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Datasheet for the decision of 26 September 2014

Case Number: T 0355/11 - 3.2.06

Application Number: 01127938.7

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Language of the proceedings: EN

Title of invention:
Cooling structure for a gas turbine

Patent Proprietor:
MITSUBISHI HEAVY INDUSTRIES, LTD.

Opponent:
Alstom Technology Ltd

Headword:

Relevant legal provisions:
EPC Art. 123(2)
EPC 1973 Art. 54(1), 54(2)

Keyword:
Amendments - added subject-matter (yes) - unallowable intermediate generalisation - main request, auxiliary request 1
Novelty - broad claim - auxiliary request 2 (no)

Decisions cited:

Catchword:

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Case Number: T 0355/11 - 3.2.06

D E C I S I O N
of Technical Board of Appeal 3.2.06
of 26 September 2014

Appellant: (Opponent)	Alstom Technology Ltd CHTI-Intellectual Property Brown Boveri Strasse 7/664/2 5401 Baden (CH)
Respondent: (Patent Proprietor)	MITSUBISHI HEAVY INDUSTRIES, LTD. 5-1, Marunouchi 2-chome, Chiyoda-ku, Tokyo 100-8315 (JP)
Representative:	Henkel, Breuer & Partner Patentanwälte Maximiliansplatz 21 80333 München (DE)
Decision under appeal:	**Interlocutory decision of the Opposition Division of the European Patent Office posted on 22 December 2010 concerning maintenance of the European Patent No. 1221536 in amended form.**

Composition of the Board:

Chairman M. Harrison
Members: T. Rosenblatt
W. Sekretaruk

Summary of Facts and Submissions

I. The appellant (opponent) filed an appeal against the interlocutory decision of the opposition division by which it found that in amended form the European patent No. 1 221 536 and the invention to which it relates meet the requirements of the EPC.

II. The appellant contested that the amendments of claim 1 found allowable by the opposition division satisfied the requirement of Article 123(2) EPC and that its subject-matter was novel in view of *inter alia*

D1 : EP-A-0 902 167.

III. In the communication annexed to a summons to oral proceedings, the Board informed the parties that it provisionally concurred with the objections of the appellant.

IV. In its letter of 26 August 2014 the respondent (patent proprietor) submitted two auxiliary requests.

V. Oral proceedings were held before the Board of Appeal, during which the appellant confirmed its request that the decision under appeal be set aside and that the European patent No. 1 221 536 be revoked.

The respondent (patent proprietor) requested that the appeal be dismissed or the European patent be maintained on the basis of auxiliary request 1 or auxiliary request 2 both filed 26 August 2014.

VI. Claim 1 underlying the decision under appeal (**main request**) reads as follows:

"A cooling structure for a gas turbine including multiple diffusion holes (45c,46c,47c) formed in high temperature members (45,47,46) of the gas turbine (10) for blowing a cooling medium to outer surfaces of the high temperature members for film cooling thereof, wherein said diffusion holes are formed so as to open in a direction nearly coinciding with a secondary flow direction (V2) of high temperature gas flowing on the outer surfaces of the high temperature members, and wherein the high temperature members include a shroud (46,47) of a turbine stationary blade body (44); wherein said diffusion holes (46c,47c) in said shroud (46,47) are formed so as to open in a direction running from a high pressure side blade surface (45a) of a turbine stationary blade (45) to the low pressure side blade surface (45b) of an adjacent turbine stationary blade (45) confronting the high pressure side blade surface (45a), and so as to be offset from the primary flow direction (V1) of high temperature gas along the camber line (C) of the turbine stationary blade (45)."

Claim 1 according to **auxiliary request 1** reads (amendments compared to the main request underlined by the Board):

"A cooling structure for a gas turbine including multiple diffusion holes (45c,46c,47c) formed in high temperature members (45,47,46) of the gas turbine (10) for blowing a cooling medium to outer surfaces of the high temperature members for film cooling thereof, wherein said diffusion holes are formed so as to open in a direction nearly coinciding with a secondary flow direction (V2) of high temperature gas flowing on the outer surfaces of the high temperature members, and wherein the high temperature members include inner and outer shrouds (46,47) of a turbine stationary blade

body (44), which turbine stationary blade body (44) is composed of stationary blade (45) and outer shroud (47) and inner shroud (46) fixed in a casing;
wherein said diffusion holes (46c,47c) in said inner and outer shrouds (46,47) are formed so as to open in a direction running from a high pressure side blade surface (45a) of a turbine stationary blade (45) to the low pressure side blade surface (45b) of an adjacent turbine stationary blade (45) confronting the high pressure side blade surface (45a), and so as to be offset from the primary flow direction (V1) of high temperature gas along the camber line (C) of the turbine stationary blade (45)."

Claim 1 according to **auxiliary request 2** reads (amendments compared to auxiliary request 1 marked by the Board with strike-through and underline):

"A cooling structure for a gas turbine including multiple diffusion holes (45c,46c,47c) formed in high temperature members (45,47,46) of the gas turbine (10) for blowing a cooling medium to outer surfaces of the high temperature members for film cooling thereof, ~~wherein said diffusion holes are formed so as to open in a direction nearly coinciding with a secondary flow direction (V2) of high temperature gas flowing on the outer surfaces of the high temperature members, and~~
wherein the high temperature members include inner and outer shrouds (46,47) of a turbine stationary blade body (44), which turbine stationary blade body (44) is composed of stationary blade (45) and outer shroud (47) and inner shroud (46) fixed in a casing;
wherein plural of said diffusion holes (46c,47c) in the entire structure of said inner and outer shrouds (46,47) are formed so as to open in a direction nearly coinciding with a secondary flow direction (V2) of high

temperature gas flowing on the outer surfaces of the high temperature members, and are formed so as to open in a direction running from a high pressure side blade surface (45a) of a turbine stationary blade (45) to the low pressure side blade surface (45b) of an adjacent turbine stationary blade (45) confronting the high pressure side blade surface (45a), and so as to be offset from the primary flow direction (V1) of high temperature gas along the camber line (C) of the turbine stationary blade (45)."

VII. The appellant's arguments, as far as relevant to the present decision, can briefly be summarised as follows.

a) Main request and auxiliary request 1

The term "body", taken from the description of the third embodiment in the published application underlying the impugned patent, was disclosed only in combination with other features which could not be omitted when adding it to claim 1.

b) Auxiliary request 2

The subject-matter of claim 1 lacked novelty in view of D1. The secondary flow direction was dependent on many undefined parameters and was therefore not well-defined. The holes 52 arranged in the illustrated upper section of the shroud 20' in Figure 11 of D1 were oriented from the high pressure side shroud 20' to the lower pressure side shroud 20 and the direction of at least two of them was offset from the primary gas flow direction 40.

VIII. The respondent's arguments, as far as relevant to the present decision, can briefly be summarised as follows.

a) Main request

The amendments to claim 1 were only of clarifying nature and were anyway supported by the third embodiment disclosed in the application as filed, in particular in paragraph [0039], together with original claims 1 and 5 and the last sentence of paragraph [0058].

b) Auxiliary request 1

All features of the third embodiment were included in the claim. The additional explicit definition of the plurality of holes mentioned in paragraph [0044] of the published application was not required because multiple diffusion holes were already defined in the claim.

c) Auxiliary request 2

D1 did not disclose primary and secondary flow directions. These directions, in particular that of the secondary flow on the surfaces of the inner and outer shrouds, were well defined for the main operating point of the turbine stage employing the stationary blade bodies according to the claim. Also D1 did not disclose that the diffusion holes were intentionally oriented in regard to the secondary flow direction. This feature of the claim should basically be understood like a method feature.

Reasons for the Decision

1. Main request

The respondent's main request cannot be allowed because the amendments to claim 1 underlying the decision under appeal give rise to subject-matter not meeting the requirement of Article 123(2) EPC.

1.1 The Board cannot accept the respondent's argument that the amendment made, which consists *inter alia* in the introduction of the term "body" into granted claim 1, was only of clarifying nature without limiting its subject-matter. According to the application as filed (reference is made here and in the following to the published application), the feature "stationary blade" designates an airfoil. The expression "stationary blade body" in contrast designates a specific structural element which is composed of *inter alia* a stationary blade *per se* and inner and outer shrouds, see for example paragraph [0039] and Figure 8. The amendment thus limits the subject-matter of the claim and is not a mere clarification thereof.

1.2 In this regard, it lacks relevance whether or not an amendment is intended merely to be a clarification of the features defined in the granted claim. If such clarification was required in view of a ground of opposition, which is the reason for which such amendments are permitted (Rule 80 EPC), the corresponding amendment must still comply with the requirement of Article 123(2) EPC.

1.3 This is not the case here because the subject-matter resulting from that amendment constitutes an unallowable intermediate generalisation between the

combination of features of originally filed claims 1 and 5 and that of the originally disclosed specific third embodiment. According to the feature combination based on original claims 1 and 5, as defined in granted claim 1, the "high temperature members include the shroud of [a] stationary blade". This general definition encompasses high temperature members in which the shroud includes either the inner or the outer shroud or could even include the combination of both inner and outer shrouds (cf. column 10, lines 16-18 of the published application). It does not limit the subject-matter in regard to the presence of a connection of the inner or outer shroud to the respective blade; in stationary turbine stages both inner and outer shrouds may be connected to the blade or only one of them may be connected to it whereby a gap is formed between the blade tip and the other unconnected shroud respectively. In the description of the specific third embodiment, which was indicated *inter alia* by the respondent as constituting the basis for the introduction of the term "body" into claim 1, the blade body is disclosed as being composed of the blade and inner and outer shrouds (cf. paragraph [0039]), the two blade extremities being connected to respective inner and outer shrouds (see also Figure 8), plural diffusion holes being formed on each of the inner and outer shrouds (cf. [0038, 0042, 0045], Figures 9A, 9B). In contrast, the amended claim encompasses other embodiments covered by the combination of original claims 1 and 5 which are however not directly and unambiguously derivable from the application as filed such as for example, a high temperature member including a single shroud connected with the blade, both constituting the stationary blade body; or a single shroud separated by a gap from the tip of the blade of a stationary blade body. The

respondent was unable to indicate any passage in the application as filed for the subject-matter resulting from the intermediate generalisation and the Board could also not find such basis. The subject-matter of claim 1 thus extends beyond the content of the application as originally filed.

1.4 The Board disagrees with the respondent that the term "shroud" in claim 1 of the main request would be read by the skilled person differently in the light of the description, in particular in view of the statement referred to already above, column 10, lines 14 to 18, to implicitly designate both inner and outer shrouds, excluding thereby all other possibilities. Irrespective of the fact that there is no basis to adopt such a limited interpretation of the claim language, the entire paragraph [0058] from which this statement is quoted neither refers to a blade body nor does it contain any indication that such a particular meaning should be assigned to the term "shroud" in all circumstances.

2. Auxiliary request 1

This request is also not allowable, at least because the requirement of Article 123(2) EPC is not met.

Although the subject-matter of claim 1 has been further limited by additional features of the third embodiment, not all features which are structurally and functionally linked to those added features have been included in the claim. For example, claim 1 does not define that the inner and the outer shroud each comprise a plurality of diffusion holes, although this is specifically disclosed in Figures 9A and 9B in combination with paragraph [0044] of the application as

filed. Whereas the claim indeed defines multiple holes formed in the high temperature members (first two lines of the claim) and further down refers to "said diffusion holes in said inner and outer shrouds" (following on from the third instance of "wherein" in the claim), as also pointed out by the respondent, it encompasses nevertheless embodiments in which for example only two holes in total are formed, each shroud having only exactly one hole formed therein. Whilst the respondent could see theoretically that such an interpretation would literally fall under the claim, it contested that such an embodiment would have been considered by the skilled person. The Board cannot however accept this argument since there is no apparent reason for which the skilled person would exclude such technically meaningful embodiment. The respondent could not indicate any other basis for the omission of the aforementioned feature in the application as filed and the Board also could not find any such basis. The resulting subject-matter thus also constitutes an unallowable intermediate generalisation and consequently extends beyond the content of the application as filed.

3. Auxiliary request 2

Irrespective of whether claim 1 of this request could be regarded to be clear (Article 84 EPC 1973) in regard to the feature "composed of stationary blade (45) and outer shroud and inner shroud (46) fixed in a casing", and in particular to the terminology "fixed in a casing" as objected to by the appellant, its subject-matter lacks novelty in view of D1 (Article 54(1) and (2) EPC 1973).

3.1 Interpretation of Claim 1

3.1.1 First and secondary flow directions

Claim 1 refers to two types of flow of hot gas which can occur during the operation of a turbine with a turbine stationary blade body. The direction of a primary flow of hot gases between two circumferentially adjacent blades is defined in the claim as being substantially parallel to the blade's camberline. Since the camberline is an essentially invariable property of a blade the primary flow direction, the Board sees no problem with the primary flow direction being defined in this case in such a manner.

The secondary flow on the surface of the shrouds results however from perturbations of the (ideal) primary flow induced by *inter alia* (locally varying) leakage flows and (locally varying) pressure differentials between the high pressure side of a blade and the low pressure side of an adjacent blade (see for example the leakage flow V3 in Figure 2B; see also [0007, 0015, 0025-29] of the patent specification). Secondary flow and its direction are thus dependent on a number of parameters, like for example the operating conditions and the structure of the stationary blades (bodies) and of the axially adjacent rotor stage(s), none of which are defined in the claim. The respondent argued that the secondary flow direction was nevertheless well-defined because the stationary blades or blade bodies of a gas turbine were designed for a particular operating point so that changing flow conditions, for example in a transient regime, would not have to be considered. The Board however does not accept this argument because claim 1 does not refer to any particular operating conditions, let alone to a

specific operating point in a certain application for which the blade bodies might be designed. The reference in claim 1 to a gas turbine also does not limit the subject-matter to stationary power plants operating primarily at such design operating point. Rather, claim 1 encompasses structures applicable to all types of gas turbines including power plants as well as *inter alia* aircraft applications subject to varying operating conditions.

The feature "a secondary flow direction" in claim 1, although it may be determined experimentally or by CFD for a particular configuration of stationary blade bodies and adjacent rotors under specific operating conditions, is thus structurally indeterminate. It must therefore be understood to encompass any deviation from an ideal or unperturbed primary gas flow direction (see above and also end of [0026] of the patent).

Concerning the meaning of the expression "nearly coincides", the variation from a direction which is coincident with the secondary flow direction which is encompassed within this expression is not explicitly defined in claim 1. Only in dependent claim 5 of this request is a preferred range of up to ±20° deviation defined. It follows that the subject-matter of claim 1 covers hole opening directions allowing a divergence to an even greater extent from an already undefined secondary flow direction, as also argued by the appellant.

In regard to the structural limitation imposed by the references to the secondary flow direction in claim 1 for the orientation of the opening of the diffusion holes, any opening pointing generally in some direction from a high pressure surface side of a blade to a low

pressure surface side of an adjacent blade, which direction diverges from or intersects with (see the expression "offset" in claim 1) the direction of the primary flow between the two adjacent blades as defined by a blade's camber line, thus falls under the wording of claim 1.

3.1.2 The feature "plural of said diffusion holes in the entire structure of said inner and outer shrouds"

The respondent's interpretation of the expression "in the entire structure" in the sense of "distributed all over the surface of each of the inner and outer shrouds", so that each portion of the surface contained at least one hole, is not accepted. On the one hand there is no basis for such a particular limited interpretation in the patent. On the other hand and as also remarked by the appellant, this interpretation would lead to a contradictory teaching in respect to the orientation of the holes on shroud portions lying axially in front of the leading edge of a blade. According to other embodiments disclosed in the patent, the presence of horse shoe vortex flow in these portions would require diffusion hole orientations which were incompatible with the requirement defined by claim 1 according to which the holes should be directed from the high pressure side blade to the low pressure side blade. The cited expression therefore cannot be taken to mean "distributed all over the surface" since some portions must be excluded.

The Board concludes therefore that the cited expression has to be given a broad meaning. For example, a technically meaningful construction of the feature encompasses embodiments in which in the entire, i.e. circumferentially complete structure of the shrouds

(inner and outer) a plurality of diffusion holes is formed on each shroud segment of the shroud for each blade, even if these pluralities are formed only on a limited section of each individual shroud segment.

3.2 D1 discloses in Figures 1, 9, 10 and 11 a cooling structure for a gas turbine including multiple diffusion holes 52 formed in high temperature members including the inner and outer shrouds, represented by a plurality of individual shroud segments (20, 20') of a turbine stationary blade body. The body is composed of a stationary blade 14, in fact a plurality of blades (as also encompassed by the claim). The outer shroud and inner shroud are fixed to a casing. Each of the inner and outer shroud segments are provided with this cooling structure composed of the plurality of diffusion holes 52 (cf. e.g. column 9, lines 44/45 of D1). The plurality of segments 20 and 20' form the entire structure of the respective shroud. Since each of the segments 20, 20' is provided with the plurality of diffusion holes 52 the plurality of holes is formed "in the entire structure" of the respective shroud. The diffusion holes 52 on shroud segment 20' shown in Figure 11 are directed from the high pressure side (20') blade surface to the low pressure side (20) blade surface of two respective adjacent blades (see also column 12, lines 6-14 and Figure 3). The camberline of the blades 14 defines a primary flow direction. The holes 52 may be oriented perpendicular to the border of the segment 20', as illustrated in Figure 10, in which case they necessarily intersect the primary flow direction defined by the blade's camberline. In accordance with the interpretation of claim 1 mentioned above in regard of the holes' orientation with respect to a "secondary flow direction" (see above item 3.1.1),

the orientation of the openings of the holes 52 is therefore encompassed by the wording of claim 1.

3.3 The Board concludes that there is no difference in terms of structural features between the subject-matter of claim 1 and the cooling structure known from D1.

3.4 The respondent disputed that D1 disclosed a direction of secondary flow at all and as a consequence thereof the intentional orientation of the diffusion holes along this direction as defined in claim 1. It was undisputed that secondary flow will necessarily occur also in a gas turbine including the stationary stage disclosed in D1. As to the direction of secondary flow, the Board considers that a missing explicit disclosure thereof in D1 is not sufficient to establish novelty because the direction of the secondary flow as defined in claim 1 is itself indeterminate and dependent entirely on e.g. non-defined operating conditions, and the only structural limitation implied for the orientation of the diffusion holes' openings by claim 1 (see item 3.1.1 above) is also met by the holes 52 of D1. Whether or not the holes are "intentionally" oriented according to (indeterminate) secondary flow directions is therefore irrelevant. Even though such an intention might be followed throughout a design process on a particular installation running at specific operating conditions, this could however not be distinguished on a given blade and shroud product by itself, as also undisputed by the respondent. Further, the Board disagrees with the respondent that the features defining the orientation of the hole openings with respect to the secondary flow should be understood as being directed to a method. The relevant features are neither defined as method steps, nor is there any particular method, be it of manufacture or of

operation, defined or implied by the claims, let alone disclosed in the patent.

It is also irrelevant to which direction (primary or secondary flow) the stream of hot gas 40 in Figures 3 and 11 of D1 actually corresponds. The only well-defined direction in claim 1 is given by the camberline of the blades. The orientation of the hole openings is only limited in respect of a possible deviation from that direction and in respect of the direction of the pressure differential. The orientation of the holes 52 on segment 20' in Figure 11 of D1 is thus found to be encompassed by the respective features of claim 1.

3.4.1 The respondent further contested that D1 disclosed the feature "plural of said diffusion holes being formed in that direction in the entire structure of said inner and outer shrouds". This alleged difference results however from the respondent's limited interpretation of the expression "in the entire structure". As set out before (item 3.1.2), the expression has to be interpreted more broadly.

4. In the absence of any request which meets the requirements of the EPC, the patent has to be revoked according to the appellant's request.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The European patent is revoked.

The Registrar: The Chairman:

I. Aperribay M. Harrison

Decision electronically authenticated