at 5%. However, even if this argumentation was followed, the resulting alloy - having a Ta concentration of 5% - would not fall under the definition in claim 1 of the amended patent (which requires a Ta content of 2-4%).

Secondly, only half of the C content proposed in D2 (0,010 - 0,020%) falls within the claimed range for C (0,015-0,1%). As can be seen from the Zr and B ranges disclosed in D5, even if the accordingly reduced C content was chosen in the claimed range, still the ratio criterion would not automatically be fulfilled.

Therefore, the C sub-range derivable by application of the D2 teaching would need to be further reduced - without any indication in the prior art suggesting doing so - in order to fulfil the ratio criterion as well as to fall within the C range claimed in the amended patent. This further selection of a sub-range can only be arrived at by an *ex-post facto* analysis. The appellant has argued that the C content could be

optimized by appropriate experimental testing. However such testing would then be necessary also for determining Ta, Mo and Nb contents (in order to possibly arrive at a mandatory presence of all three), a task which amounts to a full research program rather than to an obvious action of the skilled practitioner.

To conclude, the sub-range claimed in the amended patent does not evolve in an obvious way from the combined disclosure in documents D5 and D2.

4. The above reasoning equally applies to independent claims 5 and 10, which refer to an article having the composition of claim 1 and to a method for preparing an article by furnishing a mass of compacted powders having the composition of claim 1.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

V. Commare T. Kriner

Decision electronically authenticated