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Datasheet for the decision of 24 April 2024

Case Number: T 0769/22 - 3.2.04

Application Number: 17153735.0

Publication Number: 3211178

IPC: F01D5/18

Language of the proceedings: EN

Title of invention:
TURBINE BLADE

Patent Proprietor:
Mitsubishi Power, Ltd.

Opponent:
Siemens Energy Global GmbH & Co. KG

Headword:

Relevant legal provisions:
EPC Art. 56, 83

Keyword:
Inventive step - (yes)
Sufficiency of disclosure - (yes)

Decisions cited:

Catchword:

Europäisches Patentamt
European Patent Office
Office européen des brevets

Beschwerdekammern

Boards of Appeal

Chambres de recours

Boards of Appeal of the
European Patent Office
Richard-Reitzner-Allee 8
85540 Haar
GERMANY
Tel. +49 (0)89 2399-0
Fax +49 (0)89 2399-4465

Case Number: T 0769/22 - 3.2.04

D E C I S I O N
of Technical Board of Appeal 3.2.04
of 24 April 2024

Appellant: (Opponent)	Siemens Energy Global GmbH & Co. KG Otto-Hahn-Ring 6 81739 München (DE)
Respondent: (Patent Proprietor)	Mitsubishi Power, Ltd. 3-1, Minatomirai 3-chome, Nishi-ku, Yokohama 220-8401 (JP)
Representative:	MERH-IP Matias Erny Reichl Hoffmann Patentanwälte PartG mbB Paul-Heyse-Strasse 29 80336 München (DE)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted on 13 January 2022 rejecting the opposition filed against European patent No. 3211178 pursuant to Article 101(2) EPC.**

Composition of the Board:

Chairman	A. de Vries
Members:	C. Kujat
	K. Kerber-Zubrzycka

Summary of Facts and Submissions

I. The appeal lies from the decision of the opposition division of the European Patent Office rejecting the opposition filed against European patent No. 3 211 178 pursuant to Article 101(2) EPC.

II. The opposition division held that the patent and the invention to which it related met the requirements of the EPC, having regard inter alia to the following pieces of evidence:

D1: JP 2013-194667 A
D2: US 8,070,454 B1
D4: US 2007/148003 A1
D5: US 2015/369060 A1
D8: US 2013/121839 A1
D11: US 4,121,894
D13: English translation of D1, filed on 16 July 2020

III. The appellant opponent requests that the decision under appeal be set aside and that the patent be revoked.

IV. The respondent proprietor requests that the appeal be dismissed, alternatively, that a patent be granted on the basis of one of the auxiliary requests 1 to 4, submitted with letter of 23 January 2024.

V. In preparation for oral proceedings the Board issued a communication pursuant to Article 15(1) RPBA setting out its provisional opinion on the relevant issues. Oral proceedings were duly held on 24 April 2024.

VI. Independent claim 1 according to the relevant main request (patent as granted) reads as follows:

"A turbine blade (11) comprising:
at least one cooling passage (15a to 15f) that is formed in the blade and extends in a blade height direction, wherein the at least one cooling passage (15a to 15f) comprises a final cooling passage (15f) that is the closest to a blade trailing edge, wherein the final cooling passage (15f) communicates with a trailing edge discharge passage (19) which is adapted to discharge air that has been flow through the final cooling passage (15f), wherein blade surfaces (12, 13) on a suction side and a pressure side are covered with thermal barrier coating (14), wherein a design point (P1) on the suction side is set on the blade surface (12) on the suction side in each blade section perpendicular to the blade height direction within a range from a position on a back side of and including a throat position (S), at which a distance between turbine blades is the global minimum, to a position in front of and not including a position (R) of a tailing end of the final cooling passage (15f), and wherein thickness distribution of the thermal barrier coating (14) on the suction side of each blade section is configured such that a thickness of the thermal barrier coating (14) is uniform from a blade leading edge to the design point (P1) and gradually reduces from the design point (P1) toward the back side up to the blade trailing edge."

VII. The appellant argued as follows:

The subject-matter of claim 1 of the main request is insufficiently disclosed. It moreover does not involve an inventive step over D1 alone, in combination with common general knowledge or with D2.

VIII. The respondent argued as follows:

The subject-matter of claim 1 of the main request is sufficiently disclosed and involves an inventive step over the cited prior art.

Reasons for the Decision

1. The appeal is admissible.

2. *Background*

The invention concerns a turbine blade, e.g. for a gas turbine, with a cooling passage 15 in the blade height direction. A final cooling passage 15f is located closest to a blade trailing edge, see figures 4 and 5 of the patent. The blade is covered with a thermal barrier coating 14 (TBC). Considered along the blade chord the thickness distribution of the TBC on the suction side of the blade is uniform from a blade leading edge to a "design point P1" (see below), while it is gradually reduced from that point towards the blade trailing edge. As a TBC thickens the blade, any reduction of the TBC towards the trailing edge improves the aerodynamic performance of the blade, see paragraph 0004 of the patent.

3. *Claim interpretation*

3.1 Before the Board can decide on sufficiency and inventive step, it must interpret the feature

"a design point (P1) on the suction side is set on the blade surface (12) on the suction side in each blade section perpendicular to the blade height direction within a range from a position on a back side of and

including a throat position (S), at which a distance between turbine blades is the global minimum, to a position in front of and not including a position (R) of a tailing end of the final cooling passage (15f)"

in claim 1 of the main request.

3.2 It is common ground that the design point on the suction side of the turbine blade can be identified only indirectly by means of the thickness of the TBC. When seen in a direction from the leading edge towards the tailing end of the blade, the thickness of the TBC is uniform from the blade leading edge to the design point P1, and gradually reduced from there towards the blade trailing edge. Therefore, the design point P1 is the position where the thickness reduction of the TBC starts. As the throat position S is the position at which the distance between adjacent turbine blades is the global minimum, and R is the position of the tailing end of the final cooling passage of a given blade, the above feature is effectively directed to a range of possible starting positions along the suction side of the blade for the thickness reduction of the TBC. This range begins at the throat position S and ends before the tailing end R of the final cooling passage. For the present decision, only the end point of that range is of interest.

4. *Inventive Step*

The opponent as appellant disputes the decision's finding that the subject-matter of granted claim 1 involves an inventive step over document D1 alone or in combination with the common general knowledge or with D2. At the oral proceedings before the Board they

indicated not to have any further inventive step attacks.

4.1 The Board concurs with the parties that document D1 constitutes a suitable starting point for the assessment of inventive step. The embodiment shown in figure 1 of that document concerns a turbine blade with a cooling passage formed inside the blade and extending in a blade height direction. A final cooling passage 2a is located closest to a blade trailing edge and communicates with a trailing edge discharge passage 19 adapted to discharge air that has flown through the final cooling passage. The blade surfaces on a suction side and a pressure side are covered with a thermal barrier coating 3, i.e. a TBC. The thickness of the TBC on both sides of the blade is uniform apart from the blade trailing edge portion 4, where it is gradually reduced towards the blade trailing edge, see paragraph 0029 of the English translation D13. The thickness reduction is shown in cross-section below the dashed line L in figures 1(a) and 3(a) of D1. The TBC can be applied by thermal spray coating, and the relationship between the amount of TBC material and the position of the coating nozzle along the blade is depicted in figure 3(b), where the thickness reduction begins to the right of the dashed line L.

It is common ground that the gradual thickness reduction in the blades according to figures 1 and 3 of D1 begins at the tailing end of the final cooling passage. Formulated in the terms of claim 1, these figures disclose that the design point on the suction side of the blades is set at the position R of the tailing end of the final cooling passage. In order to apply the problem-and-solution approach, the Board must now determine the distinguishing features over D1.

4.2 Contrary to the appellant opponent's assertion, the Board is of the opinion that claim 1 of the main request contains a distinguishing feature:

4.2.1 In their grounds of appeal, see the bridging paragraph between pages 9 and 10, the appellant argues that the design point relates to a cliché without any technical meaning or effect ("Worthülse"). The Board disagrees, since the gradual thickness reduction of the TBC begins at the design point, see above. Therefore, the thickness of the TBC is uniform before the design point, and gradually reduced after the design point. That is precisely the technical meaning and effect of this feature. In addition to that, the design point can be identified on any given blade, e.g. in a cross-section which exposes the thickness profile of the TBC. It therefore refers to a physical characteristic of the turbine blade, and not only to the inner shape of the turbine blade as unconvincingly argued by the appellant.

4.2.2 As the design point relates to a physical characteristic, the Board concurs with the appellant's alternative interpretation that the claimed range for the design point, i.e. from S to a position in front of and not including a position R, lies immediately next to the design point of D1, see the first full paragraph on page 10 of their grounds of appeal. However, the Board rebuts the appellant's conclusions that claim 1 lacks novelty because of an infinitesimally small distance between the design points of D1 and the patent in suit. Instead, the exclusion of the tailing end of the final cooling passage, i.e. its end-point R, in claim 1 will be construed by a mind willing to understand in the sense that there is a measurable

distance, e.g. the usual tolerance in the field of turbine blades, between the excluded end-point R and the claimed "position in front of and not including a position (R) of the tailing end of the final cooling passage". In such a reasonable reading the design point is thus positioned at the throat position or somewhere between the throat position and the position of the tailing end up to a point that is separated from the latter by normal machining tolerances. Further, for logical reasons, the claimed turbine according to claim 1 must be novel if it differs at least in a single physical characteristic from the turbine blades disclosed in D1. As the design points of the known blades and the claimed blade are distanced from each other by at least the usual tolerance in the field of turbine blades, they and the corresponding thickness profiles of the TBC cannot be identical. Thus, these physical differences establish novelty, no matter which technical effects - the same or different ones - occur in these two points.

4.2.3 This conclusion is not altered by the appellant's reference to manufacturing tolerances of the TBC. The Board understands this argument in the sense that the turbine blades in D1 inevitably fall within the claimed range due to a potential misalignment between the final cooling passage and the portion of the TBC with reduced thickness. Indeed, these blades can be obtained according to figure 3 of D1 by a two-step process in which the TBC is applied in a second step by thermal spray coating of a previously manufactured blade body with integrated cooling channels. However, in the Board's view, the skilled person is well aware of inevitable tolerances during the fabrication of cooling channels in a blade body - be it by casting of a partially hollow blade or by manufacturing the blade

with its channels in an additive process - , as well as additional alignment tolerances of the coating nozzle for the sprayed-on TBC. The skilled person will therefore take these tolerances into account when they apply the TBC in D1 by thermal spray coating. Thereby, they will make sure that the thickness of the TBC is reduced only in a blade trailing edge portion, i.e. without any overlap with the final cooling passage.

4.2.4 For these reasons, the subject-matter of claim 1 differs from the disclosure of D1 in that the design point is set within a range from a position on a back side of and including a throat position, at which a distance between turbine blades is the global minimum, to a position in front of and not including a position of a tailing end of the final cooling passage, which is the distinguishing feature of claim 1.

4.3 With regard to the formulation of the objective technical problem, the Board already concluded that the distinguishing feature has a technical effect, see paragraph 4.2.1 above. The Board therefore does not endorse the appellant's view that no objective technical problem can be formulated in the absence of a technical effect, see their page 9, first full paragraph of their letter of 6 February 2024. Instead, the Board formulates the objective technical problem underlying the above distinguishing feature starting from that mentioned in paragraph 0010 of the patent in suit as alleviating the deceleration gradient of the fluid and suppressing the loss of aerodynamic force. A similar effect is already achieved in D1, see translation D13, paragraph 0017 and figure 2, which shows decreased pressure loss (or aerodynamic force) and thus improved aerodynamic performance for reduced thickness of the blade trailing portion. Consequently,

the associated objective technical problem can be reformulated as *further* suppressing loss of aerodynamic force.

The Board must now examine whether a skilled person would arrive at a turbine blade in which the gradual thickness reduction of the TBC commences before the tailing end of the final cooling passage as a matter of obviousness from D1 alone, or by combining the teachings of D1 and common general knowledge or D2.

4.4 In accordance with established jurisprudence, the Boards of appeal apply the "could-would approach". This means asking not whether the skilled person could have carried out the invention, but whether they would have done so in the expectation of solving the underlying technical problem (CLBA, 10th edition 2022, I.D.5). In this particular case, the critical question is whether the skilled person starting from D1 would have seriously contemplated choosing a tapering point further inward of the trailing end or edge.

In the present case, it is common ground that document D1 already hints at variations of the turbine blade, see paragraph 0037 of its English translation D13, which explicitly discloses that the trailing edge portion, i.e. the zone wherein the thickness of the TBC is gradually reduced, may be extended beyond 10% of the total blade length. Therefore it can be argued that the skilled person could have arrived at a design point within the claimed range. However, the respondent proprietor holds the view that the skilled person would not do so. The Board shares the respondent's view for the following reasons.

4.5 The Board shares the appellant's view that the skilled person could shift the position of the plane L, i.e. the start of the gradual thickness reduction of the TBC in D1, further upstream in the light of paragraphs 0030 and 0037 of that document, and thereby arrive at a longer blade trailing edge portion. However, there is a consistent teaching in D1 which links the plane L to the tailing end of the final cooling passage. This teaching can be found in the context of the invention of D1 in figures 1-3, and in the context of the prior art in figures 5 and 6 of that document. Further, and contrary to the appellant's assertion in the first paragraph on page 13 of their grounds of appeal, this consistent teaching can also be found in paragraph 0036 of D1. According to that paragraph, see the English translation D13, the thickness of the thermal barrier coating decreases gradually toward the blade trailing edge end portion. In the same paragraph, the blade trailing edge portion is defined as the region "between a trailing end portion of the blade height direction cooling passage closest to a blade trailing edge end portion, and the blade trailing edge end portion". Similar formulations can be found in claim 1 of D1, see page 2 of D13. The Board construes the word "between" in these passages only in the sense that the "trailing end portion" of the final cooling passage, i.e. its tailing end in the terms of claim 1 of the main request, must be the start of the gradual thickness reduction of the TBC. Thus, even if D1 considers longer trailing end portions of more than 10% of the blade length, TBC taper always begins where according to D1 the trailing end portion starts.

The Board must therefore investigate whether the skilled person has other reasons for decoupling the start of the thickness reduction of the TBC from the tailing end of the final cooling passage of D1.

4.6 In that respect, the appellant argues with reference to the turbine blade in figure 1(a) of D1 that the cooling air which leaves the cooling 2 channel towards the trailing edge discharge passage 5b is accelerated by the tapered shape of the cooling passage 2a. As that acceleration improves the cooling efficiency, the start of the thickness reduction of the TBC could be shifted upstream, see the paragraph bridging pages 11 and 12 of their grounds of appeal. The Board is not convinced by this argument, since figure 1(a) discloses a reduced thickness of the TBC only downstream from the end of the tapered passage, i.e. where the cooling air flows through passage 5b of constant thickness. Whether or not there is still enough cooling in the tapered passage to allow shifting the virtual plane (marking the beginning of the trailing end portion) upstream such that the turbine blade would still be thermally stable is mere speculation. The Board has no compelling reason to believe, and is thus unconvinced, that the skilled person would as a matter of course consider the flow acceleration of the cooling air for deciding where to begin tapering of the thickness of the TBC.

The Board is similarly unconvinced by the unsubstantiated allegation that the skilled person would consider shifting the start point of the taper by a small amount upstream as this would lead to improved aerodynamic properties of the turbine blade, see the third complete paragraph on page 12 of their grounds of appeal.

4.7 Further, and contrary to the appellant's view, it does not suffice for rendering claim 1 obvious that there is no hindrance to modify the teachings of D1 (grounds of appeal, second complete paragraph on page 12: "Keinesfalls hält "irgendwas" in D1 den Fachmann davon ab, die beschriebene Modifikation vorzunehmen"; reply of 6 February 2024, fourth complete paragraph on page 5: "Fachmann wäre in keiner Weise daran gehindert"). By the same token, it is immaterial whether paragraphs 0027 and 0028 of the patent in suit incite the skilled person to do so (grounds of appeal, first complete paragraph on page 13). The Board cannot follow these lines of argument, since the correct use of the problem-and-solution approach must rule out any ex post facto analysis that uses knowledge of the invention. This also applies to the other passages of the patent in suit cited by the appellant (see their grounds of appeal, page 11, fourth complete paragraph: "durch die frappierende Ähnlichkeit der D01 mit der Offenbarung des Streitpatents... Modifikationen vorgenommen hätte" or the last paragraph on page 9 of their reply of 6 February 2024: "Er würde gemäß Streitpatent, vgl. Absätze [0010] und [0030], zwangsläufig und ohne Hindernisse eine längere Strecke für die Verzögerung der Strömung bereitstellen").

4.8 Furthermore, the Board is willing to accept that a skilled person looking to further suppressing losses of aerodynamic forces might consider document D2, since it also relates to turbine blades with thermal barrier coatings. Figure 3b of that document discloses a turbine blade with a TBC which tapers off towards the blade trailing edge. The description states that a thermal barrier coating allows for reduced cooling air allotment, see column 1, lines 55-57, and that the TBC

forms a smooth aerodynamic surface, see column 2, lines 25-27. Assuming arguendo that cooling air allotment implies that the blades of D2 have internal cooling channels, no such channels are shown in the figures or explicitly mentioned in the description. Therefore, even a combination of D1 and D2 does not disclose that the gradual thickness reduction of the TBC begins upstream from the tailing end of the final cooling passage.

4.9 From the above it follows that a skilled person will not arrive at the subject-matter of claim 1 starting from D1 either in view of common general knowledge or in combination with D2 in an obvious manner. Therefore, claim 1 of the main request involves an inventive step in the light of this prior art, Articles 100(a) and 56 EPC.

5. *Disclosure of the invention*

The appellant opponent disputes the decision's finding that the patent discloses the invention in a manner sufficiently clear and complete for it to be carried out by the skilled person.

5.1 In its communication, the Board was of the preliminary opinion that this objection is not convincing. The Board presented the following preliminary view (see paragraph 2 of the communication):

"2. Sufficiency

The invention seems to be sufficiently disclosed:

2.1 The Board shares the appellant's view that the "design point" must meet the requirement S<= P1<R,

which seems to define a broad range. However, as no specific effect related to the location of the design point seems to be claimed, no design programme (for achieving that claimed effect) must be carried out.

2.2 The Board shares the appellant's view that the "throat position S" refers to a distance between adjacent blades while claim I is directed to a single blade. It might therefore seem questionable whether such a throat position can still be identified on the suction side of a single blade. According to paragraph 0027 of the patent in suit, "the velocity increases from the blade leading edge to the throat and decreases from the throat to the blade trailing edge". As adjacent blades in a gas turbine seem to be identical, a single blade seems to suffice for identifying the throat.

2.3 The Board shares the appellant's view that there may be interdependencies between the aerodynamic efficiency of a blade and its heat dissipation. However, in the absence of any features directed to an improved aerodynamic efficiency in claim 1, this is immaterial for sufficiency."

As the appellant refrained from further comment, the Board confirms its provisional opinion that the objection is not convincing.

5.2 As to the appellant's argument that the underlying advantages that are described in the patent but not expressed in the claim, in particular alleviating the deceleration gradient of the fluid flowing along the thermal barrier coating on the suction side, suppressing the growth of the boundary layer, and suppressing the loss of the aerodynamic force (cf.

patent, paragraph 0008), cannot be realised by the features of claim 1, the Board adds that this does not relate to the question of whether or not the invention as defined by the features of granted claim 1 can be put into practice in the sense of Articles 100(b) and 83 EPC. The Board follows herein established jurisprudence, see CLBA,II.C.3.2, according to which the requirement of sufficiency of disclosure relates to the invention defined in the claims, and in particular to the combination of structural and functional features of the claimed invention, and there is no legal basis for extending such a requirement also to encompass other technical aspects possibly associated with the invention (such as results to be achieved or technical effects) mentioned in the description but not required by the claimed subject-matter.

6. In conclusion, the Board finds that the decision was right to hold that the patent discloses the invention defined in claim 1 of the main request (patent as granted) in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art, Articles 100(b) and 83 EPC, and that the subject matter of claim 1 of the main request involves an inventive step, Articles 100(a) and 56 EPC.

The appeal thus fails on all points.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

G. Magouliotis A. de Vries

Decision electronically authenticated