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**Datasheet for the decision
of 11 June 2024**

Case Number: T 1896/22 - 3.2.06

Application Number: 12191003.8

Publication Number: 2589752

IPC: F01D5/14, F02K3/06, F01D9/04

Language of the proceedings: EN

Title of invention:
Non Axis-Symmetric Stator Vane Endwall Contour

Patent Proprietor:
RTX Corporation

Opponents:
Safran Aircraft Engines
Siemens Energy Global GmbH & Co. KG

Headword:

Relevant legal provisions:
EPC Art. 100(a), 54, 56, 123(2)

Keyword:

Grounds for opposition - novelty (no)

Amendments - allowable (no) - extension beyond the content of
the application as filed (yes)

Inventive step - auxiliary request (no)

Decisions cited:

Catchword:



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 1896/22 - 3.2.06

D E C I S I O N
of Technical Board of Appeal 3.2.06
of 11 June 2024

Appellant: RTX Corporation
(Patent Proprietor) 10 Farm Springs Road
Farmington, CT 06032 (US)

Representative: Dehns
St. Bride's House
10 Salisbury Square
London EC4Y 8JD (GB)

Respondent: Safran Aircraft Engines
(Opponent 1) 2 boulevard du Général Martial Valin
75015 Paris (FR)

Representative: Cabinet Beau de Loménie
158, rue de l'Université
75340 Paris Cedex 07 (FR)

Respondent: Siemens Energy Global GmbH & Co. KG
(Opponent 2) Otto-Hahn-Ring 6
81739 München (DE)

Decision under appeal: **Interlocutory decision of the Opposition
Division of the European Patent Office posted on
31 May 2022 concerning maintenance of the
European Patent No. 2589752 in amended form.**

Composition of the Board:

Chairman M. Harrison
Members: T. Rosenblatt
 J. Hoppe

Summary of Facts and Submissions

- I. The appellant (patent proprietor) filed an appeal against the interlocutory decision of the opposition division, in which it found that European patent No. 2 589 752 in an amended form met the requirements of the EPC.
- II. The parties were summoned to oral proceedings before the Board.
- III. In a subsequent communication pursuant to Article 15(1) of the Rules of Procedure of the Boards of Appeal (RPBA), the Board informed the parties of its preliminary opinion on the present case.
- IV. Oral proceedings before the Board were held on 11 June 2024.
- V. The appellant (patent proprietor) requested at the end of the oral proceedings that the decision under appeal be set aside and the patent be maintained as granted (main request) or as an auxiliary measure that the patent be maintained in amended form based on one of auxiliary requests 1 to 8, filed with the grounds of appeal.
- VI. The respondents (opponents 1 and 2) requested at the end of the oral proceedings that the appeal be dismissed.
- VII. Independent claim 1 of the **main request** has the following wording:

"An airfoil (42) comprising:
an airfoil portion having pressure (48) and suction (47) surfaces extending in an axial direction from a leading edge (45) to a trailing edge (46), the leading and trailing edges extending in a radial direction from a root section (49) to a tip section (50) and defining a mean span therebetween;
an inner endwall (43) extending in axial and circumferential directions adjacent the root section (49) of the airfoil portion; and
an outer endwall (44) extending in axial and circumferential directions adjacent the tip section (50) of the airfoil portion,
wherein at least one of the inner endwall or the outer endwall has a non axis-symmetric contour defined by varying radial deviations from a circumferentially uniform nominal inner (R_{ID}) or outer radius (R_{OD}), respectively;
characterised in that:
the radial deviations of the at least one of the inner endwall and the outer endwall vary by at least three percent of the mean span along the axial and circumferential directions."

Compared to claim 1 of the main request, the characterising portion of claim 1 of **auxiliary request 1** (marked as "First auxiliary request") reads

"the radial deviations of the at least one of the inner endwall and the outer endwall vary by more than five percent of the mean span along the axial and circumferential directions."

Compared to claim 1 of the main request, the following feature has been added to the characterising portion of claim 1 of **auxiliary request 2**

"and in some locations the radial deviation is more than five percent of the mean span."

Compared to claim 1 of the main request, the last feature before the characterising portion and the characterising portion itself of claim 1 of **auxiliary request 3** have been amended to read as follows

"wherein the inner endwall and the outer endwall each have a non axis-symmetric contour defined by varying radial deviations from a circumferentially uniform nominal inner (R_{ID}) or outer radius (R_{OD}), respectively;
characterised in that:
the radial deviations of the the [sic] inner endwall and the outer endwall vary by at least three percent of the mean span along the axial and circumferential directions and in some locations the radial deviation is more than five percent of the mean span."

Compared to claim 1 of the main request, the designation of the subject-matter of claim 1 of **auxiliary request 4** has been changed to "[a] vane airfoil" and its characterising portion has been amended to read as follows

"the radial deviations of the at least one of the inner endwall and the outer endwall include two or more individual features of contour which vary from the respective circumferentially uniform nominal radius by more than five percent of the mean span along the axial and circumferential directions."

Also claim 1 of **auxiliary request 5** is directed to a "vane airfoil" and, compared to claim 1 of the main request, its characterising portion has been amended to read as follows

"the radial deviations of the outer endwall include two or more individual features of contour which vary from the circumferentially uniform nominal outer radius by more than five percent of the mean span along the axial and circumferential directions."

Claim 1 of **auxiliary request 6** is again directed to a "vane airfoil" and, compared to claim 1 of the main request, the last feature before the characterising portion and the characterising portion itself have been amended to read as follows

"wherein the inner endwall and the outer endwall each have a non axis-symmetric contour defined by varying radial deviations from a circumferentially uniform nominal inner (R_{ID}) or outer radius (R_{OD}), respectively;
characterised in that:
the radial deviations of the inner endwall and the outer endwall vary by at least three percent of the mean span along the axial and circumferential directions; and
the radial deviations of the outer endwall include two or more individual features of contour which vary from the circumferentially uniform nominal outer radius by more than five percent of the mean span along the axial and circumferential directions."

Claim 1 of **auxiliary request 7** is again directed to a "vane airfoil" and, compared to claim 1 of the main request, the last feature before the characterising portion and the characterising portion itself have been amended to read as follows

"wherein each of the inner endwall and the outer endwall has a non axis-symmetric contour defined by varying radial deviations from a circumferentially uniform nominal inner (R_{ID}) or outer radius (R_{OD}), respectively;
characterised in that:
the radial deviations of both the inner endwall and the outer endwall include two or more individual features of contour which vary from the respective circumferentially uniform nominal radius by more than five percent of the mean span along the axial and circumferential directions."

Compared to claim 1 of the main request, the following feature has been added to the characterising portion of claim 1 of **auxiliary request 8**

"wherein the inner endwall (43) contour defines a maximum radial deviation of at least five percent of the mean span, the radial deviation located axially between 25% and 50% of an axial chord (L) extending from the leading edge (45), and circumferentially between 25% and 75% of a circumferential passage width (W) defined from a mean camber line (C) of the airfoil and increasing from the suction surface (47) along the inner endwall contour."

VIII. The following document from the impugned decision is referred to in the present decision:

D3 : S. Reising et al., "Non-Axisymmetric End Wall Profiling In Transonic Compressors. Part I: Improving The Static Pressure Recovery At Off-Design Conditions By Sequential Hub And Shroud End Wall Profiling", GT2009-59133, Proceedings of ASME Turbo Expo, 2009

IX. The arguments of the appellant, as far as relevant to the present decision, may be summarised as follows.

Main request

D3 was a numerical study of endwall profiling for a hub and a shroud end wall using a neural network and computational fluid dynamics (See abstract: "a numerical study", "a design exercise", "at off-design conditions"). It did not propose a specific design for a real airfoil. In the conclusion section, the paper described itself as presenting a method to demonstrate possibilities (i.e. rather than proposing a specific design). It was stated that the potential for the application of non-axisymmetric end walls with 3-D airfoils remained to be shown. A numerical simulation which looked at varying parameters in off-design conditions in an isolated section of blading, which was not a realistic operating environment, did not amount to an enabling disclosure of the designs that were modelled, and would not be seen by the skilled person as a concrete and technically realistic proposal for an actual airfoil.

Auxiliary requests 1 to 7

The subject-matter of claim 1 of auxiliary requests 1 to 3 was based on the description of the application as filed, notably on paragraphs 30, 49, 51 and 52, as well as Tables 1 and 2. The skilled person derived from these passages of the application as filed, when seen in combination, that the lower limit of more than five percent of mean span for the variation of the radial deviation in the inner and outer endwall constituted a feature in itself, which was not linked to the locations referred to in Tables 1 or 2 or in paragraphs 51 and 52.

Similarly, the amendments to claim 1 in auxiliary requests 4 to 7 were based on at least paragraphs 30 and 46 to 52 in combination with Figures 4A and 4B. Whereas the disclosure in paragraph 49 related to an entire endwall contour as defined by the values in Tables 1 and 2, paragraphs 51 and 52 explicitly related only to individual features. The items marked by a minus ("-") sign in Figures 4A and 4B represented such individual features. The skilled person understood from the combination of the cited passages and figures that the lower limit of more than five percent for the radial deviation of these individual features, as mentioned in paragraphs 51 and 52, was an independent feature which was not related to any specific locations.

Consequently, the subject-matter of claim 1 of auxiliary requests 1 to 7 did not extend beyond the content of the application as filed.

Auxiliary request 8

D3 failed to disclose a maximum radial deviation as defined by the features added to claim 1 which were based on original claim 7 of the application as filed. The maximum deviation suggested with respect to the hub of D3 was 4.3% and its position was not clearly in the range between 25% and 75% of a circumferential passage width as required by amended claim 1. Given the precise contour shown in Figure 21(a) of D3 there would have been no motivation for the skilled person to increase the size of the variation and move it to a different position. The difference between 4.3 % according to D3 and the maximum radial deviation of more than five percent constituted in fact a huge difference of some 10%. Even slight variations in the parameters or geometry of airfoils could have a huge effect on the efficiency of an engine. The skilled person would therefore not have had any motivation to further change the precise contour of the airfoil obtained as a result of the numerical modelling in D3. The tolerances mentioned in claim 2 related just to the manufacture of the airfoils and were of no relevance for the maximum radial deviation as defined in claim 1. Consequently, the subject-matter of claim 1 was not obvious to the skilled person.

- X. The arguments of the respondents, as far as relevant to the present decision, may be summarised as follows.

Main request

The opposition division was right to state that there were no further restrictions in Article 54(1) EPC to be imposed on a document when considering whether the content made available by it before the priority date

of the patent in suit could effectively be used (or excluded) as a disclosure of the state of the art in the sense of Article 54 EPC. The information contained in D3 was sufficient to enable the skilled person to put its technical teaching into practice. D3, page 2 made explicit reference to specific existing products (e.g. the *Rolls-Royce Trent 500 engine*), or to a specific test rig (*Darmstadt Transonic Compressor*). The study was based on real conditions as reported notably on page 2, in the passage bridging the left and right columns. Further, an intended industrial application of the results of the study was also indicated in the left column on page 14, by the reference to the cooperation with *Rolls-Royce Deutschland*. The airfoil disclosed in D3 indeed comprised all features of claim 1, see in particular Figures 21(a) and 24(a), disclosing radial deviations of 4.3 percent and of 5.7 percent of span, respectively, for the respective inner and outer endwalls.

Auxiliary requests 1 to 7

The subject-matter of claim 1 of auxiliary request 1 was allegedly based on the final sentence of paragraph 49. However, this paragraph made reference to Tables 1 and 2 which disclosed variations of the radial deviations linked to specific locations. There was no basis to amend the lower limit for the radial deviations without specifying these locations in the claim. Thus, the requirement of Article 123(2) was not met. This deficiency was present for corresponding reasons also in all other auxiliary requests 2 to 7.

Auxiliary request 8

Claim 1 of this auxiliary request did not involve an

inventive step when starting from the airfoil profile of D3 as the closest prior art. Figure 21(a) disclosed a maximum radial deviation of 4.3 percent span at a position corresponding to the range of 25% to 75% according to the claim. The single difference between the subject-matter of claim 1 and the airfoil of D3 was thus the value of the maximum radial deviation of at least 5% as indicated in claim 1. The patent did not disclose any effect related to this specific value of the maximum radial deviation or in relation to the specific location of such radial deviation on an endwall. The slight difference between the claimed value and the value known from D3 could not be considered to involve inventive activity for the skilled person looking for alternative geometries to the airfoil of D3 so as to further try to improve the effects achieved by the known configuration. The known value for the radial deviation on the inner endwall according to D3 was moreover very close to the claimed value, within the same order of magnitude and far less than, for example, twice the value which in turn could indeed be considered as artificial. Moreover, the maximum radial deviation disclosed in D3 for the outer endwall was 5.7%, hence more than five percent of span, so that in view of this disclosure the skilled person could be expected to consider similar higher variations of the radial deviation also for the inner endwall without requiring an inventive step.

Reasons for the Decision

Main request

1. The appellant's main request is not allowable. The arguments submitted by the appellant by which it contested the conclusion in the impugned decision that the subject-matter of claim 1 of the patent as granted was not new in view of D3 are found unconvincing by the Board for the following reasons.
2. The appellant did not contest the disclosure of any specific feature of claim 1 in D3.

The appellant rather argued, in essence, that the content of D3 would not amount to an enabling disclosure for an airfoil but was confined to a numerical study. The results of the numerical study presented therein would result only in a numerical model of an airfoil and not in a specific or real airfoil for a real engine operating under realistic conditions.

As already stated in its communication pursuant to Article 15(1) RPBA, the Board is not convinced by this argument, even when taking into account the appellant's subsequent submissions made during the oral proceedings before the Board.

- 2.1 Articles 54(1) and (2) EPC define the conditions by which it is decided whether claimed subject-matter is novel or not against some element of the state of the art. Except for the further specific circumstances set out in Articles 54(3) to (5) and 55 EPC, which are of no relevance to the present case, there are no other

limiting conditions to be applied during the examination of novelty. Under Article 54(2) EPC, the state of the art comprises everything made available to the public by means of a written or oral description, by use, or in any other way, before the filing or priority date of the European patent application.

In the context of its considerations on the information to be derived from a public use of products in opinion G 1/92 (OJ EPO 1993, 277), which was considered to be governed in principle by the same conditions as is information disclosed by oral or written description, the Enlarged Board of Appeal held that an essential purpose of any technical teaching is to enable the person skilled in the art to manufacture or use a given product by applying such teaching (Reasons 1.2 to 1.4).

The Board is not aware of any further restrictions to the state of the art that would generally limit the state of the art to only "real" objects or to (patent) documents disclosing "real" objects conceived for real and specific applications, of necessarily commercial or industrial interest, under realistic operating conditions.

The Board therefore does not see any reason to deviate from the general principles developed in G 1/92 (see above) in the present case.

It is therefore required to examine whether D3 discloses information which enables the skilled person to manufacture or put into practice the airfoil resulting from the numerical modelling reported therein.

- 2.2 Claim 1 is directed to an unspecific airfoil. The features defined in claim 1 imply neither any particular use of the claimed airfoil nor any particular effect to be achieved in a gas turbine engine. The claimed airfoil could be used in whatever section, i.e. low or high pressure stages of a compressor or in a turbine section, of a gas turbine (for aircraft, or even for stationary applications or in a steam turbine). The claimed subject-matter is thus no more specific than the rather specific airfoil resulting from the numerical modelling of D3. The Board therefore does not share the limited interpretation of the claimed subject-matter by the appellant as relating to an airfoil for some specific gas turbine engine. Without a specification of a material or an otherwise limiting aspect in this sense (e.g. temperature, operating conditions, engine type), an airfoil made even from wood (for example, as a demonstration model of such an airfoil) or made from plastics, as discussed during the oral proceedings, would anticipate the claimed subject-matter if all structural features defined in claim 1 were realised in it.
- 2.3 The numerical modelling according to D3 is performed under the assumption of real engine conditions (see page 2, in the sentence bridging the left and right columns, and Tables 1 and 2 on that page), as was pointed out also by the respondents. Tables 1 and 2 on page 2 of D3 indeed set out specific operating conditions and specific airfoil design parameters underlying the numerical modelling (see also at the bottom of the right hand column on page 2 of D3). The Board has no doubts that the final (optimised) airfoil obtained from the modelling - which undisputedly has all the features specified in claim 1 (for the feature in its characterising portion see in particular Figure

21(a) together with page 11, left hand column, the second sentence under the heading "*Analysis of Optimization A - Hub Design*" and Figure 24A together with page 12, the first full sentence in the right column) - is also a sufficient disclosure for it to be put into practice (e.g. manufactured) by the skilled person. Moreover, the airfoil design obtained as the outcome of the modelling based on the parameters fixed in Tables 1 and 2 of page 2 is directed to a particular application ("*Darmstadt Transonic Compressor*", see for example, page 2, at the bottom of the right hand column). Despite D3 being conceived as a design exercise (see the abstract), there is no reason why D3 would not enable the skilled person to put the resulting airfoil design into practice to test its performance in at least the application forming the boundary conditions for the modelling. It is furthermore also suggested for some other application to other machines in the final paragraph of the section "*Conclusions*", on page 14 of D3 ("*There is currently no data for comparison available but Rolls-Royce Deutschland is working on this issue*").

- 2.4 The Board also concludes that the information disclosed in D3 is no different to that of a patent document. Patent documents, including those in the present area of technology, commonly disclose the underlying invention in rather broad terms or sometimes even rather conceptually, without too much detail of a specific operating environment (in contrast to D3). If a patent document is intended to be used in a novelty objection against some claim of another patent (or application), its disclosure is normally understood in the sense that it could be put into practice by the skilled person (cf. point 2.1 above), particularly where structural elements are concerned as is the case

here. This may however require several design choices before a "real" object embodying the claimed subject-matter is available. The process leading to the "real" object involves, for example, the selection of specific materials, dimensions, geometries and frequently further tests and adaptations, all necessarily to be performed within the borders set by skilled person's common general knowledge. Also, the airfoil of claim 1 of the patent in suit would need to be manufactured in an appropriate material with appropriate dimensions and (airfoil) geometry if a specific use or required suitability is defined (e.g. for use in a particular part of a gas turbine). However no such use or suitability is defined in the claim nor disclosed in the patent (except for some potential uses in paragraph 14 and some dimensional indications in paragraph 32 of the specification). Similar considerations, although to an even more limited extent, have to be performed by the skilled person in view of D3. There is consequently no reason to treat the disclosure of D3 differently to that of a patent document, simply based on the fact that it relates to numerical modelling and that its end result is a (numerical) airfoil design.

- 2.5 It is also not apparent why the conditions literally disclosed on page 2 of D3 as being "real engine conditions", as further detailed in Tables 1 and 2, would be unrealistic or would lead to an unrealistic airfoil design as a result of the numerical study, as alleged by the appellant during the oral proceedings before the Board. The lack of an indication of a temperature in these tables or of a specific (commercial) engine for which the listed parameters could apply, as argued by the appellant during the oral proceedings, is by itself not sufficient to question the validity of the explicit indication that these

parameters represent a realistic assumption for an airfoil investigated by the numerical modellisation in D3. No evidence has been submitted which would allow a contrary conclusion. Also the fact that numerical modelling in D3 is performed at a wider range of conditions, including even optimisations at off-design conditions, does not contradict the above findings.

The fact that the authors of D3 discuss advantages and disadvantages of other studies performed for example on linear cascades as reported in the left hand column on page 2, as well as suggested modifications in view of the reported studies, also does not contradict that the numerical modelling carried out by them is indeed based on real engine conditions as set out on page 2.

3. As a consequence, the ground of opposition under Articles 100(a) and 54 EPC prejudices maintenance of the patent as granted such that the appellant's main request cannot be allowed.

Auxiliary requests 1 to 7

4. The subject-matter of claim 1 of auxiliary requests 1 to 3 extends beyond the content of the application as filed and therefore contravenes Article 123(2) EPC.

In the following, for the purpose of comparing the subject-matter of any amended claim with the content of the application as filed, reference is made to the A2-publication of the application as filed.

- 4.1 In the characterising portion of claim 1 of auxiliary request 1, the lower limit of the open range for the variation of the radial deviation of the inner and outer endwalls has been increased from "at least three

percent" to "more than five percent".

4.2 This amended lower limit for the radial deviation is disclosed in the application as filed only in the context of specific locations of radial deviations on the inner and outer endwalls. Notably the last sentence in paragraph 49 of the application as filed, to which the appellant *inter alia* referred as a basis for the amendment, is to be read in the context of the preceding lines which are directed specifically to the complete profile of variation of the inner and outer endwalls disclosed by Tables 1 and 2 of the application as filed. Similarly, the mention of the same lower limit in paragraphs 51 and 52 is also only disclosed for specific locations of such variation of the radial deviations at the inner and outer endwalls, respectively. Amended claim 1 of auxiliary request 1 does not define corresponding locations. There is no other basis in the application as filed from which the above identified amendment could be derived directly and unambiguously, in isolation from the specific locations mentioned in paragraphs 49, 51, 52 and Tables 1 and 2.

4.3 According to the appellant, the skilled person would have understood on the basis of paragraphs 30, 49, 51, 52 in combination that the amended lower limit ("more than five percent") represented a feature in itself. The Board does not share this view. The passages referred to by the appellant do not support its contention. Paragraph 30 of the application as filed addresses the variation of the radial deviation on the inner and outer endwalls only in general and is silent in respect of the amount of variation which could be intended. The broad reference in the final sentence of this paragraph to the following description ("as

described below") in regard to the contouring of the inner and outer endwalls, does not contain any direct and unambiguous pointer for the skilled person to the increased limit of the radial deviation's variation being independent of any location on the endwall. There is thus no link between the paragraphs cited by the appellant which would allow the amended lower limit to be derived directly and unambiguously in the claimed generality.

4.4 The further amendments to claim 1 in auxiliary requests 2 and 3, in addition to the crucial amendment of claim 1 of the first auxiliary request, cannot change this conclusion, as also acknowledged by the appellant during the oral proceedings before the Board.

4.5 The Board concludes that the request to maintain the patent in amended form according to any one of auxiliary requests 1 to 3 cannot be allowed.

5. For similar reasons also the subject-matter of claim 1 of auxiliary requests 4 to 7 extends beyond the content of the application as filed and thus contravenes Article 123(2) EPC.

5.1 The characterising portion of claim 1 of auxiliary request 4 has been amended to define that the radial deviations "*include two or more individual features of contour which vary from the respective circumferentially uniform nominal radius by more than five percent*". The wording is essentially based on paragraphs 51 and 52 of the application as filed. This amendment fails to comply with the requirements of Article 123(2) EPC for essentially the same reasons as indicated above: the added feature is disclosed in these passages only in relation to specific locations

of such "*individual features of contour*" indicated in these paragraphs. The Board could also not find any other basis in the application as filed allowing the generalisation of the features taken in isolation from the disclosure of paragraphs 51 and 52.

- 5.2 The further parts of the application referred to by the appellant to support its argument that the amendment met the requirement of Article 123(2) EPC, i.e. again paragraph 30 and paragraphs 46 to 50 together with Figures 4A and 4B, do not lead the Board to a different conclusion. The general statement in paragraph 30 has been considered above and its assessment in the context of the present amendment cannot be different. Paragraphs 46 to 50 are directed to the specific endwall profiles as defined by the values in Tables 1 and 2. These paragraphs do not comprise any disclosure of a lower limit for the radial deviation separate from the specific locations shown in the tables. Also Figures 4A and 4B of the application as filed do not change the Board's conclusion since they do not indicate any specific lower limit (value) at all. Also, the "*individual features of contour*" (marked by a "-", according to the appellant) are shown at particular locations corresponding essentially to those mentioned in paragraphs 51 and 52, respectively.
- 5.3 The further amendments to claim 1 in auxiliary requests 5 to 7, in addition to the crucial amendment of claim 1 of auxiliary request 4, do not change this conclusion. The appellant also did not argue that this could be the case.
- 5.4 The Board therefore concludes that the request to maintain the patent in amended form according to any

one of auxiliary requests 4 to 7 cannot be allowed.

Auxiliary request 8

6. The subject-matter of claim 8 does not meet the requirement of Article 56 EPC.
- 6.1 It is common ground that D3 can be considered to represent the closest prior art to the subject-matter of claim 1 of auxiliary request 8.
- 6.2 In the Board's communication pursuant to Article 15(1) RPBA, the following preliminary opinion was given:

"4.1.1 It is uncontested that the features added from granted dependent claim 7 to (granted) independent claim 1 are not known in their entirety from D3, notably from its Figure 21A and the corresponding description in the left column of page 11, under the heading "Analysis of Optimization A - Hub Design". Whereas respondent 1 considers the only difference between the subject-matter of amended claim 1 and the hub design illustrated by Figure 21A to be the higher lower limit for the maximum radial deviation of at least five percent of the mean span (compared to 4.3% in Figure 21A of D3), the appellant further contests also the disclosure of the location of the corresponding depression to lie in the range of 25% to 75% of the circumferential passage width. Due to a lack of scale in the Figure 21A of D3, it appears not directly and unambiguously recognisable that the depression marked by the deep blue area (or at least part of it) lies inside the claimed range. It could lie just outside, e.g. slightly above 75% of circumferential width, but this may be discussed during the oral proceedings. In the following the Board will

assume initially, in favour of the appellant, that these two technical differences indeed exist.

4.1.2 The technical effect achieved by these differences and the corresponding objective technical problem(s) may require consideration in order to assess whether the subject-matter of claim 1 involves an inventive step or not.

4.1.3 The appellant did not refer to any particular effect achieved by the identified distinguishing features. The appellant rather argues that the skilled person would have had no motivation to modify the precise contour of Figure 21A of D3. The Board is not convinced by this argument since it is not apparent that a slight variation in these two parameters (relative deviation and location interval) provides for any technical effect over the whole breadth of the claim.

4.1.4 The respondent argues that the patent does not mention any particular technical effect related to the specific values of the radial deviation. This appears to be correct. The Board of its own motion could at least not find any particular technical effects disclosed in relation to the claimed lower limit of at least 5% (compared to 4.3% in D3) for the maximum radial deviation and/or in relation to the slightly different location thereof within the circumferential range defined by claim 1. The general effects attributed to endwall profiling discussed in paragraphs 16, 23 to 26, 34 to 35, referred to by respondent 1, appear indeed to be known from D3, and are not specifically related to the precise values and ranges defined by claim 1. The distinguishing features therefore seemingly only constitute an alternative

design of the airfoil endwalls. An objective technical problem might thus be to provide an alternative airfoil design.

4.1.5 Absent any technical effect due to the slight modifications of the relative radial deviation and of its location, these differences do not appear to be based on inventive activity but would appear to rather fall within the range the skilled person would consider to test as part of their common practice (see also the arguments of respondent 1 in its reply to the grounds of appeal)."

- 6.3 During the oral proceedings before the Board the question of the technical effect achieved by the assumed two distinguishing features was further discussed (cf. points 4.1.1 and 4.1.2 of the above recited preliminary opinion). However, the Board cannot find any indication in the patent that the contouring of the inner endwall at the specific location and with the claimed minimal size defined by the additional features in the characterising portion of claim necessarily results in an improvement of whatever effect of an airfoil, or of the efficiency of a gas turbine employing such airfoil, over the whole scope of the claim, i.e. irrespective of the particular geometry of the remaining parts of the airfoil, of its specific location in whatever stage or section of a gas turbine engine and irrespective of any operating conditions. The Board therefore sees no reason to deviate from the objective technical problem considered in point 4.1.4 of its preliminary opinion (see above) and consequently confirms that the objective technical problem might be seen as to provide an alternative airfoil design.

- 6.4 Having considered the arguments submitted by the appellant during the oral proceedings, the Board also has no reason to deviate from, and therefore confirms its preliminary opinion set out in point 4.1.5 of the Board's communication pursuant to Article 15(1) RPBA (see above).
- 6.4.1 The Board is not convinced by the appellant's argument that the precise airfoil design resulting from the specific numerical modelling would not be changed by the skilled person for the reason that slight modifications of a parameter in an engine could have large effects on the efficiency of such engine. The Board appreciates that modifications on a given endwall design may indeed affect the efficiency of an engine operating with such modified airfoil design. However, in view of the breadth of the claim, which leaves it completely open under which conditions (e.g. type of turbomachinery, stage, section, operating parameters) the airfoil shall be used, and which precise dimensions and geometry (e.g. its blading) it would finally have, the claimed lower limit of five percent radial deviation, together with a possibly slightly differing location on the inner endwall can only be seen to constitute an arbitrary selection, not based on inventive activity.
- 6.4.2 The appellant contested that the difference between the radial deviation disclosed in D3 (4.3 percent of span) and the minimum defined in claim 1 (more than five percent of mean span) could be seen as a slight difference; it was considered rather as a huge change. However, the Board is not convinced by this argument since the patent itself discloses tolerances for the radial deviations to lie within two percent of mean span (see for example claim 2 of the patent or of

auxiliary request 8). Irrespective of whether or not such tolerances would be understood to constitute manufacturing tolerances (for which the plain wording of the claim at least does not comprise any indication), applying these tolerances to the lower limit for the maximum radial deviation as defined by claim 1 (or to the values mentioned in claim 2) would signify that the lower limit could indeed present a span between three to seven percent. Such seemingly acceptable variations according to the patent are much larger than the comparatively small difference between the radial deviation in the closest prior art airfoil of D3 (4.3 percent of span) and the claimed airfoil (five percent of mean span). Moreover, and as pointed out by the respondents, radial variations exceeding five percent of span are known from D3 itself, at least for the outer (shroud) endwall. In the light of D3, the claimed maximum radial deviation of at least five percent of mean span does therefore not constitute as an excessively high value, which the skilled person would never have considered as a possible alternative design option. At least for these reasons, the appellant's argument is unconvincing. The Board sees no reason that the skilled person would have excluded such comparatively small variations (from 4.3 to at least 5 percent) when faced with the problem of finding an alternative airfoil design, taking into account the content of D3 and the skilled person's common general knowledge.

- 6.5 Since claim 1 of auxiliary request 8 does not involve an inventive step (Article 56 EPC), the request for maintenance of the patent in this amended form cannot be allowed either.

7. Since neither the appellant's main request for maintenance of the patent as granted nor any of auxiliary requests 1 to 8 submitted with the statement of grounds of appeal could be allowed, the appeal has to be dismissed.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:



D. Grundner

M. Harrison

Decision electronically authenticated