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D E C I S I O N
of 24 June 2004

Case Number: T 1110/02 - 3.2.1

Application Number: 95900528.1

Publication Number: 0728101

IPC: B64C 9/24

Language of the proceedings: EN

Title of invention:
Leading edge slat/wing combination

Patentee:
THE BOEING COMPANY

Opponent:
Airbus Deutschland GmbH

Headword:
-

Relevant legal provisions:
EPC Art. 54, 56

Keyword:
"Novelty (yes)"
"Inventive step (yes)"

Decisions cited:
-

Catchword:
-

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Case Number: T 1110/02 - 3.2.1

D E C I S I O N
of the Technical Board of Appeal 3.2.1
of 24 June 2004

Appellant: (Opponent)
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Decision under appeal:
Decision of the Opposition Division of the European Patent Office posted 27 September 2002 rejecting the opposition filed against European patent No. 0728101 pursuant to Article 102(2) EPC.

Composition of the Board:

Chairman: S. Crane
Members: J. Osborne
G. E. Weiss

Summary of Facts and Submissions

I. The appeal is directed against the decision posted 27 September 2002 in which the opposition against European patent No. 0 728 101 was rejected.

II. The following evidence played a role during appeal:

E1: US-A-4 650 140

E3: DE-A-2 426 245

E4: US-A-3 089 666

E8: "A300 Aircraft maintenance manual", section 27·81·00 pages 9 to 12, section 57·40·00 pages 3 and 14 and section 57·50·00 pages 20 and 23 to 29

E9: Statutory declaration by Günter Behrens regarding public availability and disclosure of E8

E10: *R.F. Back et al*, "The A320 Wing - Designing for Commercial Success", British Aerospace PLC

E12: "transpress Lexikon Luftfahrt", 3rd edn., Berlin, transpress VEB Verlag für Verkehrswesen, 60.

III. In oral proceedings held 24 June 2004 the appellant requested that the decision under appeal be set aside and that the patent be revoked. The respondent requested that the patent be maintained as granted (main request) or in the alternative that it be maintained in amended form on the basis of claims 1 to

16 filed with a letter of 24 May 2004 (auxiliary request).

IV. Claim 1 according to the respondent's main request (as granted) reads as follows:

"A slat/fixed wing combination, comprising:
a. a fixed wing having a leading edge portion, an upper surface comprising a concealed forward nose and upper surface portion, and a main upper surface portion located rearwardly of the concealed forward nose and upper surface portion, and also a lower surface;
b. a slat having a leading edge, a trailing edge, and a forward and upper surface portion extending from said leading edge to said trailing edge, said slat being mounted to said leading edge portion of the fixed wing in a manner to be movable between three positions, namely:
i. a first cruise position where the slat is immediately adjacent to the fixed wing leading edge portion to conceal said concealed forward nose and upper surface portion;
ii. a second intermediate takeoff/climb position where the slat is located forwardly of the cruise position, and the trailing edge of the slat is in contact with, or closely adjacent to, said forward concealed nose and upper surface portion; and
iii. a third high lift position where the slat is moved forwardly and downwardly from the second position with the trailing edge of the slat forming an aerodynamic high lift position gap with the leading edge portion of the fixed wing;

c. said fixed wing having a fixed wing outer contour envelope contained within said upper and lower surfaces of said fixed wing;

d. a slat actuating mechanism comprising a substantially circularly curved carrier track means having a forward end to which the slat is mounted with a substantially fixed angular orientation relative to said track means, said track means having an arcuate lengthwise track axis extending in a substantial curve along said track means, said track means being mounted for movement along said track axis from a rear track position where the slat is positioned in the first cruise position, to an intermediate track position where the slat is positioned in said second intermediate position, and a forward track position where the slat is located in said third high lift position;

e. said track means having a track structural and operating envelope having a maximum width dimension generally perpendicular to said lengthwise track axis and a maximum length dimension extending along said lengthwise track axis, said track means being arranged relative to said outer surface contour envelope of said fixed wing in a manner that in the cruise position the track structural envelope is positioned substantially entirely within the outer surface contour envelope of the fixed wing, wherein the lengthwise axis of the carrier track means has a center of curvature for said track means, said trailing edge of the slat has three trailing edge point locations at said first, second and third positions of the slat that define a trailing edge arcuate path of travel for the trailing edge of the slat, which trailing edge arcuate path has a center of curvature for the slat trailing edge path of travel,

and a leading edge point of said slat has three leading edge point locations at the first, second and third positions of the slat, and the three leading edge locations of the slat define a leading edge arcuate path of travel having a center of curvature of the path of travel of the leading edge of the slat, characterized in that the center of curvature of the track, the center of curvature of the slat trailing edge path of travel, and the center of curvature of the slat leading edge path of travel are all coincident."

Claims 2 to 11 as granted define features additional to the subject-matter of claim 1.

V. The appellant's arguments may be summarised as follows:

The subject-matter of claim 1 according to the main request is not novel in comparison with the prior art known from each of E1, E3, E4 and E8/E9.

The respondent accepts that the features of the preamble are known from E1 and in the second embodiment of that document (Figure 9) the slat is rigidly mounted on an arcuate track. Although there is reference to the variable cambering of the slat, according to column 9, lines 6 to 12 the slat nose may remain fixed to the slat frame. Moreover, although Figure 9 does not illustrate the slat in the high lift position this is merely a schematic indication and the skilled person understands that the position shown is not a true representation.

As regards E3 the skilled person is aware that it is conventional that the slat is movable to three

positions, as acknowledged in the contested patent specification in column 1, lines 14 to 29. Only the extreme ones of the three positions are shown in E3 but there is reference in the final paragraph of page 5 to the positions "ii" and "iii" defined in present claim 1.

E4 shows in Figures 41 and 42 slats which are movable by means of an arcuate track, resulting in the characterising features of present claim 1.

According to E8 the slats are operated by a five position control lever, resulting in the positions "i" to "iii" defined in present claim 1. The skilled person understands that the slats are rigidly connected to the arcuate track which, according to E9, was circular. Moreover, E9 states that the intermediate position "ii" was known, resulting in the features of the characterising portion of present claim 1.

In the event that it were to be found that E1 does not disclose the characterising features of present claim 1 in combination with those of the preamble it would be obvious for the skilled person to combine the teachings of the second embodiment of E1 with the fixed slat nose arrangement of E3, thereby arriving at the subject-matter of present claim 1. Similar argumentation arrives at an obvious combination of E8/E9 with the second embodiment of E1.

VI. The respondent countered essentially as follows:

The basic teaching of E1 relates to the change in camber of the slat nose portion and this has the inevitable result that the common centre defined in the

characterising portion of claim 1 is not present. The illustration of the embodiment of Figure 9 is of the slat in its fully extended position, corresponding to the second position of the first embodiment. There is no disclosure of the third position in this embodiment.

E3 discloses only two positions for the slat. Moreover, whereas present claim 1 requires that the carrier track is part of the actuating mechanism this is not so according to E3.

E4 does not disclose a slat/fixed wing combination. The movable member illustrated in Figures 41 and 42 is a baffle plate which has only retracted and extended positions. In the latter position it can be additionally pivoted into an orientation in which the respective centres of curvature defined in the characterising portion of present claim 1 are no longer coincident.

Also in E8 the guidance and actuation of the slat are performed by separate constructions. Furthermore, the slats are not fixed relative to the track such that the coincidence of the respective centres of curvature is not present. Only two positions of the slat are disclosed and it is not even clear whether the extended position illustrated is a high lift position as defined in present claim 1. The reference to five positions of the control lever is no evidence that the slat is movable into three positions. Finally, according to case law it is necessary in a case such as this for the appellant to prove all aspects relating to a prior use "up to the hilt". This has not been done in the present case.

As regards inventive step the first embodiment of E1, which does comprise the three slat positions defined in present claim 1, also comprises the feature of a variable camber on the slat. This excludes the possibility of the common centres of curvature as defined in present claim 1 and there is no suggestion to delete this feature. The present invention results from a simplification of the prior art slat mechanism whilst nevertheless achieving improved aerodynamic performance by closing the gap between the slat trailing edge and the wing in the intermediate position. No cited document relates to this problem; E3 relates to problems of stalling whilst E8/E9 has no mention of the intermediate position.

Reasons for the Decision

1. The Board considers it useful to summarise some general points regarding the general art with which the present patent is concerned before considering the cited prior art in detail.

1.1 The present patent relates to the combination of a slat and a fixed aircraft wing. The slat is arranged on the leading edge of the wing and is movable into various positions in order optimise conditions of lift and drag. In the cruise condition, position "i" in claim 1, the slat is fully retracted to provide the wing with an optimised aerodynamic configuration and conceals the forward nose and upper surface portions of the wing. For take-off and climb, position "ii" in claim 1, the slat is moved towards an intermediate position which

provides increased lift by extending the chord length of the wing whilst avoiding excessive drag. A fully extended, high lift position, position "iii" in claim 1, provides adequate lift at relatively low speeds for landing but at the expense of increased drag. The aerodynamic gap results in airflow from beneath the slat upwardly through the gap and over the upper forward surface portion of the fixed wing.

1.2 It is acknowledged in the introduction to the description of the patent specification that it has long been known to mount the slat on an arcuately shaped carrier track. In an early configuration the slat was fixedly mounted on the carrier track and in both the intermediate and high lift positions the trailing edge of the slat formed a gap with the upper surface portion of the wing. In a development of this arrangement the slat was pivotally mounted on the carrier track and its orientation was controlled by a cam arrangement which positioned the trailing edge of the slat in contact with the upper surface of the wing when in the intermediate position and rotated the slat about the pivot point to create an aerodynamic gap when it moved into the high lift position.

2. E1 relates to a slat/wing combination in which the curvature of the upper surface of the slat is variable. The slat is formed in two parts, a slat frame and a slat nose portion which are relatively movable and the upper surfaces of which are connected by a flexible panel. Two embodiments are described, in both of which extension of the slat frame from the cruise position "i" is by a curved carrier track to which the slat frame is mounted. During this extension the nose

portion is moved anti-clockwise relative to the slat frame under the control of a camber programming track and actuating arm, thereby increasing the camber on the flexible panel.

2.1 In the first embodiment, to which Figures 1 to 8 relate, the slat frame is pivotally mounted relative to the carrier track, the relative position being controlled by means of a slat programming track and arm arrangement. The arrangement is such that the slat is movable into the three positions designated in present claim 1 as "i", "ii" and "iii", shown in Figures 1, 2 and 4 respectively. Figures 1 to 4 and 6 are different spanwise sections showing the camber and slat programming tracks respectively. Figure 5 is a side view at a further spanwise section showing the carrier track at the extended end of its travel.

2.2 The second embodiment is illustrated only in Figure 9 which is similar to Figure 5 in as far as it is a sectional side view showing the carrier track at the extended end of its travel. In this embodiment the slat frame is fixedly mounted on the arcuate carrier track whereby the slat programming track and arm arrangement of the first embodiment is no longer required. However, the relative movement of the nose portion and slat frame in order to provide variable camber of the flexible surface portion under the control of the camber programming track and arm remains.

In this second embodiment the nose portion moves relative to the slat frame during the extension of the slat whereas the slat frame moves about the centre of curvature of the carrier track. It follows that the

characterising feature of present claim 1 that the centre of curvature of the slat leading edge path of travel is coincident with that of the carrier track is not present. The appellant argues that E1 column 9, lines 6 to 10 teaches that the relative movement between the nose portion and frame is an optional feature. However, this is not the case. The wording to which the appellant refers merely serves to explain that the majority of the angular movement of the nose portion in the first embodiment is caused by the movement of the nose portion relative to the slat frame. It is that movement which is explicitly stated to be present in the second embodiment and there is therefore no basis for the appellant's assertion that the wording to which it refers renders this feature optional.

Moreover, there is no clear disclosure that the slat according to the second embodiment is able to adopt the same three positions as the arrangement according to the first embodiment. Although the carrier track is illustrated in Figure 9 as being in its most extended position, the trailing edge of the slat is located adjacent to the surface of the wing, i.e. not in the high lift position "iii" defined in present claim 1. However, Figure 5 which similarly illustrates the carrier track of the first embodiment in its most extended position also shows the trailing edge of the slat located adjacent to the surface of the wing. The Board concludes that it is not possible to rely on the disclosure of the figures in this respect. Moreover, even if the most extended position of the slat according to the second embodiment of E1 would place the slat in the position "iii" there is no disclosure that in an intermediate position the trailing edge of

the slat would be in the same position relative to the wing upper surface as in the first embodiment. In this respect the Board refers to the present patent specification (column 15, lines 23 to 48; Figure 8) from which it is clear that the surface contour of the concealed portion of the fixed wing also is a factor in achieving the intermediate position "ii". Consequently, it is not necessarily the case that the arrangement according to the second embodiment of E1 would place the trailing edge of the slat when in its intermediate position in contact with, or closely adjacent to the surface of the wing, as required by present claim 1.

3. According to E3 this document relates to slats which can move to an extended position ("eine ausgefahrene Stellung") in order to increase lift. Correspondingly, the two figures illustrate the slat in the cruise and extended positions ("in der ausgefahrenen Lage") respectively. The slat is illustrated as being fixedly mounted on a carrier track and is movable by mans of a hydraulic actuator.

3.1 The aim of the invention according to E3 is to provide a system which permits the position of the slat to be controlled either automatically in dependence on the inclination of the aircraft or manually and to this effect a control system is proposed. However, the control system, whether operated manually or automatically under the influence of an inclination sensor, is capable of placing the hydraulic actuator only in two positions, a cruise position and an extended position. The final paragraph of page 5, to which the appellant refers, merely states that the slats can be manually operated for take-off, descent

and landing. Contrary to the appellant's assertion this fails to specify whether it refers to more than one extended position of the slats.

3.2 In the extended position the trailing edge of the slat is shown spaced somewhat from the surface of the wing. However, E3 contains no explanation of the aerodynamic aspects of the extended position and it is not clearly derivable from E3 whether this position is intended to correspond to the high lift position "iii" in present claim 1 or a single extended position in which the trailing edge portion of the slat is spaced from the upper surface portion of the fixed wing.

4. E4 relates to an aircraft having power plants of which the thrust direction relative to the fuselage can be changed so as to direct thrust in a primarily forward or downward direction. A problem which occurs with such an arrangement is that at certain angles of the engine a flow of air is created which passes downward at high speed around the leading edge of the wing, resulting in negative lift. The solution proposed by E4 is to provide a baffle plate at the leading edge of the wing which can be extended into a position in which it creates an obstruction to the downward movement of the air which thereby is deflected upwards over the wing. As discussed under 1 above, a slat as specified in present claim 1 is a device on the leading edge of a wing which may be extended to modify the aerofoil in order to increase lift at low speeds. By comparison the baffle plate of E4 operates when the airflow approaches the wing from a direction considerably different from that at which the wing is normally intended to operate

as an aerofoil. Consequently, E4 does not disclose a slat/wing combination as defined in present claim 1.

5. E8 contains various sectional views of a slat/wing combination both in the cruise position and in an extended position in which a large gap is present between the trailing edge of the slat and the leading edge portion of the wing, thereby clearly corresponding to the high lift position "iii" in present claim 1. However, there is no illustration of an intermediate position.

5.1 In section 3 "system description" (27·81·00 page 9) it is stated that "the position of the wing slats is selected by means of a five-position control lever" and in the Board's view this is an implicit disclosure of an intermediate position. This is consistent with the statement by Günter Behrens in E9 that the slat may be placed in several positions and that it passes from the cruise position though an intermediate position into its extended position. However, there is no information in either E8 or E9 as regards the relationship between the trailing edge of the slat and the upper surface of the wing in the intermediate position.

5.2 E8 relates to a prior use of the Airbus A300 aircraft which is a product of the appellant itself. The respondent argues that the appellant has failed, as judged by the standards set by the Boards of Appeal in such a case, to sufficiently prove the public availability of the alleged prior use. In the Board's view there is no serious doubt that the information presented was in the public domain before the priority date. However, despite the wealth of information which

the appellant would have available in respect of its own product, that provided by the appellant in respect of the intermediate position is vague. The appellant's assertion with reference to E12 that the intermediate position is conventional within the art also fails to fill this gap in its case since the information contained therein relates merely to a single aircraft. Indeed, E10 relating to the design of a slat/wing combination for an Airbus A320 discloses that the best (intermediate) position for take-off was with a gap between the slat trailing edge and the wing surface (4.3 and Figure 27).

6. It follows from the foregoing that none of the documents relied on by the appellant destroys the novelty of the subject-matter of claim 1 according to the main request (Article 54(1) EPC).

7. The above analysis of the cited prior art shows that the only disclosure of the claimed intermediate position "ii" is in respect of the first embodiment in E1. In that embodiment the location of the trailing edge of the slat relative to the upper surface portion of the wing is controlled by the slat programming track and arm arrangement. Other prior art arrangements including that of E1 Figure 9 and E8 are simpler in as far as the trailing edge of the slat follows a path determined only by the arcuate movement of the carrier track but they do not result in a slat which is movable into both of the positions "ii" and "iii" of present claim 1. According to present claim 1 the paths of travel of the slat leading and trailing edges share a common centre of curvature with the carrier track, thereby dispensing with the complexity of the first

embodiment of E1. The description of the patent specification illustrates with reference to Figures 8 to 10 that this result is achievable by changing the surface contour of the concealed surface portion of the fixed wing.

7.1 As already discussed above, in all of the prior art relied upon by the appellant with the exception of the first embodiment of E1, the slat occupies either only two positions or three positions in the intermediate one of which the trailing edge of the slat is not in contact with or closely adjacent to the fixed wing portion. It follows that a combination of the teachings of the second embodiment of E1 with the arrangement according to either E3 or E8/E9, as argued by the appellant, would not result in the subject-matter of present claim 1.

7.2 The closest prior art is defined not by the second embodiment of E1 but by the first in which a slat arrangement which provides the claimed positions "i", "ii" and "iii" is known and the subject-matter of present claim 1 differs therefrom by the feature to be found in part (d) of the preamble of the claim that the slat is mounted with a substantially fixed angular orientation relative to the track means in combination with the features of the characterising portion. In the other prior art relied upon by the appellant there is no teaching that the combination of the aerodynamic arrangements "ii" and "iii" could be achieved in any way other than the complex cam arrangement of the first embodiment of E1.

7.3 The Board therefore concludes that the subject-matter of claim 1 according to the main request also involves an inventive step (Article 56 EPC). Since claims 2 to 11 contain all features of claim 1 this conclusion applies equally to those claims.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

A. Vottner S. Crane