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Datasheet for the decision of 11 October 2022

Case Number: T 0031/20 - 3.2.04

Application Number: 09167793.0

Publication Number: 2159403

IPC: F02K1/08, F02K1/52

Language of the proceedings: EN

Title of invention:
Variable slope exhaust nozzle

Patent Proprietor:
General Electric Company

Opponent:
Raytheon Technologies Corporation

Headword:

Relevant legal provisions:
EPC Art. 123(2), 56
RPBA 2020 Art. 13(2)

Keyword:
Amendments - extension beyond the content of the application as filed (no)
Inventive step - non-obvious modification
Amendment after summons - exceptional circumstances (yes)

Decisions cited:

Catchword:

Europäisches Patentamt
European Patent Office
Office européen des brevets

Beschwerdekammern

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Case Number: T 0031/20 - 3.2.04

D E C I S I O N
of Technical Board of Appeal 3.2.04
of 11 October 2022

Appellant: (Opponent)	Raytheon Technologies Corporation Pratt & Whitney 400 Main Street East Hartford, CT 06118 (US)
Representative:	Dehns St. Bride's House 10 Salisbury Square London EC4Y 8JD (GB)
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:	**Interlocutory decision of the Opposition Division of the European Patent Office posted on 28 October 2019 concerning maintenance of the European Patent No. 2159403 in amended form.**

Composition of the Board:

Chairman	T. Bokor
Members:	S. Hillebrand
	S. Oechsner de Coninck

Summary of Facts and Submissions

I. The appeal was filed by the Opponent against the interlocutory decision of the Opposition Division finding that the patent in suit in amended form according to auxiliary request 2 met the requirements of the EPC.

In particular, the Opposition Division held that the subject-matter of claim 1 did not extend beyond the content of the application as filed and involved an inventive step.

II. In a communication pursuant to Rule 15(1), the Board confirmed the Opposition Division's assessment of inventive step, but expressed preliminary concerns with regard to added subject-matter.

III. On 11 October 2022 oral proceedings were held before the Board in the presence of all parties.

IV. The Appellant (Opponent) requests that the decision under appeal be set aside and that the patent be revoked.

The Respondent (Proprietor) requests that the appeal be dismissed and in the alternative that the patent be maintained on the basis of auxiliary requests 3 to 5 filed with letter dated 5 September 2022, auxiliary request 4 corresponding to the previous auxiliary request 3 filed with the reply to the grounds of appeal.

V. The independent claim of auxiliary request 2 (as upheld by the Opposition Division) reads as follows:

"A turbofan aircraft gas turbine engine exhaust nozzle {36) comprising:
a generally conical inner shell {30) disposed coaxially inside a surrounding outer shell (32) to define an annular flow duct (34) therebetween terminating in an outlet {38) at a trailing edge (40) of said outer shell (32), and said inner shell {30) terminates in a trailing edge (44) aft of said outlet {38); and
said inner shell {30) varies in axial cone angle circumferentially therearound both forward and aft of said outlet {38); **characterized in that:**
a pylon (14) and a beam (48) interrupt circumferential continuity of said duct, said pylon and said beam being at diametrically opposed positions of said nozzle;
wherein said axial cone angle has local minimum values (A) directly adjacent to or at said pylon and said beam, said axial cone angle increasing to local maximum values (B) circumferentially away from said pylon and said beam on laterally opposite sides of said nozzle {36); and wherein:
said inner shell {30) diverges aft inside said duct (34) to a hump (SO) disposed inside the fan duct (34) forward of said outlet {38) and then converges aft to said trailing edge (44) thereof;
said cone angle (B) varies circumferentially over both said diverging and converging portions of said inner shell {30); and
said outer shell (32) increases in radius (F) as said cone angle (B) increases in value circumferentially around said duct (34)."

VI. In the present decision, reference is made to the following documents:
D1: US 3 806 067
D2: US 6 820 410 B2.

VII. The Appellant's arguments can be summarised as follows:
The subject-matter as claimed is a generalisation of the embodiment described in paragraphs [0043] and [0044] of the original description and omits features, which are inextricably linked to the technical effects stated in paragraphs [0047] and [0048].
Starting from the gas turbine exhaust nozzle of D2, the solution proposed in claim 1 is obvious for the skilled person in the light of the disclosure of D1.

The Respondent's arguments can be summarised as follows:
The features allegedly missing in claim 1 are presented as being optional in the original description and not essential for obtaining the technical effects of the invention.
The approach of D1 for solving the problem is diametrically opposite to the invention and can thus not lead to the invention as claimed.

Reasons for the Decision

1. The appeal is admissible.

2. **The patent and its technical background**

2.1 The patent deals with turbofan engines, in particular annular fan ducts separated by pylons and opposite beams into two mirrored C-ducts. Pylons and beams disturb the flow of pressurized fan air through the fan duct. The patent proposes a specific fan nozzle shape, which contributes to alleviate the negative effects of irregular circumferential velocity and pressure distribution caused by these obstacles in the fan duct.

2.2 The generally conically inner shell of the fan nozzle extends axially beyond its outer shell and thus the fan duct outlet. Conventionally, as in a regular cone, the cone angle of this inner shell would be constant, resulting in circular cross-sections of the inner shell along the nozzle axis. According to the independent claim as upheld, the cone angle of the inner shell varies *circumferentially* from a minimum cone angle directly adjacent to the pylon and the beam (on both sides) to a maximum cone angle on laterally opposed sides of the nozzle, resulting in generally "flattened" circular cross sections along the nozzle axis (see arrow E in Figs. 2, 4 and Fig. 6 as an example). Furthermore, the radius of the outer shell follows the circumferentially increasing cone angle of the inner shell (see arrow F in Figs. 2, 4 as a corresponding example). Thereby, the height of the fan duct and thus the available flow area is not only maintained in spite of the increasing cone angle and diameter of the inner shell in the laterally opposite regions of the nozzle, but further increased, paragraphs [0057], [0078] and Fig. 6 of the patent.
This leads to relatively higher flow speeds in regions *away* from the pylon and beam and reduces pressure loss.

2.3 The "generally conical" shape of the inner shell is detailed in claim 1 as upheld as first diverging inside the fan duct to a "hump" with a maximum diameter forward of the outlet (defined by the aft end of the outer shell) and only then actually conically converging towards the end or trailing edge of the inner shell located outside the fan duct.

3. **Auxiliary request 2 - added subject matter**

3.1 In its decision, the Opposition Division dealt with three objections pursuant Article 100(c) EPC in sperate dedicated sections. In particular, it held in respective sections 3.1 and 3.3 that on the basis of original claims 1 to 3 and paragraphs [0044] - [0046], [0076], [0077] of the description, it was not necessary to include a *symmetric* increase of the cone angle and specific *locations of the maximum cone angles* with regard to axial cross sections of the nozzle in order to comply with the provisions of Article 123(2) EPC. Referring individually to both of these sections in points 9 to 11 and 12 to 13, respectively, the Appellant took issue with the Opposition Division's argumentation drawing upon the same paragraphs of the original description.
Also the Board treated the two objections in its communication according to Article 15(1) RBPA, emphasized their different character and even reached different preliminary conclusions for each one (see below), again relying on original claims 1 - 3 and paragraphs [0010] and [0041] - [0047] of the description.

3.2 Symmetry

3.2.1 According to the Appellant, basis for the feature that the cone angle increases in magnitude or value circumferentially on laterally opposite side of the nozzle can be found in original paragraph [0044], in which this feature is, however, integral part of the preferred option "[the cone angle ... increases in magnitude...], *preferably symmetrically on laterally opposite sides of the nozzle*". Isolating part of this preferred option and omitting the aspect of symmetry in

claim 1 was not justified by the original disclosure.

3.2.2 The Board had adopted in section 1.2 of its communication the following different preliminary interpretation of the passage in question:
"*Presently the Board understands from paragraph [0044] that the increase of cone angle circumferentially away from pylon and beam is only symmetrical as a preference. In other words, neither the rate of increase or the "gradient" has to be the same on both laterally opposite sides of the nozzle, nor the maximum value respectively achieved.*
It appears, however, that the location of the maximum value is not presented alike as being a mere option in the following paragraphs [0045] - [0046]. In broadest terms paragraph [0046] seems to require that each locally maximum value of the cone angle is "located about circumferentially midway between the two locally minimum values of the cone angle at the junctions with the pylon and beam". This seems to represent rather an additional mandatory aspect than a further optional limitation of the statement in paragraph [0044], since both, the rate of increase and the maximum values could still be different on both lateral sides of the nozzle."

Furthermore, the Board had indicated in section 1.3 that claim 1 as upheld combined the disclosure of original claims 2 and 3 with that of the original description. Original claim 2 reads:
"*A nozzle according to claim 1 wherein said cone angle (B) increases circumferentially on laterally opposite sides of said nozzle (36)*".

3.2.3 Neither in their reply of 5 October 2022 nor during oral proceedings did the Appellant comment on the Board's preliminary view that the omission of the optional feature "symmetrically" did not lead to an extension of the subject-matter of claim 1 beyond the content of the application as filed, Article 123(2) EPC. The Board does therefore not see a reason for deviating from this view.

3.3 Locations of the maximum cone angles

3.3.1 The Appellant refers to the further features added to claim 1 from original paragraph [0048] concerning the position of the hump being "forward of the outlet 38". Although the paragraphs [0043], [0044] and [0048] did not only relate to a specific embodiment, but contained general information about the invention, the cross-section of the nozzle at the axial position of the now incorporated hump was an inextricable part of this general information (see points 8 and 12 of the appeal brief). Consequently, the positions at twelve o'clock and six o'clock for the minimum cone angles and at three o'clock and nine o'clock for the maximum cone angles as disclosed in paragraph [0045] (and as also shown in figure 6 in relation to the hump) were equally relevant and could not be ignored. This was confirmed in paragraph [0046], in which the reference to "about circumferentially midway between the two locally minimum values of cone angle" could only be understood as "at about 3 o'clock and at about 6 o'clock".

3.3.2 Here, the Board had applied a different reasoning with a slightly different outcome in its communication, as cited in point 3.2.2, above. The Board saw actually an intermediate generalisation of an embodiment, but did not consider the absolute example values of clockwise

positions disclosed together with a specific value for the maximum cone angle (16.5°) in paragraph [0045] to be presented as necessary limitations. Rather the more general "about midway between the two locally minimum values" of paragraph [0046] corresponded with regard to the level of generalisation and the relative definition to the features already designating the position of the minimum cone angles in claim 1, namely "directly adjacent to or at the pylon and beam".

3.3.3 In their letter of 5 September 2022, the Respondent amended their case by indicating a further basis for the subject-matter of claim 1 in the original application. They referred to clause 10, which corresponds to original claim 10.
Since this amendment was made after the summons, its admission lies within the discretion of the Board. According to Article 13(2) RPBA, the Board can only admit it in case of exceptional circumstances.

The Board accepts the Respondent's view that the reasoning given in the Board's communication with regard to the missing positions of the maximum cone angles deviated from that of the Appellant and shed a new light on the question of original disclosure. Such unforeseen developments of the appeal proceedings represent exceptional circumstances to which a party should have a fair chance to react. The Board also accepts that the totality of the disclosure, i.e. essentially of the whole application as filed, formed already part of the appeal case, in view of the previous objections under Article 123(2) EPC.

For these reasons, the Board has admitted the new argument of the respondent with regard to original disclosure to the proceedings, also considering the

relative simplicity of the issue, in view of the totality of the circumstances.

3.3.4 The combination of features of claim 1 stems from original claims 1 to 5 and 10 (corresponding to original clauses 1 to 5 and 10). In particular, original claim 10 provides a basis for a combination of the features pylon, beam, positions of locally minimum cone angles at said pylon and beam and positions of locally maximum cone angles circumferentially therebetween, without further limiting the latter to "midway therebetween". Furthermore, original claim 4 introduces a "hump" formed by the inner inner shell diverging "inside said duct", which in turn terminates in an outlet at a trailing edge of the outer shell according to original claim 1.
The Board thus identifies a clear independent basis for the subject-matter of claim 1 in these claims and clauses of the original specification.

3.3.5 Only the wording of some of the features already being part of this originally disclosed combination has been clarified and "illustrated" by formulations taken from the original description, such as "[local minimum values (A)] *directly adjacent to or* [at said pylon and said beam]" and "[said axial cone angle increasing to local maximum values (B)] *circumferentially away from said pylon and said beam* [on laterally opposite sides of said nozzle]" taken from paragraphs [0043] and [0044]. Likewise, the location of the hump *inside the fan duct* has been complemented by "*forward of said outlet*" (of the fan duct) from paragraph [0048], which not only appears self-evident, but also said to be a configuration "in accordance with general practice" in that paragraph. Including this expression in claim 1 does therefore not necessarily link the claimed

subject-matter to the cross-sectional configuration of inner and outer shell at the axial position of the hump as shown in figure 6 and described in paragraph [0045]. Because no further feature, i.e. neither a further element nor new information with regard to an element already present, has actually been added to the original combination of clauses or claims 1 to 5 and 10 from the embodiment described in paragraphs [0041] - [0048], the question of a possible intermediate generalisation of this embodiment's original disclosure does presently not arise.

3.3.6 The problem to be solved as stated in paragraph [0012] of the application is to provide an exhaust nozzle having improved efficiency notwithstanding circumferential interruptions thereof. According to paragraph [0085], this problem is solved by reducing pressure losses near the pylon and beam, which is in turn achieved by a specific fan duct geometry leading to flow speeds decreasing from locations of maximum cone angles to locally minimum values along both pylon and beam (see end of paragraph [0084]). A person skilled in the art, an engineer with specific knowledge of turbofan engines, understands that this distribution of flow speeds can be realised irrespective of the exact positions of the maximum cone angles in the unspecified "lateral plane" disclosed in paragraph [0084]. In particular, they recognize that this distribution of flow speeds is actually realised by the features incorporated in claim 1 from original claim 5 and original claim 10 referring back directly to orignal claim 5. Since claim 5 requires that the outer shell increases in radius as the cone angle (of the inner shell) increases in value, both claims define together a fan duct geometry providing minimum cross-sectional areas for air flow close to pylon and beam

and maximal cross-sectional areas for the air flow on lateral opposite sides of the nozzle circumferentially away from pylon and beam. This leads to the "pattern" of air speed distribution basically required for solving the problem (see also original paragraph [0041]), independently of the exact positions of the maximum cone angles, which are consequently not mentioned in original claim 10.

The Board is therefore convinced that taking into account the entire disclosure of the application according to the "gold standard", the positions of the minimum cone angles at or adjacent to pylon and beam are not inextricably linked to the maximum cone angles being located about *midway* inbetween them. Neither of these features is linked to the presence of a hump forward of the outlet, as set out above.

3.4 For these reasons the subject-matter of claim 1 as upheld does not extend beyond the content of the application as originally filed, Article 123(2) EPC.

4. **Auxiliary request 2 - inventive step**

4.1 D2 discloses as closest prior art a turbofan engine 10 comprising a generally conical inner shell 30 defining together with a surrounding outer shell 32 an annular flow duct 40. The inner shell terminates in a trailing edge (at 34) aft of the outlet 42 defined by the trailing edge 44 of the outer shell 32. Pylon 46 and beam (between end walls 48) interrupt diametrically opposed the circumferential continuity of the fan duct 40, see column 2, lines 57-67, column 3, lines 6-18, 34-52, figures 1, 2.
Inside the fan duct 40, the inner shell 30 diverges to a hump of maximum diameter (close to flap 58), after which the inner shell 30 converges to the trailing edge (at 34), figure 1.

4.2 The subject-matter of claim 1 differs from the turbofan engine according to D2 in that the axial cone angle of the inner shell varies circumferentially, having local minimum values at the pylon and beam and local maximum values on opposite lateral sides of the nozzle between the locations of the local minim values. Furthermore, the radius of the outer shell increases as the cone angle of the inner shell increases, i.e. also circumferentially and away from the local minimum values at the pylon and beam.

4.3 The technical effects of the differing features are described in paragraphs [0035], [0078] and [0079] of the patent as reducing pressure losses induced by the pylon and beam in the fan duct by means of altering the speed and pressure distribution of fan air compared to that of a conventional fan duct with circular ring cross sections. In line with paragraph [0012], the problem to be solved can therefore be considered as

increasing the efficiency of a turbofan exhaust nozzle equipped with pylon and beam.

4.4 D1 aims at mitigating negative effects of a pylon 66 or "any engine accessory which might affect the fan exhaust flow", column 1, lines 58-68. A skilled person would therefore consider the teaching of D1 as being relevant for solving the objective problem.
In the above citation, D1 does not propose an "area-ruled" geometry of the fan duct in general, but more specifically such an area ruled geometry, which provides flow relief areas "at the location of the pylon". As in the patent, flow relief areas are those having greater cross-sectional area for the air flow and thereby enabling higher air speeds. But differently from the patent, in D1 these flow relief areas are located at both sides of the pylon, not away from the pylon as claimed in claim 1. In particular (see column 4, lines 20-43), D1 teaches an increased radius of the outer shell 62 at the pylon 66 (reference signs 74 in figure 4, see column 4, lines 3-10) in combination with a decreased or minimum cone angle of the inner shell 54 at the pylon 66 (reference 100 in figures 1, 2, see column 4, line 63 to column 5, line 4).

Since pylon and beam are similar structures, a corresponding nozzle geometry would obviously be applied at a beam. This results in a locally increased flow area in the "bottom portion" of the nozzle, contrary to the features of claim 1, which provide for a locally decreased flow area in this region.
The Board is unconvinced that the other use of D1's concept as shown in figures 6 and 7 would be employed for a beam, whose structure corresponds far more to that of a pylon than to that of a local bulge in the inner shell 54 for housing engine controls (see column

4, lines 20 - 36). However, even if employed, the "area ruled principle" of D1 results also here in an increased radius 82 and thus flow area 84 in the region of the beam (see column 4, lines 43 - 52), not circumferentially away from it as claimed.

Consequently, the combination of D2 and D1 does not lead to the subject-matter of claim 1.

4.5 The Appellant suggests that starting from D1's general teaching of providing some area ruled geometry of the fan nozzle, it was obvious for the skilled person to try some other area ruled geometries in order to solve the problem, such as other circumferential developments of the cone angle leading to other locations of its maximum and minimum values than shown in figure 2 of D1. Thus the skilled person could and would arrive at the claimed solution without undue burden. For example, moving the location of the inner shell's maximum cone angle and the outer shell's maximum radius only slightly circumferentially away from the pylon in D1 (and then also from pylon and beam in D2) would already lead to a fan nozzle geometry falling in claim 1.

Whilst the Board agrees that the skilled person always tries to find an optimised solution, this does not go so far as to turn D1's concept completely around, i.e. to provide minimum flow areas instead of maximum flow areas around obstacles in the fan duct such as pylons and beams and to increase the cross-sectional area of the fan duct instead of decrease it circumferentially away from these obstacles. Such measures would not present only slight, but fundamental modifications of the teaching of D1, which do not fall within the customary practice of the skilled person. In the absence of further explicit motivation and/or

stimulation for doing so, which the Appellant did not argue, the Board does not consider such fundamental modifications as being obvious.

4.6 For the above reasons, the subject-matter of claim 1 involves an inventive step in the sense of Article 56 EPC in the light of the cited prior art.

5. **Conclusion**

The Board confirms the Opposition Division's findings that the subject-matter of claim 1 as upheld meets the requirements of the EPC, in particular does not extend beyond the content of the application as originally filed and involves an inventive step, Articles 123(2) and 56 EPC. Consequently, the Opponent's appeal against the Opposition Division's corresponding decision to maintain the patent in the amended form of auxiliary request 2 has to be dismissed.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

G. Magouliotis T. Bokor

Decision electronically authenticated