Internal distribution code:
(A) [-] Publication in OJ
(B) [-] To Chairmen and Members
(C) [-] To Chairmen
(D) [X] No distribution

Datasheet for the decision of 27 October 2011

Case Number: T 0734/09 - 3.4.02

Application Number: 02794681.3

Publication Number: 1417464

IPC: G01L1/00

Language of the proceedings: EN

Title of invention:
STRUCTURAL MONITORING SYSTEM FOR HELICOPTER ROTOR COMPONENTS

Applicant:
Sikorsky Aircraft Corporation

Headword:

Relevant legal provisions:
EPC 1973 Art. 56, 84
EPC Art. 123(2)

Keyword:
Added subject-matter (no - amended claims)
Clarity (yes - amended claims)
Inventive step (yes - amended claims)

Decisions cited:

Catchword:

Europäisches Patentamt | European Patent Office | Office européen des brevets

Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T0734/09 - 3.4.02

D E C I S I O N
of the Technical Board of Appeal 3.4.02
of 27 October 2011

Appellant: (Applicant)
Sikorsky Aircraft Corporation
Legal-IP Dept.,
6900 Main Street,
Mailstop S316A,
P.O. Box 9729
Stratford, CT 06497-9129 (ETATS-UNIS D'AMERIQUE)

Representative:
Klunker / Schmitt-Nilson / Hirsch
Patentanwälte
Destouchesstrasse 68
80796 München (ALLEMAGNE)

Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 15 October 2008 refusing European patent application No. 02794681.3 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman: A. G. Klein
Members: F. J. Narganes-Quijano
B. Müller

Summary of Facts and Submissions

I. The appellant (applicant) has lodged an appeal against the decision of the examining division refusing European patent application No. 02794681.3 based on the International application No. PCT/US02/25170 (published with the International Publication No. WO 03/014683).

In its decision the examining division held with regard to the set of claims then on file that the amendments made to the independent claims contravened the requirements of Article 123(2) EPC, that the subject-matter of the independent method claim was not clear within the meaning of Article 84 EPC 1973, and that the subject-mater of the independent claims did not involve an inventive step (Article 56 EPC 1973) with regard to the following documents of the state of the art:

D3 :"Assessment of structural damage in composites utilizing acoustic emission technology", W. C. Boyce *et al.*, 41st Annual Forum proceedings (1985), American Helicopter Society, Fort Worth, TX (US), Vol. 2, pages 665 to 677

D9 : "Acoustic emission - 2 / Acoustic emission amplitudes", A. A. Pollock, Non-destructive Testing (UK), Vol. 6 (1973), pages 264 to 269

D10: "Energy analysis in acoustic emission", A. G. Beattie, Materials evaluation (US), Vol. 34 (1976), pages 73 to 78

D11: "Amplitude distribution analysis of acoustic emission signals", K. Ono, Materials evaluation (US), Vol. 34 (1976), pages 177 to 174.

II. With the statement setting out the grounds of appeal the appellant requested setting aside of the decision under appeal and the grant of a patent.

III. During the written proceedings the appellant filed with the letter dated 7 October 2011 an amended set of claims 1 to 8 and amended pages 2 to 5 of the description and with the letter dated 13 October 2011 amended pages 1 and 1a of the description, replacing the corresponding parts of application as published.

The set of claims amended according to the present request of the appellant comprises independent claims 1 and 6, dependent claims 2 to 5 referring back to claim 1, and dependent claims 7 and 8 referring back to claim 6. The wording of independent claims 1 and 6 reads as follows:

"1. A system (30) for determining a structural condition of a helicopter rotor component, comprising:
a piezoelectric sensor (32) that is adapted to be supported by the helicopter rotor component and that provides a sensor signal (62) during helicopter operation, the sensor signal (62) being indicative of stress waves (44) in the helicopter rotor component;
a signal processor (34) that processes the sensor signal (62) and provides an output signal having at least one characteristic that is indicative of the content of the sensor signal (62); and
a signal analyzer (36) that receives the output signal and determines the structural condition based upon the output signal characteristic,
characterised in that
the signal processor (34) includes a demodulation portion (48) that demodulates the sensor signal (62) to

thereby generate as the output signal an envelope representation (64) of the sensor signal (62);
the system includes a transmitter that transmits the envelope representation output signal (64) in a wireless manner; and
the system includes a remotely located receiver associated with the signal analyser (36), wherein the remotely located receiver receives the transmitted envelope representation output signal (64) and the signal analyser (36) determines the structural condition from the envelope representation output signal (64), wherein the envelope representation output signal (64) is indicative of a rise time of the sensor signal (62) and the signal analyzer utilizes the rise time information as an indicator of the structural condition."

"6. A method of determining a structural condition of a helicopter rotor component, comprising the steps of:
(A) attaching a piezoelectric sensor (32) to the helicopter rotor component;
(B) detecting stress waves (44) in the helicopter rotor component during helicopter operation using the sensor;
(C) generating a stress signal (62) indicative of the detected stress waves;
(D) generating an output signal that has at least one characteristic indicative of the content of the stress signal;
(E) determining the structural condition of the aircraft element based upon the output signal characteristic;
characterised in that
step (D) further comprises generating an output signal (64) that is an envelope representation of the stress signal (62), transmitting the envelope representation output signal (64) in a wireless manner, and receiving

the transmitted envelope representation output signal (64) at a remotely located receiver; and
step (E) further comprises determining the structural condition from the envelope representation output signal, wherein the envelope representation output signal (64) is indicative of a rise time of the stress signal (62) and the rise time information is utilized as an indicator of the structural condition."

IV. The arguments submitted by the appellant in support of its requests are essentially the following:

None of the cited prior art references discloses the claimed feature relating to the wireless transmission of the envelope representation to the signal analyser. Accordingly, there is no doubt regarding the novelty of the claimed invention.

While wireless transmission has been known in general, no prior art reference gives any hint or indication towards the utilization of wireless transmission at the particular point of the signal processing chain of the present invention. In particular, the claimed invention allows to perform a first step of signal processing right at the helicopter rotor component, namely to generate the envelope representation output signal, such that an intermediate signal is generated that requires less transmission bandwidth, but still carries sufficient information for determining the structural condition of the helicopter rotor component. This signal can then be efficiently transmitted in a wireless manner to a remotely located receiver in a non-rotating part of the helicopter. There, the second step of signal processing can be performed in order to determine the structural condition of the helicopter

rotor component based on the rise time of the sensor signal as an indicator of the structural condition. Accordingly, the invention allows for an optimized trade-off between a reduction of signal processing complexity required right at the helicopter rotor component, on the one hand, and required transmission capacities between the rotating frame of reference and the non-rotating frame of reference of the helicopter, on the other hand. In this way, necessary information about the structural integrity of the helicopter rotor component, in particular the rise time of the sensor signal, becomes available for the final signal processing in determining the structural condition of the helicopter rotor component, while low bandwidth requirements have to be fulfilled for the wireless transmission. Consequently, the claimed invention is inventive over the cited prior art.

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments*

2.1 In its decision the examining division held that the subject-matter of the independent claims amended according to the request then on file were directed to the determination of the structural condition of a portion of an aircraft element but included features that were disclosed in the application as published only in connection with the determination of the structural condition of a portion of a helicopter rotor assembly, and that for this reason the amended subject-matter was contrary to Article 123(2) EPC.

The independent claims presently on file, however, have been amended so that the claimed subject-matter is specifically directed to the determination of the structural condition of a helicopter rotor component. In these circumstances, the objection raised by the examining division with regard to the claims then on file does not apply any longer to the present claims - and consequently there is no need to address the question of whether the objection raised by the examining division was well founded.

2.2 In addition, the Board is satisfied that the application documents as amended according to the present request of the appellant comply with the requirements of Article 123(2) EPC. In particular,

- claim 1 is based on claims 1, 4, 8 and 10 as published together with the passages on page 1, lines 5 to 9 and 12 to 14, page 2, lines 1 to 8, page 3, lines 19 to 26, and page 4, lines 6 to 16 of the application as published,
- independent claim 6 is based on independent claim 11 as published together with the corresponding amendments made to present claim 1, and
- dependent claims 2 to 5, 7 and 8 are respectively based on dependent claims 2, 3, 5, 6, 12 and 15 as published.

As regards the description, its text has been revised and brought into conformity with the invention defined in the claims as presently amended, and the pertinent prior art has been appropriately acknowledged in the introductory part of the description (Article 84 EPC 1973, second sentence and Rule 42(1), paragraphs (b) and (c) EPC).

3. *Clarity*

In its decision the examining division held that the set of claims then on file was not clear (Article 84 EPC 1973) because some claims referred simultaneously to an aircraft element and to a rotor assembly. The claims presently on file, however, consistently refer to a helicopter rotor component. Independent claim 6 also uses in its wording the expression "the aircraft element", but in the context of the claim it is immediately clear to the skilled reader that "the aircraft element" corresponds to the helicopter rotor component previously defined in the claim. Accordingly, the objection of lack of clarity raised by the examining division does not apply to the present set of claims, and the Board is satisfied that the claimed subject-matter is clear within the meaning of Article 84 EPC 1973.

4. *Inventive step*

4.1 Independent claim 6 is directed to a method of determining the structural condition of a helicopter rotor component. According to the claimed method, the stress waves detected by a piezoelectric sensor in the helicopter rotor component are processed and analyzed, and the claim requires, among other features, demodulating the output signal of the piezoelectric sensor into an envelope representation representative of the signal.

In its decision the examining division held that the method defined in the sets of claims then on file was obvious in view of the disclosure of document D3 relating to the detection of structural damage in helicopter rotor blades using acoustic emission

technology, in combination with the teaching of documents D9, D10 and D11 relating to the use of demodulation and envelope techniques in the processing of stress wave signals. During the appeal proceedings the appellant disputed that any of documents D9, D10 or D11 suggested the use of such processing techniques.

Nonetheless, independent claim 6 as presently amended further requires transmitting the envelope representation signal in a wireless manner to a remotely located receiver where the structural condition of the helicopter rotor component is determined on the basis of the rise time of the envelope representation signal, and - irrespective of whether documents D9, D10 and D11 (or any of the other documents considered by the Board during the appeal proceedings) teaches the use of demodulation and envelope processing techniques in the processing of stress wave signals in the technical field of aircraft and helicopter machinery - the available prior art documents are insufficient to question inventive step of the amended claimed combination of features. In particular, none of the documents discloses or suggests the transmission in a wireless manner of the envelope representation signal of the stress wave signal detected by the piezoelectric sensor to a remotely located receiver for the determination of the structural condition of the rotor component on the basis of the rise time of the signal, nor the technical improvements associated therewith, namely the reduction of the signal processing complexity and a ready and efficient transmission of the signal between the rotating and the non-rotating parts of the helicopter by means of the envelope representation signal which is less complex and requires a lower bandwidth for its

transmission from the helicopter rotor component to the remotely located receiver.

In view of the above considerations, the Board concludes that the available prior art does not render obvious the subject-matter of independent claim 6 within the meaning of Article 56 EPC 1973.

4.2 Claim 1 is directed to a system for determining a structural condition of a helicopter rotor component and the functional features of the different structural means defined in the claim are in one-to-one correspondence with the different steps of the method defined in independent claim 6. In these circumstances, the Board is also of the opinion that the subject-matter of claim 1 involves an inventive step (Article 56 EPC 1973) for reasons analogous to those put forward in point 4.1 above with regard to independent claim 6.

The same conclusion applies to dependent claims 2 to 5, 7 and 8 by virtue of their dependence on independent claims 1 and 6.

5. The Board is also satisfied that the application documents as presently amended and the invention to which they relate meet the remaining requirements of the EPC within the meaning of Article 97(1) EPC.

In view of the above considerations, the Board concludes that the decision under appeal is to be set aside and a patent be granted on the basis of the application documents amended according to the present request of the appellant (Article 97(1) EPC and Article 111(1) EPC 1973).

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the department of first instance with the order to grant a patent on the basis of the following documents:
   - claims 1 to 8 filed with the letter dated 7 October 2011,
   - description pages 1 and 1a filed with the letter dated 13 October 2011 and pages 2 to 5 filed with the letter dated 7 October 2011, and
   - drawing sheet 1/1 of the application as published.

The Registrar: The Chairman:

M. Kiehl A. G. Klein

Decision electronically authenticated