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Datasheet for the decision of 11 May 2023

Case Number: T 2324/18 - 3.2.06

Application Number: 07116280.4

Publication Number: 1923537

IPC: F01D5/18

Language of the proceedings: EN

Title of invention:
Double feeding for the serpentine of a cooled blade

Patent Proprietor:
GENERAL ELECTRIC COMPANY

Opponent:
Siemens Aktiengesellschaft

Headword:

Relevant legal provisions:
EPC Art. 56
RPBA Art. 12(2), 12(4)
RPBA 2020 Art. 13(2)

Keyword:
Inventive step - obvious combination of known features
Reply to statement of grounds of appeal - auxiliary requests - party's complete case - specification of all facts, arguments and evidence relied on (no)
Late-filed auxiliary request - exceptional circumstances (no)

Decisions cited:
T 0967/97, T 0021/08, T 0894/19, T 1968/08, T 2486/16

Catchword:

Europäisches Patentamt
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Beschwerdekammern

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Case Number: T 2324/18 - 3.2.06

D E C I S I O N
of Technical Board of Appeal 3.2.06
of 11 May 2023

Appellant: (Opponent)	Siemens Aktiengesellschaft Werner-von-Siemens-Straße 1 80333 München (DE)
Representative:	PATERIS Patentanwälte PartmbB Postfach 33 07 11 80067 München (DE)
Respondent: (Patent Proprietor)	GENERAL ELECTRIC COMPANY 1 River Road Schenectady, NY 12345 (US)
Representative:	Hoffmann Eitle Patent- und Rechtsanwälte PartmbB Arabellastraße 30 81925 München (DE)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted on 6 July 2018 rejecting the opposition filed against European patent No. 1923537 pursuant to Article 101(2) EPC.**

Composition of the Board:

Chairman	M. Hannam
Members:	T. Rosenblatt
	W. Ungler

Summary of Facts and Submissions

I. The appellant (opponent) filed an appeal against the decision of the opposition division rejecting the opposition against European patent 1 923 537.

II. Independent claim 1 of the patent has the following wording (feature numbering in square brackets according to the impugned decision):

"1. [M1] A turbine blade (10) comprising
[M1.1] a plurality of radially extending flow channels configured in independent forward and aft serpentine cooling circuits (2-4), (5-7)
[M1.1.1] terminating in corresponding forward and aft impingement channels (1,8);
[M1.2] a hollow airfoil (14) having [1.2.1] partitions (40) joining opposite pressure and suction sides (22,24) and spaced chordally between opposite leading and trailing edges (26,28) to define said serpentine circuits (2-4), (5-7) and said impingement channels (1,8), said first passes (4,5) of said forward and aft serpentine circuits located at a midchord location of said airfoil (14), said forward serpentine circuit terminating in its last pass (2) in said forward impingement channel (1), wherein said forward impingement channel is located behind said leading edge, and said aft serpentine circuit terminating in its last pass (7) in said aft impingement channel (8), wherein said aft impingement channel is located in front of said trailing edge;
[M1.3] a dovetail (18) integrally joined to said airfoil (14) at a platform (16), and including [M1.3.1] first, second, third and fourth inlet channels (44,46,48,50) separately joined to said serpentine

circuits to feed said serpentine circuits with an inlet flow of cooling air (34) for said turbine blade, said first inlet channel (44) joined to said forward serpentine circuit at said last pass (2) thereof, said second inlet channel (46) joined to said forward serpentine circuit at said first pass (4) thereof, said third inlet channel (48) joined to said aft serpentine circuit at said first pass (5) thereof, and said fourth inlet channel (50) joined to said aft serpentine circuit at said last pass thereof (7); and

[M1.4] a metering plate (52) joined to said dovetail (18) to cover said first, second, third and fourth inlet channels (44,46,48,50);

[M1.4.1] said metering plate (52) includes first, second, third, and fourth aperture inlets (54,56,58,60) sized in flow area to correspondingly meter said cooling flow (34) therethrough and into said corresponding first, second, third and fourth inlet channels (44,46,48,50) such that a total flowrate of said cooling flow (34) to said blade (10) is preferentially metered through said aperture inlets to, in use, increase the operating temperature of said airfoil (14) over said mid chord region thereof while decreasing the temperature of said airfoil (14) along said leading and trailing edges (26,28) as combustion gases flow over said airfoil;

wherein:

[M1.5] an airfoil tip (32) of said hollow airfoil (34) comprises a tip floor (42) recessed therein to directly cover said forward and aft serpentine circuits (2-7);

[M1.6] said first, second, third and fourth inlet channels (44,46,48,50) have larger flow areas than said serpentine circuits; and

[M1.7] said first, second, third and fourth metered inlets (54,56,58,60) have smaller flow areas than said

first, second, third and fourth inlet channels (44,46,48,50)."

The wording of independent method claim 8 is not relevant to the present decision and is thus not included here.

III. The following documents are relevant to the present decision:

D1: EP 1 361 337 A1
D2: JP 58 170 801 A
D4: EP 1 621 731 A1
D5: DE 10 2004 037 444 A1
D6: US 2005/0281674 A1

IV. With the reply to the statement of grounds of appeal the respondent (patent proprietor) submitted auxiliary requests 1 to 7.

V. In a communication pursuant to Rule 100(2) EPC, the Board invited the appellant to submit comments. The respondent submitted its reply within the time limit set by the Board.

VI. The parties were summoned to oral proceedings before the Board.

VII. In a communication pursuant to Article 15(1) of the Rules of Procedure (RPBA 2020), the Board informed the parties of its preliminary opinion on the case. The Board opined *inter alia* that starting from the turbine blade disclosed in Figures 1 to 3 of D1 as the closest prior art, the subject-matter of granted claim 1 lacked an inventive step. The Board furthermore noted that the respondent had not substantiated the amendments to

claim 1 of any of the auxiliary requests 1 to 7 in regard to all outstanding objections, including notably those pursuant to Article 56 EPC. The Board thus indicated its intention not to take auxiliary requests 1 to 7 into account (Articles 12(2) and (4) RPBA 2007).

VIII. The respondent replied to the Board's preliminary opinion with its letter dated 4 May 2023.

IX. The oral proceedings were held on 11 May 2023.

X. The appellant (opponent) requested that the decision under appeal be set aside and the patent be revoked.

XI. The respondent (patent proprietor) requested that the appeal be dismissed (main request), or in the alternative that the patent be maintained in amended form according to one of auxiliary requests 1 to 7 filed with the reply to the statement of grounds of appeal.

XII. The arguments of the appellant may be summarised as follows.

Claim 1 lacked an inventive step starting from D1 as the closest prior art. The three distinguishing features did not contribute to a synergistic technical effect. It was thus correct to assess inventive step based on three partial problems.

The opposition division was right to consider the provision of an aft impingement cooling channel at the turbine blade's trailing edge as a well known alternative to the cooling structure employed in D1. The use of impingement cooling was also not related to the effects disclosed in paragraphs 69 and 76 of the

patent.

The opposition division's reasoning in regard to the provision of a single metering plate with four aperture inlets according to distinguishing feature M1.4.1 was wrong, since such metering plates were commonly used in the art to control the distribution of cooling air to the cooling circuits, for example in order to accommodate manufacturing tolerances in a blade's inlet channels, see for example, D2, D4, D5, in particular paragraphs 8 and 23 of D5. The application of measures belonging to the common general knowledge of the skilled person did not require a further hint or motivation. The considerations by the opposition division and the respondent in regard to some specific configuration of a cooling air source and with respect to a separate and independent operation of the two serpentine cooling circuits in D1, which would allegedly prejudice the use of a single metering plate in that blade, were not persuasive since the claim was directed to a turbine blade only and the interpretation of paragraph 22 of D1 by the opposition division and the respondent was incorrect. The implementation of a single metering plate in D1 was thus obvious to the skilled person.

Concerning the relative flow areas according to feature M1.6, the patent did not specify any particular effect for this choice. The effects mentioned in paragraphs 72 and 79 were based on features which were not defined by the claim. It was commonly known that larger inlet channels also reduced the weight of the turbine, see also D1, paragraph 12. That their flow areas were chosen larger than those of the serpentine cooling circuits at some undefined location thereof constituted an arbitrary selection. Moreover the relation as

defined by feature M1.6 of claim 1 was also disclosed in D5, Fig. 1. Consequently also feature M1.6 did not rely on inventive activity.

Auxiliary request 1 to 7

The auxiliary requests 1 to 7 should not be admitted for lack of substantiation, see also T 2682/16 or T 946/17. Even after the Board's preliminary opinion no substantiation had been filed.

There were also no exceptional circumstances to admit the re-filed auxiliary request 4.

XIII. The arguments of the respondent may be summarised as follows.

Main request

The invention defined by claim 1 should not be judged from D1. Rather it should be considered from where the proprietor started. The patent disclosed as an overall objective achieving a homogeneous temperature distribution over the airfoil so as to reduce thermal stress arising from inhomogeneous temperature profiles. The design of the cooling structure of a turbine blade involved a delicate balance of a number of choices to be made in regard to the structural elements constituting the cooling circuits, including for example the choice of forward and aft impingement channels. The technical features of the claim as a whole have to be assessed to identify the technical effects provided by the invention, and not only the novel features in isolation.

The three distinguishing features contributed together to a synergistic technical effect. Based on paragraphs 69 and 76 of the patent, the problems solved by the combination of features according to claim 1 were to reduce the differential temperatures experienced by the airfoil during operation, and correspondingly reduce thermal stress therein; and to offset the loss of cooling flow from a tip leak. The specific problems were not addressed in D1. The technical problem to be solved was therefore to increase the operational lifespan of the turbine blade. The refresher passageways foreseen in D1 did not provide for the effects sought by the patent, because their flow area was too small compared, for example, to the configuration of Figure 5 or 6 of the patent. Their outlets were directed only into the final passes of the respective serpentine cooling circuits. This configuration would not allow cooling air to be fed to the middle pass so as to complement cooling air leaking from the tip in case of tip cracking, such as shown in Figure 6 of the patent. All features required to achieve these effects, as further disclosed also in paragraphs 72 and 79, were defined in claim 1.

Even if, contrary to the respondent's position, the distinguishing features were to be considered separately in partial problem-solution approaches, the claimed subject-matter could still not be considered obvious to the skilled person. In this respect the burden of proof was on the appellant to show that it would be obvious to arrive at the invention. This burden had not been discharged in respect of any of the novel features of claim 1; it was long established that it is inadequate to identify what the skilled person could have done, rather it was necessary to prove what they would have done (emphasis by the respondent). No

motivation at all had been provided to modify D1, except through hindsight.

Concerning the provision of an aft impingement channel at the trailing edge, irrespective of the fact that impingement cooling channels may be known, there was no indication that such a channel would solve the objective technical problem at hand when applied to the turbine airfoil of D1. The presence of an impingement cooling channel affected the temperature distribution across the airfoil and also the cooling flow behaviour under tip leak conditions. Despite belonging to the common general knowledge, such a modification constituted a positive change and required some motivation.

Similarly, metering plates were indeed generally known, but again the inventors of D1 deliberately chose to use separate metering plates, thus allowing separate and independent control of the cooling air flow, as was apparent from paragraph 22, in particular from column 7, lines 36-38 and line 54. The bi-feed cooling concept used in the patent, see in particular paragraph 65, was conceptually distinct from the concept applied in D1. Clearly there was also no reason to meter the flow into the entrances 37 of D1 since they were intended to accept all incoming cooling air flow. The cooling arrangement disclosed in D5 was of a specific construction which could not be implemented in D1.

Nothing suggested to increase the flow area of the refresher passageways (66) in D1. Feature M1.6 provided in particular for the technical effects disclosed in paragraphs 72 (under normal operation conditions) and 79 (in cases of cooling air leaking through the tip due to cracks). The structural features referred to in

these paragraphs were all defined in claim 1, notably by the features M1.3.1 and M1.6. A weight reduction could therefore not be considered as an objective problem in regard to the distinguishing feature M1.6.

Auxiliary requests 1 to 7

The auxiliary requests 1 to 7 should be considered since they were indeed fully substantiated in the reply to the statement of grounds of appeal. The basis for the amendment in each request, together with the reasons for filing it and supporting arguments were included in the reply. Moreover, the substantiation of inventive step in respect of the main request was also applicable to the auxiliary requests such that these requests were in fact substantiated under this ground contrary to the Board's preliminary opinion. Moreover, the Board had no power to exclude auxiliary request 4 since this request was already filed and maintained before the opposition division.

As a further auxiliary measure it was requested to nevertheless admit and consider auxiliary request 4. Besides the conditions of Article 13(2) RPBA, the Board should also consider the admittance of this request under the provisions of Article 13(1) RPBA. The subject-matter of claim 1 of auxiliary request 4 was known to the appellant since it was already filed in the opposition proceedings and had never been abandoned. It was based on a combination of only granted claims so that the appellant should have objected to this subject-matter anyway. The amendment did not raise any complex new issues. It further addressed the issues concerning the relative flow areas which arose only during the oral proceedings and was thus also *prima facie* allowable.

Reasons for the Decision

Main Request

1. The subject-matter of claim 1 of the patent in suit lacks an inventive step (Art. 56 EPC).

2. To assess the presence of an inventive step in the subject-matter of claim 1, the Board applies the problem-solution approach as developed in the case law of the Boards of Appeal (see for example section I.D.2 of the Case Law of the Boards of Appeal, 10th Edition). In a first step, the "closest" prior art, or the most promising starting point to the claimed invention is determined. Starting from such prior art and based on the identified distinguishing features of the claimed invention and their technical effects achieved, an objective technical problem (or several objective partial problems) is (are) formulated and the obviousness of the claimed solution to this problem assessed.

3. The turbine blade disclosed in Figures 1 to 3 of D1 may be considered to represent the closest prior art to the subject-matter of claim 1.

3.1 The invention underlying D1, which belongs also to the respondent, relates generally to cooling air circuits of turbine rotor blades and stator vanes in gas turbine engines and strives *inter alia* to further improve blade cooling (paragraphs 1 and 7). The disclosed turbine blade is provided with radially extending forward and aft serpentine cooling circuits (36,38). The blade has a hollow airfoil and a dovetail. Four inlet channels (66,37) are provided in the dovetail, which direct

cooling air into the forward and aft serpentine cooling circuits extending between partitions in the hollow airfoil. Only the forward cooling circuit (36) terminates in its last pass (42) in a forward impingement channel, whereas the aft cooling circuit (38) terminates in its last pass (42) in a channel in which cooling slots (76) for convective cooling are provided. The four inlet channels comprise two so-called refresher passageways (66) which correspond to the first and fourth inlet channel according to feature M1.3.1 of claim 1. These two refresher passageways (66) are provided with separate metering plates (80). According to the sectional illustration of the blade in Figure 3 of D1, the flow area of these refresher passageways appears to be relatively small compared to the flow areas of the three passes (40-42) of the respective serpentine cooling circuits (36,38). The other two inlet channels (37), corresponding to the second and third inlet channels according to feature M1.3.1 of claim 1, appear to present a larger flow area than the passes (40-42) of the cooling circuits. However, since Figure 3 of D1 represents only one sectional illustration in one plane of the blade, the relative flow areas of the four inlet channels (66, 37) compared to those of the serpentine circuits (36,38) in the illustrated turbine blade are not directly and unambiguously derivable from D1.

3.2 The respondent argued during the oral proceedings that due to the complexity and the efforts invested during the design of the cooling structure of a turbine blade, the invention should be judged from the point or prior art from which the patent started, instead of starting from the state of the art disclosed in D1.

There may indeed be different possible starting points

from which the problem-solution approach may be conducted. If the skilled person has a choice of several workable routes, i.e. routes starting from different documents, which might lead to the invention, the rationale of the problem-solution approach requires that the invention be assessed relative to all these possible routes, before an inventive step can be acknowledged. Conversely this means that if the invention is obvious to the skilled person in respect of at least one of these routes, then an inventive step is lacking (see T 21/08, Reasons 1.2.3, or T 967/97, Catchword I).

Consequently, although it might be possible to assess inventive step also from the prior art mentioned in the patent, this would not alone be sufficient to conclude that the claimed invention meets the requirement of Article 56 EPC, if there is further prior art, like D1, from which the skilled person may start. Absent any technical reason that could disqualify D1 as a starting point, the Board rejects the respondent's argument.

4. It is undisputed that the subject-matter of claim 1 is distinguished over this closest prior art turbine blade by the following features:

(a) an aft impingement channel as defined by features M1.1.1 and M1.2,
(b) the metering plate with four metering holes according to features 1.4, 1.4.1,
(c) and the relative flow areas defined in feature M1.6.

5. As already stated in its preliminary opinion, the Board concurs with the appellant that the three distinguishing features do not contribute to a single,

synergistic technical effect in the sense that the effect achieved by these features was more than the sum of the effects of each feature taken individually.

5.1 It is accepted that, as argued by the respondent, these distinguishing features in combination with the remaining features of claim 1 affect, at least to a certain degree, the cooling performance of the turbine blade and therefore may have an impact on the turbine's life span. The patent is however silent in regard to a specific functional link or an interaction resulting in a particular, unexpected technical effect, between the combination of, for example, the cooling structure at the trailing edge and the provision of a metering plate with four aperture inlets as defined by feature M1.4.1. The respondent has at least not indicated any passage in the patent from which it could be concluded that these two distinguishing features in combination achieved an unexpected effect going beyond their individual effects. Rather each of these two features provides for the effect which would be normally expected by the skilled person. The same conclusion applies in regard to the combination of the relative flow areas of the inlet channels and the serpentine channels according to feature M1.6 with the metering plate according to feature M1.4 and/or with the provision of an aft impingement channel according to features M1.1.1 and M1.2.

The Board moreover notes that the general problem identified by the respondent, to increase the operational lifespan of the turbine blade, is clearly also within the ambit of D1 (see for example, column 1, line 23-25), since extended lifespan is one of the principal reasons for cooling turbine blades. D1 indeed does not specifically mention a reduction in

differential temperatures across the airfoil profile during operation and a corresponding reduction of thermal stress. However, the features which according to the patent in suit provide for this effect are already embodied in D1. From paragraphs 41 to 43 together with paragraph 68 of the patent it can only be concluded that an improved temperature distribution over the airfoil profile is mainly due to supplemental cooling air introduced in the last passes of the respective serpentine cooling circuits, enabled by the provision of the supplemental (first and fourth) inlet channels in the dovetail, compared to a blade without such supplemental inlet channels (see notably paragraph 68). Such supplemental cooling inlets are also embodied in D1 by the refresher passageways (66). As their name already indicates, also these known passageways direct additional cooling air in last passes (42) of the respective serpentine cooling circuits (36,38), see for example in paragraph 12, column 4 lines 9 to 14. The cooling configuration of D1 must therefore also lead to a reduction in differential temperatures across the airfoil profile during operation and consequently less thermal stress, at least to a certain extent.
Similarly, paragraph 12 of D1, in particular in column 4, lines 18 to 26, also discloses that the refresher passageways offset the loss of cooling flow from a tip leak. Furthermore claim 1 of the patent does not define the structural details of the cooling structure illustrated in Figure 6 of the patent (for example, a serpentine cooling circuit with three passes or the features mentioned in paragraph 72 of the patent) which would be necessary to allow for the introduction of additional cooling air from the supplemental first and fourth cooling inlet channels also into a middle pass of the serpentine cooling circuits. Consequently the problem(s) considered by the respondent are already

solved in D1, at least to a certain extent, and cannot be considered as being objective. The above identified distinguishing features (see point 4. above) are also not described in the patent as to specifically contribute, alone or in combination, to an unexpected improvement in relation to the problems relied upon by the respondent.

5.2 In the absence of any synergistic effect, it is therefore appropriate to formulate partial objective problems in regard to the respective distinguishing features identified above and to assess the question of whether the respective feature in combination with the remaining features of claim 1 would have been obvious to the skilled person in the art.

5.3 A particular technical effect achieved by an aft impingement channel at the trailing edge according to features M1.1.1 and M1.2, is not disclosed in the patent. Paragraph 54 discloses that such impingement cooling channels "may have any conventional configuration". It is not apparent from the patent that a general impingement cooling channel at the trailing edge would necessarily, and irrespective of specific dimensions, geometries and operating conditions, improve the cooling performance, affect the temperature distribution across the airfoil or improve the cooling flow behaviour under tip leak conditions in an unexpected way. In the absence of any particular effect necessarily achieved over the whole scope of the claim, an aft impingement (cooling) channel at the trailing edge may only be considered as an alternative to the cooling configuration used in the closest prior art.

5.3.1 A partial objective technical problem may therefore be seen in the provision of an alternative trailing edge

cooling configuration for the turbine blade of the closest prior art.

5.3.2 It was not disputed by the respondent that the skilled person was well aware that impingement cooling can also be employed at the trailing edge of a turbine blade.

The Board agrees with the reasoning given by the opposition division in the impugned decision (see in particular page 9, second paragraph) that the provision of an impingement cooling channel at the trailing edge, which belongs to the common general knowledge of the skilled person in the art and which does not provide for any other than its normally expected technical effect, does not involve an inventive step.

5.3.3 The respondent's argument submitted in writing, directed to a lack of an indication that such impingement cooling channel at the trailing edge would increase the lifespan of the turbine blade of D1, is not convincing for the reasons given already before in points 5.1 and 5.3.

5.3.4 The Board can also not agree with the respondent's argument presented orally and according to which there was no reason why the skilled person would, and not only could, have made the corresponding modification to the turbine blade of D1. In cases where the technical features embodying a certain modification of the prior art are well known to the skilled person in the art and where such a modification does not result in anything else than the well known and expected technical effects and therefore constitutes a well known alternative to the feature employed in D1, the skilled person would have applied such modification without the necessity of a specific hint (see also for example T 894/19, Reasons

3.6, or T 1968/08, Reasons 5.5).

5.4 Concerning the provision of a metering plate with four aperture inlets communicating with the respective four inlet channels in the blade's dovetail according to the feature M1.4.1, instead of only two individual metering plates (80) over only the two refresher passageways (66) in the turbine blade of D1, the relative distribution of cooling air in the whole airfoil may be controlled (paragraphs 35 to 37 of the patent). The aperture inlets may be individually sized for each inlet channel so that the cooling air flow to each inlet channel may be individually metered. This was also common ground between the parties. Such individually dimensioned aperture inlets formed in metering plates installed above the inlet channels in a turbine blade's dovetail may generally be required since the dimensions of the inlet channels are subject to manufacturing tolerances (see for example D5, paragraph 8). The cooling air flow is therefore controlled by a correspondingly adjusted hole in the metering plate installed over the inlet passage. The resulting configuration is then subject to further testing before the metering plate with a correctly dimensioned hole is finally installed on the blade's dovetail.

Providing all aperture inlets in a single metering plate, instead on a number of separate plates, does not have a particular technical effect for the final turbine blade. The respondent did at least not indicate any particular technical effect in this respect in the patent in suit.

5.4.1 A corresponding objective partial problem may thus be seen in further optimising the distribution of the

cooling air in the turbine blade.

5.4.2 The respondent acknowledged that metering plates belonged to the common general knowledge. Moreover, the opposition division had also acknowledged that the use of single measuring plates provided with as many aperture inlets as there were inlet channels in a dovetail was well known from the prior art, for example from D2 or D5 (see page 10 of the impugned decision). This was also not disputed by the respondent. D2 indeed discloses in Figure 2 a single metering plate (51) with three aperture inlets communicating with the three inlet channels of the corresponding turbine blade. D5 discloses in paragraph 8 the purpose of metering plates with several aperture inlets in general and, in Figure 1 together with paragraph 23, a single metering plate with four aperture inlets communicating with two inlet channels. The Board therefore agrees with the appellant that the application of integral or single metering plates with a number of metering holes corresponding to the number of inlet channels for the well known purpose of a controlled distribution of the cooling air to the different inlet channels of a turbine blade belongs to the common practice of the skilled person and does not involve any inventive activity.

5.4.3 The Board cannot see that D1 would teach away from the use of such a single metering plate with four aperture inlets.

The particular choice as such of the dovetail's inlet configuration with separate metering plates in D1 does not constitute a teaching which would prevent the skilled person facing the objective technical problem identified in point 5.4.1 above, from further modifying the closest prior art in the sense considered above.

The appellant's argument equates to adding a further constraint to the above formulated objective partial problem, in the sense of "by not modifying the metering plate configuration of the closest prior art". The Board cannot see any reason justifying such a constraint.

Paragraph 22 of D1, on which both the opposition division and the respondent based their reasoning concerning the non-obviousness of the single metering plate according to feature M1.4.1, also does not change the Board's conclusion. The Board does not agree that the use of a common metering plate with four appropriate aperture inlets would raise doubts as to an independent and separate operation of the refresher passageways 66 in D1. The aperture inlets of the metering plates have in any case to be individually adapted to provide the desired cooling airflow to the respective inlet channels (see also column 7, lines 46 to 51). This is independent of whether the aperture inlets are provided on a single or on separate metering plates. Claim 1 of the patent also does not define any limitation with respect to the source of cooling air. Considerations directed to possible further required modifications of a cooling air source, as made by the opposition division in the impugned decision, are therefore not relevant. Moreover, the cooling air directed to the turbine blades is normally provided by bleeding small amounts of air from the turbine's compressor (see paragraphs 4 and 5 of the patent in suit). There are no indications in the patent that this could be different with the specifically claimed turbine blade. The respondent's further reference to paragraph 65 also does not allow a different conclusion. It contains a general reference to the specific bifeed cooling configuration in Figure 1.

Apart from mentioning four metered inlets, it does however not address any particular technical effect in regard to the provision of a single metering plate with four aperture inlets.

5.5 Finally, the only technical effect disclosed in the patent for the relatively larger flow areas of the inlet channels compared to the flow areas of the serpentine cooling circuits, according to the third distinguishing feature M1.6, is directed to weight reduction and the minimisation of centrifugal loads (see paragraph 36 of the patent). The Board notes that this effect relates only to large flow areas of the inlet channels, but does not appear to be linked to the requirement expressed in feature M1.6 that the inlet channel flow areas should be relatively larger than those of the serpentine cooling circuits. As also argued by the appellant, the location at which the flow area relation of feature M1.6 must be met are not defined in the claim. The claim does not exclude that constrictions may exist between some large section of an inlet channel and some large section of the serpentine circuit, see for example the apparent constriction between entrances 37 and first passes 40 in Figure 3 of D1. No particular effect for this specific area relation (at some undefined locations) is however disclosed in the patent.

5.5.1 The respondent argued during the oral proceedings that the feature M1.6 would provide for the technical effect mentioned in paragraph 72 and at least enabled the effect mentioned in paragraph 79. This argument cannot be followed. A better mixing of cooling air from the inlet channels with air circulating in the serpentine circuits, with minimal pressure loss, as mentioned in paragraph 72, is however disclosed to be based on a

large flow area of the supplemental inlet channels at the junction with the serpentine cooling circuit, more precisely at the final bend from the circuit's second to last pass. Similarly, the extension of service life even under tip crack conditions described in paragraph 79 is achieved by the particular configuration of features shown in Figure 6 (for example, each serpentine cooling circuit having three passes, a large flow area of the supplemental inlet channels specifically at the junction with the serpentines' middle and last passes, see also paragraph 78 of the patent). The corresponding features are not defined in claim 1 so that the effects disclosed in paragraphs 72 and 79 cannot be considered to be necessarily achieved over the whole scope of the claim. Moreover, the content of these paragraphs does not relate to the relative flow areas of inlet channels and serpentine circuits.

5.5.2 Starting from the closest prior art turbine disclosed in D1, an objective partial technical problem based on the distinguishing feature M1.6 may only be seen in reducing the weight of the turbine blade.

5.5.3 D1 discloses in paragraph 12 that the refresher passageways (66), in addition to their principal purpose of providing a supplement of cooler air to the last passes of the serpentine cooling circuits and as a consequence better cooling at the blade's edges, allow for a lighter design and weight reduction. The skilled person therefore receives a direct hint from D1, that the refresher passageways present a source for weight reduction. The skilled person would obviously consider their enlargement if further weight reduction were thought useful. Moreover, it belongs to the common general knowledge that less material leads to lighter

weight of the turbine blade. Turbine blades with comparatively large inlet channels are also generally known to the skilled person in the art, see for example D2 (Fig. 2) or D5 (Fig. 1).

The Board concludes that it would have been obvious for the skilled person, faced with the objective technical problem, to correspondingly increase the flow areas of the refresher passageways.

In the absence of any particular effect attributable to the requirement defined by feature M1.6 that the inlet channels' flow areas should not only be generally large, but specifically larger than the flow areas of the serpentine circuits (at some undefined location), this more specific requirement can only be considered as arbitrary and does not involve an inventive step, as argued also by the appellant in the statement of the grounds of appeal.

5.5.4 The Board is not convinced by the respondent's argument that feature M1.3 of claim 1 defined at least implicitly the location at which the relative flow areas of inlet channels and serpentine circuits had to be compared. Although it may be accepted that feature M1.3.1 defines a junction between the inlet channels and the respective passes of the serpentine cooling circuits, the claim does not specify that the flow areas according to feature M1.6 are necessarily determined with respect to that junction.

5.6 The Board concludes that the combination of the features according to claim 1 does not involve an inventive step (Article 56 EPC), since the three distinguishing features identified above in point 2. do not contribute to a single synergistic technical effect

achieved over the whole scope of the claim and are each obvious for the skilled person in the art.

5.7 The ground for opposition under Article 100(a) in combination with Article 56 EPC thus prejudices maintenance of the patent as granted.

Auxiliary requests 1 to 7

6. According to Article 12(4) RPBA 2007, everything presented by the parties under Article 12(1) RPBA 2007 shall be taken into account by the Board if and to the extent it relates to the case under appeal and meets the requirements in Article 12(2) RPBA 2007.

Article 12(2) RPBA 2007 requires *inter alia* that the reply to the statement of grounds of appeal shall contain the respondent's complete case. It shall set out clearly and concisely the reasons why it is requested that the decision under appeal be (amended or) upheld, and should specify expressly all the facts, arguments and evidence relied on.

7. As already stated in the Board's preliminary opinion, the respondent failed to substantiate the amendments to claim 1 of any of these requests in regard to all outstanding objections, including notably those pursuant to Article 56 EPC.

8. In its written reply to the Board's preliminary opinion, the respondent argued that the requests had been substantiated according to the requirements of Article 12(3) RPBA (which, as far as the present issue is concerned, has very similar wording to Article 12(2) RPBA 2007). The Board is however not convinced by the arguments submitted in this regard. The respondent's

arguments on inventive step applicable to the main request cannot be the same for the auxiliary requests. If the subject-matter of claim 1 as granted is found to lack an inventive step it is generally necessary to explain why an amendment would overcome such objection. Such an explanation in regard to the specific amendments of the respective claim 1 of each of the auxiliary requests is missing in the reply. It has not been argued by the respondent, and the Board can also not see of its own motion, that the amendments to the claims were self-explanatory in view of the outstanding inventive step objection. Also in its written reply to the Board's preliminary opinion no arguments in this regard were submitted.

9. The argument that specifically auxiliary request 4 submitted with the reply to the statement of the grounds of appeal was already filed before the opposition division, was thus in the proceedings and could therefore not be excluded misses the point. Article 12(2) RPBA 2007 requires to set out clearly and concisely the reasons why it is requested that the decision under appeal be amended or upheld and to specify expressly all the facts, arguments and evidence relied on. Only to the extent to which these conditions are met, i.e. the facts and arguments being presented, the submissions of the respondents shall be taken into account. In regard to auxiliary request 4 there are no such facts and arguments concerning the objection under Article 56 EPC raised in the statement of grounds such that this request is manifestly not substantiated.

10. The Board therefore confirms its preliminary opinion and does not take into account auxiliary requests 1 to 7 (Article 12(2) and (4) RPBA 2007).

11. As to the respondent's request submitted during the oral proceedings to nevertheless admit and to consider auxiliary request 4, this request was not taken into account pursuant to Article 13(2) RPBA 2020.

11.1 The Board considers this request to constitute an amendment of the respondent's case according to Article 13 RPBA 2020, since it would involve the consideration of the initially missing substantiation of the corresponding amendments. Since the substantiation would be submitted only at the oral proceedings, i.e. after a summons to such proceedings was issued, the strict criteria of Article 13(2) RPBA 2020 apply.

The Board may indeed also rely on the criteria of Article 13(1) RPBA 2020, when exercising its discretion to take into account this amendment of the respondent's case. However this does not mean that criteria of Article 13(2) RPBA 2020 may be disregarded by the Board (see also T 2486/16, reasons 6.4.1 and 6.4.2). Articles 13(1) and (2) RPBA 2020 implement the second and third levels of the convergent approach. Article 13(2) RPBA 2020 imposes the most stringent limitation on a party wishing to amend its appeal at an advanced stage of the proceedings. The basic principle of the third level is that amendments shall not be taken into account. Only a limited exception is provided which requires the party to justify by cogent reasons why the circumstances in a particular appeal are indeed exceptional (see the explanatory remarks to Article 13(2) RPBA in the Supplementary Publication 2 of the OJ EPO 2020).

11.2 The Board cannot see any exceptional circumstances in the fact that auxiliary request 4 was presented in opposition proceedings, its subject-matter being based on a combination of only granted claims, known to the

appellant and should have been addressed anyway in corresponding objections earlier. Even though these facts cannot be denied, what was missing throughout the entire written appeal proceedings, even still in the respondent's written reply to the Board's preliminary opinion, was a substantiation for this request in regard to the requirement of Article 56 EPC, i.e. why the respective amendment overcame the outstanding lack of inventive step objection.

11.3 Moreover, the appellant had indeed raised an objection against the subject-matter of granted claim 2 already in its notice of opposition, as pointed out and maintained in its letter dated 13 December 2021. As mentioned already before, a counter argument, which could have been regarded as a substantiation of its auxiliary request 4 was not even submitted after the Board had issued its written preliminary opinion. If the request were admitted, the Board and the appellant would for the very first time at oral proceedings before the Board have been confronted with the respondent's counter arguments concerning the amendment of claim 1 according to auxiliary request 4.

11.4 It is true that the question of the relative flow areas according to feature M1.6 of granted claim 1 was discussed in detail for the first time during the oral proceedings. However, the appellant had objected to the lack of a technical effect of this feature already in the statement of the grounds of appeal (page 16, first paragraph). The respondent replied only by stating that nothing in D1 suggested to increase the flow area of the refresher passageways, without however addressing the basis of the appellant's objection. Rather superficially in its written reply to the Board's preliminary opinion and far more extensively during the

oral proceedings before the Board, the respondent then relied on effects mentioned in paragraphs 72 and 79 of the patent in regard to feature M1.6. The issues discussed in detail did therefore not arise from considerations which the Board or the appellant had raised for the first time at a late stage. In the present case these new issues arose only because the respondent omitted to claim the effects allegedly attributable to feature M1.6 at an earlier stage, despite the feature having been objected to in this regard in the statement of grounds of appeal.

12. Absent any set of claims complying with the requirements of the EPC, the patent has to be revoked.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The patent is revoked.

The Registrar: The Chairman:

D. Grundner M. Hannam

Decision electronically authenticated