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Datasheet for the decision of 21 October 2015

Case Number: T 0411/13 - 3.2.01

Application Number: 03013521.4

Publication Number: 1375340

IPC: B64C3/14, B64C3/10

Language of the proceedings: EN

Title of invention:
Transonic wing with spanwise tailoring of divergent trailing edge and method for forming the wing

Patent Proprietor:
The Boeing Company

Opponent:
Airbus Operations Limited(GB) / AIRBUS SAS(FR) / Airbus Operations SAS(FR) / Airbus Operations GmbH (DE) / Airbus Operations SL(ES)

Headword:

Relevant legal provisions:
EPC Art. 123(2), 84, 56
RPBA Art. 13(1)

Keyword:
inventive step (main request : no)
extended subject-matter (auxiliary requests 5, 6 : yes)
clarity (auxiliary request 2 : no)
admission of requests to the proceedings(auxiliary requests 10 and new 10 : no)

Decisions cited:

Catchword:

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Case Number: T 0411/13 - 3.2.01

D E C I S I O N
of Technical Board of Appeal 3.2.01
of 21 October 2015

Appellant: (Patent Proprietor)	The Boeing Company 100 North Riverside Chicago, IL 60606-1596 (US)
Representative:	Witte, Weller & Partner Patentanwälte mbB Postfach 10 54 62 70047 Stuttgart (DE)
Respondent: (Opponent)	Airbus Operations Limited(GB) / AIRBUS SAS(FR) / Airbus Operations SAS(FR) / Airbus Operations GmbH (DE) / Airbus Operations SL(ES) New Filton House Filton Bristol BS99 7AR (GB)
Representative:	Ribeiro, James Michael Withers & Rogers LLP 4 More London Riverside London SE1 2AU (GB)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted on 6 December 2012 revoking European patent No. 1375340 pursuant to Article 101(3)(b) EPC.**

Composition of the Board:

Chairman	G. Pricolo
Members:	C. Narcisi
	O. Loizou

Summary of Facts and Submissions

I. European patent No. 1 375 340 was revoked by the decision of the Opposition Division posted on 6 December 2012. Against this decision an appeal was lodged by the Patentee on 14 February 2013 and the appeal fee was paid at the same time. The statement of grounds of appeal was filed on 16 April 2013.

II. Oral proceedings were held on 21 October 2015. The Appellant (Patentee) requested that the appealed decision be set aside and that the patent be maintained in amended form on the basis of the claims of the main request (auxiliary request D filed during opposition proceedings), or, in the alternative, on the basis of the claims of one of the auxiliary requests 2, 5 and 6, all requests as filed with its statement of grounds of appeal, or on the basis of the claims of auxiliary request 10 (as filed with letter dated 16 September 2015) or of the new auxiliary request 10 filed during oral proceedings.

III. Claim 1 of the main request reads as follows:

"An improved transonic wing, the wing having a chord and a span, the wing comprising:
an inboard wing portion (44; 144) that is configured to be coupled to an inboard side of a fuselage (50; 150); and a mid-span wing portion (46; 146) that is coupled to a distal end (54; 154) of the inboard wing portion (44; 144);
an outboard wing portion (48; 148) that is coupled to a distal end (72) of the mid-span portion (46; 146), wherein the outboard wing portion (48; 148) constitutes about 20% of the span of the wing (30; 102),

wherein each of the inboard wing portion (44; 144), the mid-span wing portion (46; 146) and the outboard wing portion (48; 148) includes a trailing edge base (38; 138), a high pressure surface (32; 132) connected to the trailing edge base (38; 138), a low pressure surface (34; 134) opposite the high pressure surface (32; 132) and connected to the trailing edge base (38; 138) and a leading edge (36; 136) connecting the high pressure (32; 132) and low pressure surfaces (34; 134) opposite thee trailing edge base (38; 138);
wherein at least a portion of a trailing portion of each of the high pressure and low pressure surfaces of the inboard wing portion (44; 144) are defined by slopes having an included trailing edge angle (24) that converges;
wherein a trailing portion of each of the high pressure and low pressure surfaces of the mid-span wing portion (46; 146) have slopes forming an included trailing edge angle (24) that diverges; and
wherein a trailing portion of each of the high pressure and low pressure surfaces of the outboard wing portion (48; 148) have slopes forming an included trailing edge angle that diverges."

Claim 1 of auxiliary request 2 differs from claim 1 of the main request in that the wording "outboard wing portion (48; 148) have slopes forming an included trailing edge angle that diverges" is replaced by the wording "outboard wing portion (48; 148) have slopes forming an included trailing edge angle that diverges, and wherein the transition between proximal and distal ends of said inboard wing portion includes discontinuous variations".

Claim 1 of auxiliary request 5 differs from claim 1 of the main request in that the wording "outboard wing

portion (48; 148) have slopes forming an included trailing edge angle that diverges" is replaced by the wording "outboard wing portion (48; 148) have slopes forming an included trailing edge angle that diverges, the distal end of the outboard wing portion (48, 148) having an included trailing edge angle (24) of about -10°".

Claim 1 of auxiliary request 6 differs from claim 1 of the main request in that the wording "outboard wing portion (48; 148) have slopes forming an included trailing edge angle that diverges" is replaced by the wording "outboard wing portion (48; 148) have slopes forming an included trailing edge angle that diverges, the trailing edge angle reducing at a uniform rate to about -10° at the distal end (76) of the outboard wing portion (48; 148)".

Claim 1 of auxiliary request 10 differs from claim 1 of the main request in that the wording "outboard wing portion (48; 148) have slopes forming an included trailing edge angle that diverges" is replaced by the wording "outboard wing portion (48; 148) have slopes forming an included trailing edge angle that diverges, the trailing edge angle and a trailing edge bluntness reducing at a uniform rate to -10° and 0.3% of the chord (40) respectively, at the distal end (76) of the outboard wing portion (48; 148)".

Claim 1 of new auxiliary request 10 filed during oral proceedings differs from claim 1 of auxiliary request 10 in that the wording "at a uniform rate to -10° and 0.3% of the chord (40) respectively" is replaced by the wording "at a uniform rate to about -10° and about 0.3% of the chord (40) respectively".

IV. The Appellant's submissions may be summarized as follows:

The subject-matter of claim 1 of the main request is inventive over E4 (Gregg R., Hoch R., and Henne P., "Application of Divergent Trailing-Edge Airfoil Technology to the Design of a Derivative Wing", SAE Technical Paper 892288, 1989, doi: 10.4271/892288). The feature reading "wherein a trailing portion of each of the high pressure and low pressure surfaces of the outboard wing portion (48; 148) have slopes forming an included trailing edge angle that diverges" (hereinafter designated as feature (i)) has to be construed such that the the trailing portion in its entirety is provided with an included divergent angle, i.e. a divergent trailing edge (DTE). This results for instance by comparison with the corresponding feature relating to the inboard wing portion in claim 1, which reads "wherein at least a portion of a trailing portion of each of the high pressure and low pressure surfaces of the inboard wing portion (44; 144) are defined by slopes having an included trailing edge angle (24) that converges". Therefore, as in the case of the inboard wing portion, if it was intended that only a portion of the trailing edge of the outboard wing portion be provided with a DTE, then this would be clearly specified in the claim. This is confirmed by independent claim 13, segregating the wing into three portions, the outboard wing portion being the outermost portion of these three portions. Thus, contrary to the Opposition Division's view, E4 does not disclose feature (i), for it discloses at best implementation of DTE only along a portion not exceeding 63% of the wing span, thus not including the outboard wing portion. Feature (i) would also not be obvious in view of E4, for there is no suggestion in

the prior art to extend DTE up to the tip of the outboard wing portion. E4 shows in figure 6 (corresponding to figure 41 of E1 (Henne, P.A.: "Innovation with Computational Aerodynamics : The Divergent Trailing Edge Airfoil", Chapter 8, Applied Computational Aerodynamics, Progress in Astronautics and Aeronautics, pages 221-261, Washington, DC, AIAA 1990, Ed. Vol. 125 ISBN: 0-930403-69-X)) that in the "transition from DTE"-zone (zone situated between the "Full use of DTE"-zone and the "Aileron"-zone, where no use of DTE was made) a first slope of a first linear segment of the curve (representing trailing edge thickness) can be prolonged (in case that no aileron constraint exists) beyond the point were the slope changes (corresponding to a second linear segment of the curve) and in this case said first linear curve segment would cross the former aileron line at about 68% wing span. Hence the skilled person is taught by E4, that even in the absence of the aileron constraint (this constraint implying according to E4 that no DTE should be applied to the aileron wing portion) the DTE portion of the wing span would anyway not exceed 68%. The outboard wing portion would be therefore situated even in this case well outside the zone of the wing span defining the outboard wing portion (see claim 1).

The subject-matter of claim 1 of auxiliary request 2 meets the requirement of clarity. In particular, the feature reading "wherein the transition between proximal and distal ends of said inboard wing portion includes discontinuous variations" clearly refers in the context of claim 1 (as is obvious from paragraph [0025] of the description of the patent specification (hereinafter designated as EP-B)) to the included angle having discontinuous variations, i.e. that its magnitude has abrupt and discontinuous changes, for

instance in a manner similar or analogous to a step function.

The subject-matter of claim 1 of auxiliary request 5 fulfils the requirements of Article 123 (2) EPC, since the feature reading "the distal end of the outboard wing portion (48, 148) having an included trailing edge angle (24) of about -10°" is based on the original patent application as filed, in particular on claim 10 of this application as published (hereinafter designated as EP-A). Even though claim 10 was dependent on claim 8, whose features have been omitted in present claim 1, the isolation of the features of claim 10 is permitted, for these features are not evidently related or connected to those of claim 8.

Claim 1 of auxiliary request 6 additionally specifies, as compared to claim 1, the feature reading "trailing edge angle reducing at a uniform rate to about -10°", which feature is based on paragraph [0028] of EP-A. Thus this claim likewise does not comprise subject-matter extending beyond the content of the application as filed.

Auxiliary request 10 and new auxiliary request 10 were filed in response to the objections of the Respondent disputing the allowability of the previously filed requests and should therefore be admitted to the appeal proceedings. The amendments of claim 1 are based on paragraph [0028] of EP-A and comply with the formal requirements of Articles 84 EPC and 123(2) EPC. These amendments also contribute to inventive step in combination with the further features of claim 1. Indeed, no suggestion is derivable from the prior art to extend the implementation of DTE up to the tip of the wing, given that the reduced cord length in the

vicinity of the tip usually also necessitates a reduced thickness, whilst a minimum thickness of .5 % of chord length is required in order to be able to apply DTE. By contrast to this conventional wisdom, according to the invention the surprising result was found, that an included divergent angle of about -10° in combination with a thickness .3 % does not lead to the mentioned technical difficulties.

V. The Respondent's arguments may be summarized as follows:

Claim 1 of the main request is not inventive over the disclosure of E4. Feature (i) is sufficiently clearly worded in the sense that by any means it does not imply that DTE is applied to the entire outboard wing portion, and particularly not necessarily to the outermost portion of the wing, since it is not even obvious that the term "outboard wing portion" should comprise the outermost portion of the wing. This is confirmed by paragraph [0006] in EP-B, stating that "preferably, the outboard wing portion is configured such that at least a portion of a trailing portion of the high pressure and low pressure surfaces are defined by slopes forming an included trailing edge angle that diverges". In addition, the language used in various prior art documents confirms that specific wing portions or regions, such as the wing tip, are always clearly indicated by their usual technical name. Starting from E4 the skilled person would obviously aim at extending DTE to the whole span of the wing, since an additional performance improvement related to suppression of compressibility drag would be expected. As stated in E4 (page 3, left column, third paragraph), "the DTE airfoil could not be used across the span of the aileron" and in order to preserve the baseline

aircraft, which uses a manual aileron, a hinge moment constraint was enforced. Therefore, "the design restriction constrained the application of the divergent trailing-edge airfoil to the inboard 63.9 percent of the wing semispan". E4 clearly suggests to extend use of DTE to the outer portion of the wing if no aileron constraint exist (see for instance E4, page 3, left column, last paragraph; page 13, right column, first paragraph). In addition, figure 7 in E4 (corresponding to figure 42 in E1) shows that the divergent trailing edge included angle (defined as negative) in the transition region (between "Full use of DTE" zone and aileron zone) increases linearly (i.e. the degree of divergence decreases) according to the slope of a first linear segment of the curve, and the prolongation of said line, in the absence of the aileron, would lead to the presence of a divergent angle over more than 90 % of the wing span. It is concluded that the skilled person would have several options to implement DTE over the entire wing span, thus arriving in an obvious manner at the claimed invention.

Claim 1 of auxiliary request 2 is not clear since there are ambiguities as to which physical entities, such as for instance included angle or wing thickness, said "discontinuous variations" are referring to. This remains unclear even when considering the detailed corresponding description in paragraph [0025] of EP-B, on which this feature is based.

The subject-matter of claim 1 of auxiliary request 5 contravenes Article 123(2) EPC. The added feature introduced by way of amendment into claim 1 is based on claim 10 of the application as filed, which claim however depends on claim 8 as filed (see EP-A).

Omitting this feature (of claim 8) from amended claim 1 is not permitted since the features of claims 8 and 10 are interrelated.

The subject-matter of claim 1 of auxiliary request 6 does not comply with Article 123(2) EPC for the same reasons as indicated in relation to auxiliary request 5. The added feature was also originally disclosed in paragraph [0025] of EP-A, but further features disclosed in this paragraph and related to said features have likewise been omitted in an unpermissible manner.

Auxiliary request 10 and new auxiliary request 10 should not be admitted to the appeal proceedings since they were filed at a late stage of the proceedings and without giving any reasons as to why the added features should contribute to inventive step. Further, the formal admissibility of the amendments is disputed, for the wording "about -10° and about 0.3% of the chord" is unclear and omission of the term "about" would contravene Article 123(2) EPC. Moreover, the arguments presented by the Appellant on inventive step during the oral proceedings are based on an allegedly surprising result never mentioned before during the proceedings. At all events, the added features cannot contribute to inventive step since the range of values indicated for the set of parameters mentioned in claim 1 is obvious in view of E4. In effect, figures 6 and 7 of E4 (corresponding to figures 41 and 42 in E1) in combination already illustrate a divergent angle of -10° (see dashed line in the transition zone in figure 7) corresponding (at the same value of semispan fraction) to a thickness (or bluntness) in the vicinity of .3 % of local chord length. Similar parameter values are disclosed in E3 (US-A-4 858 852) (see claims 2 and

4). Hence, for the skilled person these clearly represent indications of suitable parameter values, whilst at the same time leaving open a number of obvious design options for reducing said thickness and said divergent angle to the mentioned values at the tip of the wing.

Reasons for the Decision

1. The appeal is admissible.

2. The subject-matter of claim 1 of the main request lacks an inventive step over prior art E4. As to the interpretation of said feature (i) (i.e."wherein a trailing portion of each of the high pressure and low pressure surfaces of the outboard wing portion (48; 148) have slopes forming an included trailing edge angle that diverges") the Board concurs with the Respondent's view that feature (i) does not necessarily imply that the entirety of the trailing edge of said outboard wing portion is provided with a divergent trailing edge (DTE). In effect, the term "trailing portion ... of the outboard wing portion " clearly refers to a portion which extends in the spanwise direction and whose actual extension is not further specified. Moreover, as stated in the patent specification (EP-B) itself (see paragraph [0006]), "preferably, the outboard wing portion is configured such that at least a portion of a trailing portion of the high pressure and low pressure surfaces are defined by slopes forming an included trailing edge angle that diverges". Therefore there is no doubt that the broader interpretation as asserted by the Respondent should apply to feature (i).

It is not disputed between the parties that, except for feature (i), the remaining features of claim 1 are known from E4. Concerning feature (i), it is noted that E4 clearly states that "the DTE airfoil could not be used across the span of the aileron", for "the aft lift-loading of the DTE airfoil will create an increase in the control surface hinge moments" and consequently "an aileron hinge moment constraint was enforced" (see E4, page 3, left column, third paragraph). E4 further goes on stating that "the question was whether the significant performance improvements associated with the divergent trailing-edge airfoil would be realized with the imposition of many design (geometry) restrictions" and "a primary goal of the design exercise was to determine whether the limited spanwise extent of the DTE airfoil would generate the performance benefits demonstrated in less constrained applications" (E4, page 4, left column, first paragraph; right column, first paragraph). These passages undoubtedly suggest and hint at extending DTE to other portions of the wing span and in particular, in the absence of an aileron constraint, to the wing span portion corresponding to the aileron location, given that "the spanwise restriction created by the aileron hinge moment constraint required a partial span application of DTE technology" (E4, page 4, left column, last paragraph). Consequently the skilled person, in an attempt to reduce compressibility drag and increase lift, would obviously extend the application of DTE to the wing span portion corresponding to the aileron location on the wing, i.e. to a wing span portion comprised between about 63.9% and 87% of the wing span (according to figures 6 and 7 of E4, or to figures 41 and 42 of E1). This is also suggested by figure 7 of E4 (corresponding to figure 42 of E1), which the Board considers to be more relevant

than figure 6 (corresponding to figure 41 of E1) since it directly shows the variation of the trailing-edge included angle, by contrast to figure 6 illustrating merely the thickness (or bluntness). In effect, figure 7 itself demonstrates that the abrupt variation of the included trailing-edge angle, in the "Transition from DTE"-zone of the illustrated curve (between about 0.52 and 0.639 semispan fraction), is evidently exclusively due to said aileron constraint and the figure suggests that in the absence of said constraint a linear variation of said angle implying a reduced slope of the corresponding linear segment of the curve would be more likely and technically meaningful. Thereby a curve segment in figure 7 would result having a reduced slope or gradient inducing a smoother variation of said angle, which curve segment would represent a major portion of the wing span portion occupied by said former aileron. Thereby the skilled person would provide in an obvious manner said feature (i) and would thus arrive at the claimed subject-matter (Article 56 EPC).

3. The subject-matter of claim 1 of auxiliary request 2 is not clear, for the feature reading "wherein the transition between proximal and distal ends of a wing portion includes discontinuous variations" is ambiguous. Firstly, it is not specified which physical entities are affected by said "discontinuous variations" (e.g. included angle, thickness etc.) and secondly the meaning of said "discontinuous variations" remains unclear within the technical context of the claim. Indeed, the term "discontinuous variation" can imply for instance that either of the physical entity itself or its derivative is discontinuous, or both. However it is not clear from the technical context of claim 1, which of these alternatives applies. In

addition it is noted that even when referring to the description, although the subject-matter of claim 1 should be clear per se, the aforementioned questions remain unanswered (see EP-B, paragraph [0025]). For these reasons claim 1 does not fulfil the requirements of Article 84 EPC.

4. The subject-matter of claim 1 of auxiliary request 5 extends beyond the content of the application as filed. The added feature reading "the distal end of the outboard wing portion (48, 148) having an included trailing edge angle (24) of about -10°" is based on claim 10 as filed (see EP-A). However, claim 10 as filed is dependent on claim 8 as filed and the features of claim 8 have been omitted in claim 1 of this auxiliary request. This omission constitutes an impermissible generalization, for the features of claim 10 were originally disclosed only in combination with those of claim 8 and moreover these features are technically interrelated, as the implementation of DTE implies that predetermined joint design choices for both the divergent included angle (mentioned in claim 10 as originally filed) and the bluntness (mentioned in claim 8 as originally filed) of the trailing edge have to be made. For these reasons the requirements of Article 123(2) EPC are not complied with.

5. The subject-matter of claim 1 of auxiliary request 6 is not in compliance with Article 123(2) EPC since the added feature is at least partly based on claim 10 of the application as filed (EP-A), which is however dependent on claim 8 of EP-A, whose features have been omitted in amended claim 1. Therefore the same reasons apply as for claim 1 of auxiliary request 5, i.e. no basis is provided for this amendment by paragraph [0028] of EP-A, since the features relating to uniform

reduction of the bluntness (mentioned in paragraph [0028] of EP-A) are omitted in claim 1.

6. The Board decided to exercise its discretion under Article 13 (1) RPBA (Rules of Procedure of the Boards of Appeal) not to admit the auxiliary request 10 and the new auxiliary request 10 to the appeal proceedings. These auxiliary requests were filed at a very late stage of the appeal proceedings despite the fact that they could have been filed earlier, for the Respondent's objections based on documents E1, E4 and E3 were presented already at the outset of the appeal proceedings. Moreover, the reasons why the specific subject-matter of claim 1 of these requests would overcome the Respondent's objections, particularly concerning inventive step, were presented only during the oral proceedings. Particularly, some of these arguments relating to an allegedly surprising effect were not presented earlier in the proceedings and nothing can be found in this respect in EP-A. Further, on the basis of a prima facie examination of the subject-matter of claim 1 during oral proceedings, the Board considered that, as a result of the discussion, claim 1 of these requests would anyway not overcome the outstanding objections relating to substantive matters. In effect, in addition to giving rise to questions of admissibility under Article 84 EPC and 123(2) EPC (see feature reading "at a uniform rate to about -10° and about 0.3% of the chord (40) respectively" in claim 1 of auxiliary request 10bis, and the deletion of the term "about" in this same feature of claim 1 of auxiliary request 10), the subject-matter of claim 1 of these requests does not seem to involve an inventive step in view of E4 and E3 (Article 56 EPC). In effect, as was pointed out by the Respondent (see above, point V), the added feature includes parameter values and

ranges which are suggested by, or at least lie in the immediate vicinity of parameter ranges indicated and illustrated in E4 and E3. In addition it is noted that the added feature (i.e. "the trailing edge angle and a trailing edge bluntness reducing at a uniform rate to -10° and 0.3% of the chord (40) respectively, at the distal end (76) of the outboard wing portion (48; 148)") does not indicate any specific design choice for the manner in which said uniform rate reduction of divergent angle and trailing edge thickness occurs, thus being indeed quite broad in scope (for instance the mentioned values of 10° and 0.3% could in principle be implemented at any wing span location on the outboard wing section situated before the distal end of the wing and then maintained constant up to the tip of the wing). For these reasons the Board likewise considers that the various different design options implied by this broad range as claimed cannot represent an inventive selection and, on the contrary, lie well within the capabilities of the skilled person having at its disposal adequate tools (for an appropriate choice), such as e.g. computer fluid dynamics simulations.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

N. Schneider G. Pricolo

Decision electronically authenticated