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Language of the proceedings: EN

Title of invention:
GAS TURBINE ENGINE WITH PARTIAL INLET VANE

Patent Proprietor:
Pratt & Whitney Canada Corp.

Opponent:
Safran Aircraft Engines

Headword:

Relevant legal provisions:
EPC Art. 56

Keyword:
Inventive step - (no)

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Catchword:

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Case Number: T 1491/20 - 3.2.04

D E C I S I O N
of Technical Board of Appeal 3.2.04
of 25 November 2022

Appellant: (Patent Proprietor)	Pratt & Whitney Canada Corp. 1000 Marie-Victorin (01BE5) Longueuil, Québec J4G 1A1 (CA)
Representative:	Dehns St. Bride's House 10 Salisbury Square London EC4Y 8JD (GB)
Respondent: (Opponent)	Safran Aircraft Engines 2 boulevard du Général Martial Valin 75015 Paris (FR)
Representative:	Regimbeau 20, rue de Chazelles 75847 Paris Cedex 17 (FR)
Decision under appeal:	**Interlocutory decision of the Opposition Division of the European Patent Office posted on 15 April 2020 concerning maintenance of the European Patent No. 3026240 in amended form.**

Composition of the Board:

Chairman	C. Heath
Members:	G. Martin Gonzalez
	C. Kujat

Summary of Facts and Submissions

I. The appeal was filed by the appellant (proprietor) against the interlocutory decision of the opposition division finding that, on the basis of the auxiliary request 3, the patent in suit met the requirements of the EPC.

The division held inter-alia that claim 1 of the main request and of the auxiliary requests 1 and 2 before it lacked an inventive step.

II. The appellant-proprietor requests that the decision under appeal be set aside and the patent be maintained based on the main request or alternatively according to one of auxiliary requests 1 or 2 filed with their statement of grounds of appeal on 25 August 2020, that correspond to the main and auxiliary requests 1-2 of the impugned decision.

The respondent requests dismissal of the appeal.

III. In preparation for oral proceedings the Board issued a communication setting out its provisional opinion on the relevant issues.

Oral proceedings were held before the Board by videoconference on 25 November 2022.

IV. Independent claim 1 of the requests relevant for this appeal reads as follows:

(a) Main request (as granted)

"A turbofan engine (10), the engine comprising:

a propulsive fan (12);
an inlet (24) directing the ambient air to the fan (12), said inlet (24) comprising an inlet wall (28) surrounding an inlet flow path (30), the inlet wall (28) extending axially from an upstream end (38) to a downstream end (40) adjacent the fan (12), the inlet wall (28) at the downstream end surrounding an annular portion of the inlet flow path (30) bordered radially inwardly by an annular inner wall (42), a radial distance between the inlet wall (28) and the inner wall (42) adjacent the fan (12) defining a downstream height (H) of the inlet flow path (30); and
a plurality of vanes (50; 150) circumferentially spaced around the inlet (24), each of the vanes (50; 150) extending radially inwardly from the inlet wall, a maximum radial distance between a tip of each of the vanes (50; 150) and the inlet wall (28) defining a maximum height (hmax) of the vane (50; 150), the maximum height (hmax) of each of the vanes (50; 150) being at most 50% of the downstream height (H) of the flow path (30);
wherein an upstream wall portion (32) of the inlet wall (28) extends axially from the upstream end (38) at an inlet lip (26) to the downstream end (40), the upstream wall portion (32) surrounding the inlet flow path (30) through which the air passes to reach the fan (12); and the vanes (50; 150) extend radially inwardly from the upstream wall portion (32) in an annular portion of the inlet flow path (30) to swirl the flow of air upstream of blade tips (36) of the fan to reduce the relative Mach number at the fan blade tips (36)."

(b) First auxiliary request

Claim 1 as in the main request with the following amendments (indicated by underlined text):

"...being at most 50% of the downstream height (H) of the flow path (30); and
a heating system (60) in heat exchange relationship with the vanes (50; 150);
wherein an upstream wall portion (32) of the inlet wall (28) extends axially..."

(c) Second auxiliary request

Claim 1 as in the main request with the following amendments (indicated by underlined text):

"...being at most 50% of the downstream height (H) of the flow path (30)~~;~~, wherein the vanes (50; 150) each have a stagger angle of 20 degrees or less adjacent the inlet wall;
wherein an upstream wall portion (32) of the inlet wall (28) extends axially..."

V. In the present decision, reference is made to the following documents:

(D3) CN 103835810 A

(D3_EN) Human translation of D3 filed by the appellant on 20 September 2021.

(D6) US 2012/0240594 A1

VI. The appellant's arguments can be summarised as follows:

Claim 1 of all requests involves an inventive step over the cited prior art.

VII. The respondent's arguments can be summarised as follows:

Claim 1 of the main request lacks an inventive step starting from D3, in combination with the common general knowledge of the skilled person. Claim 1 of the first and second auxiliary requests also lack an inventive step in the light of the teachings of D3, D6 and common general knowledge.

Reasons for the Decision

1. The appeal is admissible.

2. Background

The invention relates to inlets for turbofan gas engines, see specification paragraph [0001]. It aims at increasing engine fan tip efficiency and at reducing foreign object damage to the fan tips, see paragraphs [0002]-[0003]. The fan has an inlet with an inlet wall surrounding the inlet flow path. A plurality of vanes upstream the fan extend radially inwardly from the inlet wall. The vanes swirl the incoming flow of air upstream the fan blade tips and reduce the relative Mach number at the blade tips. This reduces shock losses and boundary layer separation thus improving overall fan efficiency, see paragraphs [0002] and [0024]. The vanes can also provide protection against foreign object damage (e.g. a bird) to the blade tip, see specification paragraphs [0003] and [0032].

3. Main request - Inventive step.

3.1 The Board holds that claim 1 lacks an inventive step over D3 in combination with the common general knowledge of the skilled person.

3.2 Document D3 is considered by the parties as an appropriate starting point. In contrast to the claimed vanes, document D3 describes convex hulls 18 to produce prewhirl airflow upstream the fan tips, see D3_EN par. [0032]. Contrary to the respondent's submission, these are not vanes. The term vane implies a slender and airfoil section, i.e. a thin flat or curved shape (Merriam-Webster: "a thin flat or curved object that ... or that redirects a flow of fluid").

The subject-matter of claim 1 thus differs from D3 in that it uses vanes instead of hulls.

3.3 Inventive step is discussed in the light of the two different technical effects achieved by the claimed vanes. These are the reduction of the relative Mach number at the fan blade tips, paragraph [0002] of the specification, and the provision of FOD (foreign object damage) protection, paragraph [0003].

3.4 For the determination of the objective technical problem, only the effect actually achieved vis-a-vis the closest prior art should be taken into account, see Case Law of the Board of Appeal (10th edition), I.D. 4.1. It is thus necessary to consider the technical contribution of the claimed vanes in terms of their technical effect over and above the known hulls of D3.

3.5 The effect of reducing the Mach number at the fan blade tips is already achieved by the known hulls 18 of D3. D3_EN paragraph [0032] explicitly describes this effect. Therefore, in this regard, the vanes only provide an alternative construction.

The formulation of the corresponding objective technical problem in the light of this effect is thus how to provide an alternative construction of the known hulls.

3.6 D3 itself mentions vanes as elements that also have streamlined characteristics as the convex hulls to ensure a laminar flow with little turbulence and small resistance, see D3_EN par. [0031]. It is moreover known from common general knowledge that vanes are generally used to guide air flow as is the function of the known hulls 18 for reducing the Mach number described in D3_EN par. [0032]. They are thus known as a common alternative to the skilled person. They would regard the replacement of the convex hulls in D3 by vanes as a matter of obviousness when seeking for an alternative solution.

3.7 The appellant refers to the advantageous embodiments described in [0034] and [0035] of D3_EN. The further sound muffling features and effects of these embodiments would hinder the skilled person to use vanes as an alternative. This argument is not convincing. The starting point for the assessment of inventive step is the embodiment described in the previous paragraphs, without the additional sound muffling features, and which already shows the relative Mach number reduction effect.

3.8 As regards foreign object damage (FOD) protection to the blade tips, the Board finds itself in accord with the respondent that this effect would be an inevitable bonus effect of solving the above problem. It therefore cannot justify an inventive step.

3.9 As variously stated in case law, the use of means leading to some expected improvement might well be patentable in relying on an additional effect, provided this involved a choice from a multiplicity of possibilities. The lack of alternatives in this respect might therefore create a "one-way-street" situation leading to predictable advantages which remained obvious in spite of the existence of some unexpected "bonus". An additional effect inevitably achieved by the skilled person on the basis of an obvious measure without any effort on his or her part simply represents a bonus effect under EPO case law which cannot substantiate inventive step, even as a surprising effect, see CLBA (10th edition) I.D.10.8. Worded differently, if an alternative is obvious when addressing the problem to be solved (here: reducing the Mach number), it is immaterial that the obvious alternative also has other beneficial effects (here: reducing FOD), even if these were not immediately apparent.

3.9.1 While D3 does not explicitly mention FOD protection, its convex hulls extend radially inwardly into the inlet flow path to the fan tips and can thus deflect foreign objects, as the vanes of the patent-in-suit, see paragraph [0032] of the contested patent. Contested claim 1 is not directed to any specific height of the vanes. Therefore any height should achieve FOD protection. For the same reason, also the hulls of D3

should produce that effect. In the light of this first approach to the FOD issue, it appears that the vanes as claimed achieve no FOD protection effect over and above that achieved by the known convex hulls. However, according to the appellant proprietor the vanes achieve a higher degree of FOD protection due to their different shape, no matter their dimensions. In their view, the vanes have a leading edge and also have a different aspect ratio, i.e. they are slender as compared to the convex hulls of D3. According to the appellant, these differences bring about a higher degree of protection, as they, for instance, provide a higher energy absorption in case of shock by a foreign object than the smooth front surface and convex shape of the known hulls. Hence, while leading edge thickness or vanes interspacing can be optimised for a certain foreign object (e.g. bird), as described in paragraph [0032] of the patent, the mere presence of a leading edge or of a slender geometry of any dimension achieves an improved FOD protection over convex hulls. Thus, the mere use of vanes instead of hulls achieves a higher degree of FOD protection.

3.10 Therefore, the improved degree of FOD protection is an inevitable effect of using vanes. This is however a bonus effect that does not contribute to inventive step, as explained above. Indeed, if vanes are the obvious solution to seeking for an alternative to the hulls from considerations related to the Mach number at the fan blade tips, the skilled person would also obtain higher FOD degree of protection without the need of inventive activity. Hence, the achievement of this effect does not confer inventive character, in the sense of Article 56 EPC, to the claimed subject-matter.

3.11 The Board therefore concludes that claim 1 of the main request lacks an inventive step.

4. First auxiliary request - Inventive step

4.1 This request adds to the main request the provision of a heating system in heat exchange relationship with the vanes. Such a system is also not disclosed by D3. It provides protection against icing, see specification paragraph [0027].

4.2 This effect is different from that of providing an alternative construction of the known hulls or of FOD protection. No synergistic effect is apparent. There is also no evidence in the patent specification of any synergistic effect. It can thus be assessed separately for inventive step.

4.3 The corresponding partial problem for the new feature is thus how to provide protection from icing. D6 teaches in paragraph [0044], as is also generally known, that ice tends to accrete upon edges exposed to the incoming ambient air "(e.g. the splitter 10' and inlet guide vanes 28, the leading edge 210 of the engine nacelle 200, or any other surface that is to be protected)". D6 expressly mentions the leading edge 210, see D6 figure 4. D6 also teaches to consider any other surface that is to be protected. The known hulls 18 or the obvious alternative vanes are not only in the critical area of the engine leading edge area, but also have a leading edge exposed to the incoming ambient air. It is thus immediately evident for the skilled person that they are also a surface to be protected. D6 teaches to provide a heating system at the areas to be protected, see D6 paragraph [0042] and paragraphs [0036]-[0037]. The skilled person would thus consider

the application of burner assemblies and thermally conductive elements as taught by D6 to the leading edge areas of the obvious combination of D3 with common general knowledge when confronted with the problem of icing protection as a matter of obviousness.

4.4 The first auxiliary request therefore lacks an inventive step, as concluded by the opposition division.

5. Second auxiliary request - Inventive step

5.1 With respect to the main request, Claim 1 of the second auxiliary request is amended to add that each vane has a stagger angle of 20 degrees or less adjacent the inlet wall.

5.2 The claimed angle of 20° or less provides a balance between the tip speed reduction effect and the losses induced by having inlet vanes, as is explained in specification paragraphs [0023]-[0025]. There is no evidence that this angle value is linked to an optimization of the FOD protection degree, contrary to the submissions of the appellant proprietor. Paragraph [0032], cited by the appellant, describes the optimization for FOD protection purposes only associated to variations of the vane maximum thickness at the leading edge or spacing between the vanes. As explained in the preceding paragraphs of the specification, the optimized stagger angle is selected solely on aerodynamic considerations, such as the desired Mach number and friction losses introduced by the vanes.

The corresponding objective technical problem can thus be formulated as how to obtain an optimized alternative to the convex hulls of D3.

5.3 D3 does not specify a precise stagger angle. When seeking to implement vanes as the obvious alternative in D3, the skilled person would naturally try to provide an optimized implementation in terms of performance. They would obviously seek to reduce the Mach number at the fan tips since this is the goal of the prewhirl arrangement, as taught in D3_EN par. [0032]. It is also immediately evident to the skilled person from their common general knowledge that elements deflecting air flow produce friction losses, and that while a higher air flow deflection produces higher Mach number reduction, it also produces higher friction losses. Minimizing friction losses is a main design goal of the skilled person in the art, an engineer involved in the development of turbofan engines. They would thus quite naturally seek to strike a balance between the aerodynamic load reduction effect at the fan tips and the known source of friction losses induced by the flow guiding elements as a matter of routine design practice. The particular range of 20° or less does not appear of any particular significance, other than it is dictated by the particular circumstances, such as the needed or desired degree of Mach reduction, the acceptable or desirable range of friction losses for the particular engine or engine fan or the selected type of vane design. Thus, a stagger angle falling within the claimed range of 20° or less appears to be nothing other than a routine choice or result of that obvious optimization exercise.

5.4 The Board thus concludes that claim 1 of the second auxiliary request lacks an inventive step.

6. All the appellant's requests therefore fail for lack of inventive step, Article 56 EPC. Consequently, the appeal fails.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

G. Magouliotis C. Heath

Decision electronically authenticated