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**Datasheet for the decision
of 4 December 2012**

Case Number: T 0610/09 - 3.4.02

Application Number: 98310391.2

Publication Number: 924516

IPC: G01N27/90

Language of the proceedings: EN

Title of invention:

Method and apparatus for non destructive inspection

Applicant:

United Technologies Corporation

Relevant legal provisions:

EPC Art. 56, 54(2)

Keyword:

Novelty and inventive step (yes - amended claims)



**Beschwerdekammern
Boards of Appeal
Chambres de recours**

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Case Number: T 0610/09 - 3.4.02

D E C I S I O N
of the Technical Board of Appeal 3.4.02
of 4 December 2012

Appellant:
(Applicant)

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Decision under appeal:

**Decision of the Examining Division of the
European Patent Office posted 16 October 2008
refusing European patent application No.
98310391.2 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman:

A. G. Klein

Members:

F. J. Narganes-Quijano

D. Rogers

Summary of Facts and Submissions

I. The appellant (applicant) lodged an appeal against the decision of the examining division refusing European patent application No. 98310391.2 (publication No. 0924516).

II. In its decision the examining division held by reference to its previous communications that the subject-matter defined in the set of claims then on file was not new or at least was rendered obvious by the prior art. The documents considered by the examining division during the examination proceedings were the following:

D1: US-A-3875502

D2: EP-A-0518635

D3: US-A-4016487

D4: "A new ECT probe with rotating direction eddy current", H. Hoshikawa *et al.*; Review of Progress in Quantitative Nondestructive Evaluation, Vol. 15 (1996), pages 1091 to 1098.

III. In an annex to summons to oral proceedings the Board referred to document:

A1: "Zerstörungsfreie Werkstoffprüfung nach dem Wirbelstromverfahren - Teil 2", H. Lut *et al.*; messen+prüfen/automatik, Vol. 118 (1975), pages 91 to 95.

IV. In reply to the summons to oral proceedings the appellant filed with its letter dated 2 November 2012 sets of claims amended according to a main and five auxiliary requests and subsequently, with the letter

dated 16 November 2012, the appellant filed amended pages 1, 4 to 6, 14, 24 and 25 of the description replacing the corresponding application documents on file. The appellant requested that the decision under appeal be set aside and a patent be granted.

In view of the amended requests of the appellant, the oral proceedings were cancelled.

V. The wording of independent claims 1 and 4 amended according to the main request reads as follows:

"1. A method for inspecting an object along a scan path (116; 316; 416; 516) relative to the object, the method comprising:

providing an eddy current probe (62; 262; 362; 462) having:

 a driver (70; 270; 370; 470) having a coil (82; 282; 382; 482) with an effective coil axis (124; 324; 424; 524), said driver coil having a length (132; 332; 432; 532) and a width (128; 328; 428; 528), said length of said driver coil being the dimension in a direction substantially parallel to the scanning path and said width of said driver coil being the dimension in a direction substantially perpendicular to the scanning path; and

 a receiver (72; 272; 372; 472) having a coil (92; 292; 392; 492) having a pancake-like shape and having a coil axis (126; 326; 426; 526) oriented substantially perpendicular to said driver coil effective coil axis and in a direction perpendicular to the scanning direction, said receiver coil having a length (134; 334; 434; 534), a width (130; 330; 430; 530), and a thickness (138; 338; 438; 538), said length of said receiver coil being the dimension in the direction parallel to the scanning path and said

width of said receiver coil being the dimension in a direction substantially perpendicular to the scanning path, said width of said receiver coil having a dimension substantially greater than that of said length of said receiver coil;

positioning said eddy current probe such that said receiver coil is disposed between the object and said driver coil; and

moving said eddy current probe substantially along the scan path, wherein said eddy current probe produces an electrical signal indicative of the presence of flaws in the object."

"4. A method for inspecting an object along a scan path (116; 316; 416; 516) relative to the object, the method comprising:

providing an eddy current probe (62; 262; 362; 462) having:

a driver (70; 270; 370; 470) having a coil (82; 282; 382; 482) with an effective coil axis (124; 324; 424; 524), said driver coil having a length (132; 332; 432; 532) and a width (128; 328; 428; 528), said length of said driver coil being the dimension in a direction substantially parallel to the scanning path and said width being the dimension in a direction substantially perpendicular to the scanning path, said coil of said driver having widthwise opposite edges (140, 144; 340, 344; 440, 444; 540, 544),

a receiver (72; 272; 372; 472) having a coil (92; 292; 392; 492) having a pancake-like shape and having a coil axis (126; 326; 426; 526) oriented substantially perpendicular to said driver coil effective coil axis and in a direction perpendicular to the scanning direction, said receiver coil having a length (134; 334; 434; 534), a width (130; 330; 430; 530), and a thickness (138; 338; 438; 538), said

length of said receiver coil being the dimension in the direction parallel to the scanning path and said width of said receiver coil being the dimension in a direction substantially perpendicular to the scanning path, where the magnitude of a distance between said receiver coil end at least one of said edges is less than 0.125 times the width of said driver coil; positioning said eddy current probe such that said receiver coil is disposed between the object and said driver coil; and moving said eddy current probe substantially along the scan path, wherein said eddy current probe produces an electrical signal indicative of the presence of flaws in the object."

The main request also includes dependent claims 2, 3 and 5 to 10 each referring back to at least one of claims 1 and 4.

The wording of the claims of the auxiliary requests are not relevant for the present decision.

VI. The arguments submitted by the appellant in support of its requests and pertinent for the present decision can be summarised as follows:

The amended claims relate to inspection methods in which the probe is moved along a scan path; accordingly, the definition of the dimensions of the coils in relation to the scan path constitute limiting features of the amended claimed subject-matter.

In the figures of document A1 the receiver coil is arranged within the boundary of the driver coil and does not project beyond it so as to lie between the driver coil and the object. In addition, in document A1

there is no receiver coil having a pancake-like shape. Therefore, the claimed methods are new over document A1.

Eddy current probes are characterised by their sensitivity (a qualitative measure of the capability of the probe to detect flaws in the object) and their uniformity (a measure as to the useful width of the probe). Whilst it is desired to use probes with a large uniformity so as to allow a rapid inspection of the object, problems can be experienced when detecting flaws in objects with complex geometries since it is the edge region of the probe, i.e. where the sensitivity is lower, that can be used to scan such geometries. According to one aspect of the invention (claim 1), the width of the probe is increased relative to its length so as to provide a wider inspection field without excessive degradation in sensitivity and uniformity. According to a second aspect of the invention (claim 4), the receiver is extended near to the widthwise edges of the driver without excessively decreasing the uniformity of the magnetic field under the receiver, thus providing a greater sensitivity at the edges of the probe.

Reasons for the Decision

1. The appeal is admissible.
2. *Main request - Amendments*

The Board is satisfied that the application documents amended according to the present main request of the appellant satisfy the formal requirements of the EPC.

In particular, independent claims 1 and 4 are based on independent claims 14 and 15 as originally filed, respectively, in combination with the features defined in dependent claims 7 and 8 and in the passage on page 12, lines 14 to 20 of the description as originally filed. Dependent claims 2, 3 and 5 to 10 are based on the features defined in dependent claims 2, 3, 5, 6, 9 to 11 and 13 as originally filed, respectively (Article 123(2) EPC).

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

3. *Main request - Novelty*

- 3.1 Document A1 discloses a method of inspecting an object for the detection of flaws in the object (title and page 93, penultimate paragraph) comprising moving the eddy current probe represented in Figures 19-a and 19-c with respect to the object along a scan direction (page 93, first paragraph together with Figures 27 and 28). The probe comprises a driver coil (coil 1) and a receiver coil (coil 2) arranged so that the coil axis of the receiver coil is perpendicular to both the coil axis of the driver coil and the scan direction (Figures 19, 27 and 28). In addition, the dimension of the receiver coil in a direction perpendicular to the scan direction is greater than its dimension in the scan direction (Figures 19, 27 and 28).

However, the receiver coil is schematically represented in document A1 by a coil having an annular shape (Figures 19, 27 and 28) and the document is silent as to the use of a receiver coil of the type required by claim 1, i.e. of the type commonly known as "pancake" coils characterised by having a substantially pancake-like or flattened shape (description, page 16, line 20 *et seq.*; see also paragraph bridging pages 3 and 4). In addition, while in document A1 the receiver and the driver coils are arranged with respect to each other so that a section of the driver coil lies in the plane of the annularly shaped receiver coil (Figure 19-c), claim 1 requires that the receiver coil is disposed, in use, between the object and the driver coil. The subject-matter of claim 1 of the main request is therefore new over the disclosure of document A1.

In addition, in the eddy current probe disclosed in document A1 and referred to above the receiver and the driver coils are arranged so that the driver coil is spatially inscribed within the annularly-shaped receiver coil (Figures 19, 27 and 28), resulting in a coil arrangement in which the distance between the receiver coil and the edges of the driver coil opposing each other in the direction perpendicular to the scan direction is equal to or at least close to 0 (Figures 19, 27 and 28), and in any case less than 0.125 times the dimension of the driver coil in the direction perpendicular to the scan direction as required by independent claim 4. However, as already concluded above with reference to claim 1, document A1 does not disclose a receiver coil having a pancake-like shape and disposed, in use, between the object and the driver coil, and for this reason also the subject-matter of independent claim 4 of the main request is new over the disclosure of document A1.

3.2 Documents D1, D2, D3 and D4 also disclose a method of inspecting an object using an eddy current probe (D1, Figures 1 and 2 and abstract, D2, Figures 3, 6, 14, 17, 22 and 26 and the corresponding description, D3, Figures 1, 2, 5, 6 and 8 and the corresponding description, and D4, Figures 1 and 3 and page 1091, last two paragraphs) and these documents were considered by the examining division in the decision under appeal to anticipate or at least to render obvious the subject-matter of the independent claims then on file. However, the methods defined in independent claims 1 and 4 amended according to the present main request differ in several respects from the methods disclosed in these documents. In particular, none of the receiver coils of the eddy current probes disclosed in documents D1 (Figures 1 and 2), D2 (Figures 3, 6, 14, 17, 22 and 26) and D3 (Figures 1, 2, 5, 6 and 8) has a pancake-like shape as required by claims 1 and 4. As regards document D4, the receiver coil of the probe disclosed in this document has a pancake-like shape (Figure 1 and page 1091, penultimate paragraph), but the coil has a circularly symmetric shape (Figures 1 and 3 together with page 1092, first and second paragraphs, and page 1093, fourth paragraph) and therefore the dimensions of the receiver coil in the direction parallel to the scan direction and in the direction perpendicular to it are - contrary to the requirements of claim 1 - equal; in addition, the pancake receiver coil is substantially smaller than the driver coil(s) and is positioned at a centred position between the edges of the driver coil(s) (Figure 1 and page 1093, fourth paragraph), and therefore the receiver coil is spaced - contrary to the requirements of claim 4 - a considerable distance apart from the edges of the driver coil(s). For these

reasons, none of documents D1 to D4 anticipates the subject-matter of independent claims 1 and 4.

3.3 Having regard to the above, the subject-matter of independent claims 1 and 4 amended according to the main request is novel over the available prior art. The same conclusion applies to dependent claims 2, 3 and 5 to 10 by virtue of their dependence on independent claim 1 or 4.

4. *Main request - Inventive step*

4.1 The closest state of the art is represented by the method disclosed in document A1 and referred to in point 3.1 above. As already concluded in point 3.1 above, the methods defined in independent claims 1 and 4 each differ from the method disclosed in document A1 in that the receiver coil of the probe has a pancake-like shape and is disposed, in use, between the object to be inspected and the driver coil.

According to the disclosure of the invention and the appellant's submissions (point VI above), the methods defined in independent claims 1 and 4 provide alternative, complementary solutions (page 24, lines 24 to 29 of the description) to the problem of achieving a better compromise between opposite functional requirements of eddy-current based inspection methods known in the prior art, namely between the width of the scan field of coverage and therefore the inspection time, the sensitivity of the eddy current detection response, and the uniformity in the detection along the width of the scan field (page 2, line 4 to page 3, line 16, and page 16, line 20 to page 17, line 8 of the description).

In particular, the features of the method defined in claim 1 relating to the scanning of the object with a pancake-like shaped receiver coil disposed between the driver coil and the object and having a dimension in the direction perpendicular to the scan direction substantially bigger than the dimension in the scan direction, appears to result in a wider scan field of detection coverage, and therefore in a reduced inspection time, without a substantial degradation of the sensitivity and the uniformity of the detection (*cf.* description, page 4, lines 27 to 29, page 6, line 29 to page 7, line 10, page 12, line 28 to page 13, line 15, and Figures 3 to 7 and the corresponding disclosure). Likewise, the features of the method defined in independent claim 4 relating to the scanning of the object with a pancake-like shaped receiver coil disposed between the driver coil and the object at a distance from the edges of the driver coil opposite each other in the direction perpendicular to the scan direction of less than 0.125 times the dimension of the driver coil in the direction perpendicular to the scan direction, appears to result in an improvement of the detection sensitivity at the edges of the probe without a substantial deterioration of the uniformity of the detection (*cf.* description, page 7, lines 11 to 29, and page 13, line 22 to page 14, line 18).

- 4.2 None of the documents on file suggests the combination of features defined in each of independent claims 1 and 4. In particular, as already noted in point 3.2 above, among the documents considered by the examining division only document D4 discloses the use of an eddy current probe comprising a receiver coil having a pancake-like shape, the coil being, in use, disposed between the object to be inspected and the driver coil(s). However, the document only addresses aspects

relating to the improvement of the sensitivity of the probe (page 1091, first two paragraphs, page 1092, second and third paragraphs, and Figures 4 to 7 and the corresponding discussion). It is silent as to any impact of the use of the pancake receiver coil on the other functional requirements of the inspection method, and in particular on the width of the scan field of coverage, or on the sensitivity of the probe at the edges of the same.

In addition, even assuming that the skilled person would have considered applying the teaching of document D4 to the method disclosed in document A1, he would then have replaced the receiver coil of the probe disclosed in document A1 by the pancake-like shaped coil of document D4 and would have arrived at a method involving the use of a pancake receiver coil having a circularly symmetric shape, and not a pancake receiver coil having a dimension in the direction perpendicular to the scan direction substantially bigger than the dimension in the scan direction as required by the method of claim 1. Therefore, in the Board's view the skilled person would have had no technical incentive to devise the method defined in claim 1.

Likewise, document D4 requires that the pancake receiver coil is substantially smaller than the driver coil(s) and is positioned at a centred position between the edges of the driver coil(s) in order to avoid edge effects on the detection field, and therefore is spaced a considerable distance apart from the edges of the driver coil(s) (Figures 1 and 3 together with page 1092, first and second paragraphs, and page 1093, fourth paragraph). Thus, even assuming that the skilled person would have contemplated applying the teaching of document D4 to the disclosure of document A1, he would

then have considered using in document A1 a pancake receiver coil, as disclosed in document D4, substantially smaller than the driver coil and positioned at a substantial distance from the edges of the driver coil. The skilled person would therefore not have arrived at the method of claim 4, which requires the use of a pancake receiver coil disposed close to the edges of the driver coil opposing each other in the direction perpendicular to the scan direction.

Therefore, in the Board's view the documents presently on file are insufficient to render obvious the methods defined in independent claims 1 and 4.

- 4.3 The Board concludes that the methods defined in independent claims 1 and 4 of the main request, as well as those defined in dependent claims 2, 3 and 5 to 10, involve an inventive step within the meaning of Article 56 EPC over the available prior art.

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

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 application documents:
 - claims: claims 1 to 10 of the main request filed with the letter dated 2 November 2012,
 - description: pages 1, 4 to 6, 14, 24 and 25 filed with the letter dated 16 November 2012 and pages 2, 3, 7 to 13 and 15 to 23 as originally filed, and
 - drawings: sheets 1/12 to 12/12 as originally filed.

The Registrar:

The Chairman:



M. Kiehl

A. G. Klein

Decision electronically authenticated