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D E C I S I O N
of 16 April 1996

Case Number: T 0680/94 - 3.2.1
Application Number: 88304357.2
Publication Number: 0291328
IPC: B64C 9/24, B64C 13/34, F16H 19/00

Language of the proceedings: EN

Title of invention:

A mechanism for supporting and extending a high lift device for aircraft wings

Patentee:

British Aerospace Public Limited Company

Opponent:

The Boeing Company

Headword:

-

Relevant legal provisions:

EPC Art. 56

Keyword:

"Inventive step (no)"

"Late submitted amendments - not considered"

Decisions cited:

T 0095/83, T 0153/85

Catchword:

-



Case Number: T 0680/94 - 3.2.1

D E C I S I O N
of the Technical Board of Appeal 3.2.1
of 16 April 1996

Appellant:
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Decision under appeal: Decision of the Opposition Division of the
European Patent Office posted 23 June 1994
revoking European patent No. 0 291 328 pursuant to
Article 102(1) EPC.

Composition of the Board:

Chairman: F. Gumbel
Members: S. Crane
B. Schachenmann

Summary of Facts and Submissions

- I. European patent No. 0 291 328 was granted on 9 January 1991 on the basis of European patent application No. 88 304 357.2.

Claim 1 of the granted patent reads as follows:

"A mechanism for supporting and extending a high lift device relative to an aerofoil, comprising one or more carrier beams (10) adapted to be connected to said aerofoil, a pair of spaced apart chordwise extending wing ribs (20) bounding the or each said carrier beam, supporting means (23) mounted between said wing ribs (20) for supporting said carrier beam(s) (10) the or each said carrier beam (10) carrying a gear rack (12) with gear teeth facing downwardly and a pinion gear (13) in meshing engagement with said gear rack (12), and an actuator (14) in driving engagement with said pinion gear (13) to extend and retract the high lift device (2-6) relative to said aerofoil (1), characterised in that a pair of bearing housing assemblies (45, 47) are provided for rotatably supporting said pinion gear (13) between said wing ribs (20) about a generally transverse axis of rotation independently of said actuator (14), each bearing housing assembly (45, 47) including self-aligning bearings (46) with inner bearing sleeves (48, 49) mounted fast in rotation with the pinion gear (13)."

Dependent claims 2 to 5 relate to preferred embodiments of the mechanism according to claim 1.

- II. The patent was opposed by the respondents on the ground that its subject-matter lacked inventive step (Article 100(a) EPC).

Among the documents relied upon by the respondents were:

- (D1) EP-A-0 045 988
- (D12 to D18) A technical description and drawings relating to the flap actuation system of the Boeing 747 aircraft.

III. By its decision given at oral proceedings on 8 June 1994 and issued in written form on 23 June 1994 the Opposition Division revoked the patent.

The reasons given for the decision can be summarised as follows:

Document D1, on which the preamble of claim 1 was based, disclosed a power drive unit which was remote from the supporting and extending mechanism and which drove a speed reducer on the output shaft of which the pinion gear was arranged. There was no reason why the power drive unit of document D1 should not be equated to the actuator required by claim 1 and it was clear that the pinion gear was supported "independently of" this actuator. Furthermore, the structure of the "bearing housing assemblies" was undefined in the claim and on a normal interpretation of this term it clearly extended to the bearing assemblies shown in document D1. Thus the only distinguishing feature was the use of self-aligning bearings. These were, however, wholly conventional in the context, as had been conceded by the appellants (proprietors of the patent).

IV. An appeal against this decision was filed on 18 August 1994 and the fee for appeal paid at the same time.

The statement of grounds of appeal was filed on 3 November 1994.

The appellants requested that the contested decision be set aside and the patent maintained in granted form.

- V. A summons to oral proceedings before the Board pursuant to Rule 71(1) EPC was issued on 9 October 1995.

In an annex to the summons the Board stated its provisional opinion that in the light of the description of the patent specification the requirement that the pinion gear be supported for rotation "independently of the actuator" should not be interpreted in the way contemplated by the contested decision and that consequently this feature of claim 1 was not disclosed in document D1. However, having regard to the arrangement known from the Boeing 747 aircraft, which was indisputably prior used, the adoption of independent support for the pinion gear did not appear to involve an inventive step.

This summons stated that any further submissions in preparation for the oral proceedings should be filed one month before the date set.

- VI. At the oral proceedings, which were held on 16 April 1996, the appellants submitted an amended claim 1 according to an auxiliary request for maintenance of the patent in amended form.

This claim reads as follows:

"A mechanism for supporting and extending a high lift device relative to an aerofoil, comprising one or more carrier beams (10) adapted to be connected to said aerofoil, a pair of spaced apart chordwise extending wing ribs (20) bounding the or each said carrier beam, supporting means (23) mounted between said wing ribs (20) for supporting said carrier beam(s) (10), the or

each said carrier beam (10) carrying a gear rack (12) with gear teeth facing downwardly and a pinion gear (13) in meshing engagement with said gear rack (12), and an actuator (14) having a splined output shaft engaging said pinion gear (13) to extend and retract the high lift device (2-6) relative to said aerofoil (1),

characterised in that a pair of bearing housing assemblies (45, 47) are mounted upon the inner faces of each respective rib (20) for rotatably supporting said pinion gear (13) between said wing ribs (20) about a generally transverse axis of rotation independently of said actuator (14), each bearing housing assembly (45, 47) including self-aligning bearings (46) with inner bearing sleeves (48, 49) mounted fast in rotation with the pinion gear (13)."

VII. The arguments put forward by the appellants in support of their requests can be summarised as follows:

The leading edge flap constructions as shown in document D1 and as used in the Boeing 747 aircraft were completely different to each other. In the latter the flap was carried on the torque tube and it was therefore essential that this be independently supported by bearings on the wing ribs. In the former the flap was supported by rollers acting on the top and bottom surfaces of the carrier beam. The pinion gear played no role in the actual support of the flap. There was therefore no reason why the skilled person seeking to develop the construction of document D1 should have any reference to the construction used in the Boeing 747.

The teaching of document D1 was clear as to how the pinion gear was to be arranged. It was splined to the output shaft of the rotary actuator and this shaft was supported by bearings located in bores in the wing ribs.

When the actuator was removed for inspection or servicing the pinion gear had to be removed with it. This was intended as it was thought necessary for the pinion gear to be inspected, serviced and/or replaced at the same time. The claimed invention was based on a different concept which enabled accurate positioning of the pinion gear with respect to the gear rack and hence reduction in its wear. Thus the pinion gear could generally be left in place when the actuator was removed, maintaining the accurate meshing between itself and the gear rack, and to this end was supported independently of the actuator by the bearing housing assemblies. Means did however have to be provided to allow removal of the pinion gear at longer intervals. This was achieved in that the bearing housing assemblies were positioned between the wing ribs and not located in bores therein. The particular arrangement of the bearing housing assemblies also enabled an adjustment in the position of the pinion gear independently of the position of the bores in the wing ribs so as to achieve the desired accurate meshing. There was no equivalent bearing arrangement disclosed in documents D12 to D18 which related to the Boeing 747.

The authors of document D1 had clearly been aware of the structure of the Boeing 747 when the document was drafted. This being the case it could have been expected that document D1 would also have proposed independent support of the pinion gear, if this had been obvious.

According to claim 1 of the auxiliary request it had been clarified that the actuator was proximate to the pinion gear and that the bearing housing assemblies were mounted on the inner faces of the respective wing rib. These features were in fact implicit in granted claim 1 when proper account was taken of the disclosure of the patent specification. Furthermore, the importance of the

latter of these features had been emphasised during the course of the opposition proceedings so that the respondents could not claim that they were surprised by the introduction of this clarification into the claim.

VIII. In support of their request that the appeal be dismissed the respondents argued substantially as follows:

Document D1 had to be read in context. It was concerned with a major breakthrough in the way high-lift flaps were supported and extended. The way in which the pinion gear which meshed with the gear rack carried by the carrier beam was arranged was wholly incidental to the central teaching of the document. As disclosed, the pinion gear was splined to the output shaft of the rotary actuator and this shaft was supported by bearings positioned in bores in the wing ribs. It was thus removed at the same time as the actuator during servicing. It was however well known from the Boeing 747 aircraft, as could be seen from documents D12 to D18, to provide an arrangement in which the actuator could be removed without disturbing any part of the flap extension mechanism as such. This option was freely available to the skilled person for use with a rack and pinion mechanism as disclosed in document D1. All that it required was for the pinion gear to be directly supported by bearing assemblies in the way the torque tube was in the Boeing 747.

The appellants had placed much emphasis on the accurate meshing between the gear rack and the pinion gear. This was however achieved by features which did not appear in granted claim 1 and had nothing to do with the way the pinion gear was supported. In particular, there was no suggestion that the particular form of the bearing housing assemblies used was advantageous in this respect.

The submission of an auxiliary request at the oral proceedings was an abuse of the procedure and to admit it would be unfair to the respondents. It was wholly evident that the additional feature introduced concerning the positioning of the bearing housing assemblies was not a mere "clarification", as claimed by the appellants, since the granted claim was perfectly clear in this respect. The proposed amendment had not been foreshadowed in the submissions made by the appellants in the course of the proceedings and the respondents had had no opportunity to prepare their case with respect to it. As for the proposed restriction of the relationship between the actuator and the pinion gears this should also not be allowed since the appellants had explicitly refused to make such an amendment before the Opposition Division.

Reasons for the Decision

1. The appeal complies with the requirements of Articles 106 to 108 and Rules 1(1) and 64 EPC. It is therefore admissible.
2. *Main request*

Document D1 discloses, with particular reference to Figures 1 to 7, a mechanism for supporting and extending a high-lift device, in particular a wing leading edge flap. The flap is mounted on a plurality of carrier beams which have an inverted generally U-shaped cross-section. The carrier beams are supported by rollers which extend between respective pairs of wing ribs and engage upper and lower surfaces of the beams. Each carrier beam is provided with a gear rack disposed between the open arms of its U-shaped cross-section, the

gear rack meshing with the teeth of a pinion gear driven by a rotary actuator in the form of a reduction drive driven by a remote power unit. The actuator is attached to one of the wing ribs with its output shaft supported by bearing assemblies located in respective bores in the wing ribs and the pinion gear is splined to the output shaft.

Document D1 is referred to in the description of the present patent specification and forms the basis of the preamble of claim 1. In the description it is commented that in this prior art the pinion gear is only installed simultaneously with the actuator engaging splines on the actuator shaft. Thus, when the actuator is withdrawn for any purpose, the pinion is automatically disconnected from its engagement with the gear rack. Due to the tight interface between the pinion and the actuator necessary in this method of assembly the installation of the pinion or its removal may be difficult, particularly for reasons of access or manoeuvrability in the very limited space available within the wing structure. Furthermore the pinion may be subject to damage, contamination or misplacement. In the case of the carrier beam the use of "drilled to size" holes in the beam and gear rack is inpracticable for numerous reasons, not least of which is the difficulty of achieving accurate positioning of the gear rack to achieve the correct tooth pitch datum, and more particularly the pitch circle radius in the case of an arcuate carrier beam arrangement. To achieve an accurate and controlled meshing relationship between the single-piece gear rack and the pinion, it would be preferable that, on the one hand, means were provided to ensure that the rack is correctly jugged and located to the carrier beam prior to its assembly to the wing and, on the other, to provide an assembly in which the pinion gear is rotatably mounted to the wing structure independently of the actuator so that the track is

installed into engagement with the pinion and maintained as such even when the actuator and/or the high speed shaft system is dismantled for whatever purpose.

After these comments it is stated that the object of the invention is "to overcome these shortcomings, and to enable achievement of the desiderata set out above."

It can be seen that the above comments are concerned with two related but distinct aspects of the mechanism. The first is the connection of the gear rack to the carrier beam, the second the mounting of the pinion gear with respect to the wing ribs. Claim 1 is however silent as to any features concerned with the first aspect. The relevant features appear in fact in dependent claim 4. The features specified in the characterising clause of claim 1 are concerned only with the second aspect.

At the oral proceedings before the Board, and in the course of the opposition proceedings, the appellants argued that the particular form of the bearing housing assemblies disclosed in the patent specification, which are attached by bolts or the like to the inner surface of the respective wing rib enabled the position of the pinion gear to be adjusted so as to give the desired accurate meshing between the pinion gear and the gear rack. There is, however, no mention of this whatsoever in the patent specification. Furthermore, it does not appear to be inherent in the structure disclosed since, for example, the position of the pinion gear is also determined by the fact that it is splined to the output shaft of the actuator and the position of the later is in turn determined by the bore in the wing rib to which it is attached. In the light of this the Board is of the

opinion that the technical problem of which account has to be taken when assessing inventive step is limited to the second of the aspects mentioned above, namely the provision of means enabling the actuator to be removed with the pinion gear still in place.

Particularly in view of the comments made in the patent specification with respect to document D1 the Board is of the opinion that the skilled person would understand the feature of claim 1 that the pinion gear is supported for rotation "independently of the actuator" as meaning that the pinion gear is directly carried by the bearing assemblies and not via the intermediary of a part (the output shaft of the reduction drive) driven by a remote "actuator" (i.e. the power unit), as is the case in document D1. This feature therefore represents a genuine distinction from the state of the art.

The appellants sought to establish a further important distinction in the fact that claim 1 requires the use of "bearing housing assemblies" which according to their interpretation of the claim are located "between the wing ribs" and which therefore are clearly different to the bearing assemblies used in document D1, which are located in respective bores in the wing ribs. As a plain matter of language it is however evident that the term "between said wing ribs" refers to the position in which the pinion gear is supported by the pair of bearing housing assemblies and not to the position of these assemblies themselves. The latter is left completely open by the claim as indeed is the form of the assemblies and the way in which they are mounted with respect to the wing ribs. In general terms, as pointed out in the contested decision, the outer bearing ring or sleeve of a rolling bearing can be considered as comprising a "housing".

Thus the Board shares the view expressed in the contested decision that the rolling bearings disclosed in document D1, which are mounted via their outer bearing sleeves in respective bores in the wing ribs, constitute "bearing housing assemblies" within the meaning of claim 1. In this respect it is to be noted that the "bearing housing assemblies" actually disclosed in the patent specification also comprise nothing more than inner and outer bearing sleeves with rolling elements disposed between them, the outer sleeve being formed with a flange via which it is attached to the wing rib. Furthermore, it is apparent in document D1 that the pinion gear is mounted (via the splines on the output shaft of the actuator) "fast in rotation with the inner bearing sleeves of the bearing assemblies".

It is not in dispute that the bearings disclosed in document D1 are not "self-aligning". It is, however, equally not in dispute that the use of such bearings is wholly conventional in the relevant field as the wings of aircraft undergo considerable flexing in operation. Thus the appellants did not seek to justify the inventive step of the claimed subject-matter by reference to this feature of claim 1.

Having regard to the above it is apparent that the question of inventive step will be determined by whether it was an obvious measure to provide for support of the pinion gear independently of the actuator.

The respondents have relied in this respect on documents D12 to D18 relating to the wing leading edge flap support and extension mechanism of the Boeing 747 aircraft. The fact that this aircraft belonged to the state of the art has never been called into question. Documents D12 to D18 disclose an arrangement where the

flap is carried by a number of pivotal linkages. The main arm of each linkage is pivotally attached to the wing via a respective torque tube to which it is splined and which is supported at either end by rolling bearings each located in a respective bore of a wing rib. A rotary actuator is attached to one of the wing ribs and has an output shaft with splines which engage a splined inner end of the torque tube.

Now, the appellants argue that documents D12 to D18 are in no way concerned with the mounting of a pinion gear or with the meshing of such a gear with a gear rack so that the skilled person dealing with these problems would find nothing here which would be of relevance to him. In the opinion of the Board that argument relies partly on an incorrect evaluation of what is actually achieved by the measures of claim 1, which is not, as explained above, more accurate meshing between the pinion gear and the gear rack, and partly on an over-restricted view of the power of abstraction of the skilled person. It is the opinion of the Board that the latter would certainly be able to see in the known arrangement of the Boeing 747 aircraft means by which it is possible to arrange for the actuator to be removable while leaving all other parts of the support and extension mechanism in place, and it is only to this aspect to the technical problems mentioned in the patent specification that the subject-matter of claim 1 provides a solution. Thus the Board comes to the conclusion that independently supporting the pinion gear of the mechanism shown in document D1 by means of bearing assemblies, in the manner the torque tube is supported as shown in documents D12 to D18, is a measure which was obvious for the skilled person, and as a consequence the subject-matter of granted claim 1 lacks inventive step.

3. *Auxiliary request*

It belongs to the established jurisprudence of the Boards of Appeal that the admission of amended claims into appeal proceedings, particularly when the amendments are first submitted at oral proceedings, is at the discretion of the Boards, see for example T 95/83 (OJ EPO 1985, 75) and T 153/85 (OJ EPO 1988, 1). The factors which need to be taken into account when exercising this discretion include whether there is some clear justification for the late submission of the amendment and whether the amended documents are clearly allowable, firstly in the sense of conforming with the formal requirements of the EPC and secondly in the sense of having at least a reasonable prospect of removing the outstanding substantive objections against the documents previously on file.

In the present case the appellants sought to justify the introduction into claim 1 of the auxiliary request of the feature that the bearing housing assemblies are mounted upon the inner faces of each respective rib by arguing that this was a mere clarification of the feature of granted claim 1 that these assemblies were provided "between said wing ribs". As however explained above the latter feature does not in fact appear in granted claim 1, which contained no information about the way the bearing housing assemblies are mounted which was capable of "clarification". Furthermore, the relevant feature added to the claim is not to be found in any dependent claims as granted and is mentioned only very briefly in the description without any indication that it might be associated with specific technical advantages. Thus on the basis of the patent specification the respondent could have no reason to suspect that the relevant feature might be added to claim 1.

It is true, as also argued by the appellants, that in the course of the opposition proceedings they had made reference to the advantageous nature of the mounting of the bearing housing assemblies as disclosed in the patent specification in allowing adjustment of the position of the pinion gear. However, the Opposition Division had in the contested decision clearly explained its view, which for the reasons given above is shared by the Board, that the bearing housing assemblies as defined in granted claim 1 were not distinguished from what was disclosed in document D1. In their statement of grounds of appeal the appellants did not however refer to this issue. Furthermore, they made no written response to the annex to the summons to oral proceedings from which it was apparent that the Board in this respect followed the opinion expressed in the contested decision. On this basis it becomes clear that the relevant amendment made to claim 1 was not presaged by the manner in which the appellants had conducted their appeal up to the date of the oral proceedings. Thus it would have been unfair on the respondents to have admitted the auxiliary request of the appellants at this late stage.

As for the substantive issues involved it must also be noted that the advantage claimed for the mounting of the bearing housing assemblies on the inner surfaces of the wing ribs, namely allowing adjustment of the position of the pinion gear, is nowhere mentioned in the patent specification and on the face of what is actually disclosed is at least questionable. It is therefore difficult to see how this claimed advantage could be successfully prayed in aid for the inventive step of the subject-matter of the auxiliary request.

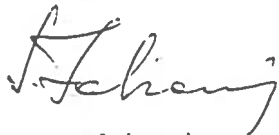
The Board therefore comes to the conclusion that the auxiliary request of the appellants is inadmissible and accordingly rejects it. In these circumstances there is no need to consider whether the amendment made to the claim concerning the relationship between the pinon gear and the actuator constitutes an abuse of the procedure, as was also argued by the respondents.

Order

For these reasons it is decided that:

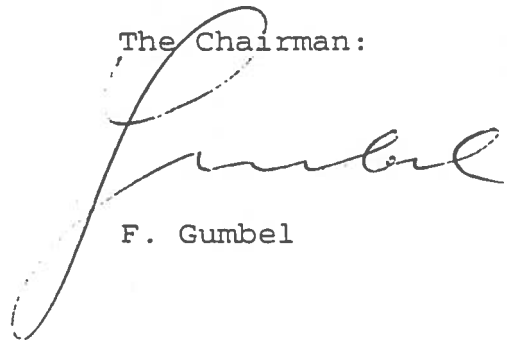
The appeal is dismissed.

The Registrar:



S. Fabiani

The Chairman:



F. Gumbel



