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Datasheet for the decision of 22 December 2010

Case Number: T 1782/07 - 3.4.01

Application Number: 00306242.9

Publication Number: 1072899

IPC: G01R 33/387

Language of the proceedings: EN

Title of invention:
Unified shimming for magnetic resonance superconducting magnets

Applicant:
GENERAL ELECTRIC COMPANY

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 123(2)

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

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

Decisions cited:
-

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 1782/07 - 3.4.01

D E C I S I O N
of the Technical Board of Appeal 3.4.01
of 22 December 2010

Appellant: GENERAL ELECTRIC COMPANY
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Schenectady
NY 12345 (US)

Representative: Pedder, James Cuthbert
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 5 June 2007 refusing European patent application No. 00306242.9 pursuant to Article 97(1) EPC 1973.**

Composition of the Board:

Chairman: B. Schachenmann
Members: P. Fontenay
G. Assi

Summary of Facts and Submissions

I. The appeal lies from the decision of the examining division to refuse European patent application No. 00 306 242.9. The decision was dispatched on 5 June 2007 and followed a request of the applicant to have a decision according to the state of the file. It makes only reference to three previous communications of the examining division in which it was held, in particular, that the claimed subject-matter lacked "*novelty or at least an inventive step*" (Articles 54, 56 EPC 1973), that the claims lacked clarity and support by the description (Article 84 EPC 1973) and also contained added subject-matter (Article 123(2) EPC 1973).

II. The appellant (applicant) filed a notice of appeal on 13 August 2007 and paid the prescribed appeal fee on the same day. The statement setting out the grounds of appeal was filed on 15 October 2007.

The appellant requested that the impugned decision be set aside and a patent be granted on the basis of the claims then on file. In the absence of any set of claims accompanying the statement of grounds, the request of the appellant was interpreted as referring to the last set of claims filed during the examination proceedings with a letter of 1 May 2007.

In the event that the Board intended to confirm the decision to refuse the application, oral proceedings were requested.

III. The appellant was accordingly summoned to attend oral proceedings due to take place on 29 October 2010.

IV. In preparation of these proceedings, the Board issued a communication pursuant to Article 15(1) Rules of Procedure of the Boards of Appeal (RPBA) on 24 August 2010, expressing its provisional opinion with regard to the request on file. The attention of the appellant was more particularly drawn to various deficiencies in the claims wording which rendered the claimed subject-matter unclear.

Moreover, in the Board's preliminary view, various publications referred to earlier in the course of the examination proceedings appeared particularly relevant when addressing the issues of novelty and inventive step. It was stressed, in this respect, that the relevance of these prior publications resulted primarily from the unclear wording of the independent claim. It was in particular questioned whether the claim definition reflected the actual teaching underlying the present disclosure according to which a volume (dubbed first imaging volume in claim 1), larger than the volume for which the conditions concerning specific homogeneity requirements were to be fulfilled, was selected for carrying out measurements of the magnetic field strength. In the Board's view, the mere evocation in the claim of this smaller volume did not imply that it effectively intervened in the execution of the claimed method.

V. Under cover of a letter dated 28 September 2010, the appellant filed new requests taking into account the observations of the Board. These requests replaced the previous request on file. In its response, the

appellant also indicated his wish to have any outstanding issues discussed over the phone.

Considering that the new requests did remedy, for the essential, to the objections raised by the Board in its previous communication, the appellant was contacted by telephone on 26 October 2010 to discuss further shortcomings regarding the clarity of the claims as well as some minor deficiencies in the description.

On 26 October 2010 a clear copy of a new request reproducing the amendments discussed previously over the phone was filed by the appellant. It was later confirmed that this new request was to replace the previous requests on file.

Oral proceedings were accordingly cancelled.

In a phone conversation held on 2 November 2010, the appellant was informed of further discrepancies identified by the Board with regard to claim 1. Possible amendments to the claim's wording were also discussed. In a letter dated 8 November 2010, the appellant confirmed that he agreed to the version of the claim discussed over the phone and subsequently forwarded to him.

The appellant thus requested the grant of a patent on the basis of following documents:

- claim 1 attached to the minutes of the phone conversation of 2 November 2010 and approved by the appellant with the letter of 8 November 2010;

- Claims 2 to 9 as filed with the letter of 26 October 2010;
- Description pages 1, 2, 2a, 2b, 3 to 11 as filed with the letter of 26 October 2010;
- Drawing sheets 1/2 - 2/2 as filed with the letter of 26 October 2010.

VI. Claim 1 of the appellant's request thus reads:

"1. A method of shimming an imaging volume of a magnetic resonance imaging magnet (10) having a central bore and an axis (6); said method including the use of passive magnetic shims (12) said method comprising:

measuring the magnetic field strength (26) in said central bore of said magnet at a predetermined number of points on a surface defining a first imaging volume (4) around the axis (6) of said magnet and at a predetermined number of points (21, 25) along the axis (6);

mapping magnetic field inhomogeneity by determining (28) harmonic coefficients (C_{lm}) from said measured magnetic field strength (26) at said predetermined number of points on said surface defining said first imaging volume (4) and along the axis (6);

characterized by:

utilizing said magnetic field measurements and said harmonic coefficients (C_{lm}) from said mapping to calculate the placement and thickness of said passive magnetic shims (12) so as to correct for magnetic field inhomogeneities in at least one imaging volume smaller than said first imaging volume; and

installing (32) said passive shims (12) in the calculated positions; and checking the homogeneity (34) of the shimmed magnet (10);

reiterating, if necessary, the previous method steps until the desired homogeneity is obtained;

thereby providing said at least one smaller imaging volume meeting homogeneity requirements of said magnetic field using said measurements of the magnetic field strength at said points on said surface of said first imaging volume (4) and at the said points (21, 25) along the axis of the magnet."

Claims 2 to 9 are dependent claims.

VII. This decision is issued after the entry into force of the EPC 2000 on 13 December 2007. Reference is made to the relevant transitional provisions for the amended and new provisions of the EPC, from which it may be derived which Articles of the EPC 1973 are still applicable to the present application and which Articles of the EPC 2000 are to apply.

Where Articles or Rules of the former version of the EPC apply, their citations are followed by the indication "1973".

Reasons for the Decision

1. The appeal is admissible.

2. Clarity - Article 84 EPC 1973

2.1 Claim 1 establishes that both a first imaging volume and a (second) imaging volume, smaller than the first imaging volume, intervene in the execution of the claimed shimming method. In particular, the indication

that the process is continued until the desired homogeneity is obtained, combined with the further statement that this process finally leads to the homogeneity specifications being met by the smaller volume, implies that these requirements are indeed considered in the execution of the method. The claim's wording thus excludes any interpretation according to which the method would refer to the first imaging volume only, wherein the increased homogeneity in the smaller imaging volume would be obtained as a mere consequence of said effect being obtained for the first imaging volume.

2.2 By specifying that the first method steps are reiterated until the desired homogeneity is obtained, the claim now includes all essential features which are required for the smaller imaging volume to meet the homogeneity requirements.

3. Added subject-matter - Article 123(2) EPC

3.1 Independent claim 1 is based, in substance, on original claim 6. The step of measuring has been further specified by reciting that said measurements are carried out at a predetermined number of points on a surface defining a first imaging volume around the axis of the magnet and along the axis. A basis for this amendment may be found in paragraphs [0012] to [0015] of the published application in combination with Figure 1. Although the example referred to in these paragraphs refers more specifically to a spherical testing volume and to test points distributed on a predetermined number of testing circles, the Board is satisfied that the omission of these additional

limitations does not constitute an unallowable intermediate generalisation. Thus, the skilled person is aware that the later determination of the harmonic coefficients is independent of the points selected for measurements and only requires that the location of said points be known with sufficient precision.

The introduction of the further limitation regarding the reiteration, if necessary, of the previously recited method steps until the desired homogeneity is obtained derives from the corresponding statement in the last sentence of paragraph [0027] together with the flow chart of Figure 2. The fact that the "desired homogeneity" in this sentence indeed refers to the homogeneity in the smaller imaging volume results from the reference in the preceding sentence to the step of checking or comparing with magnet homogeneity specifications or requirements and from the reference in the next paragraph to a specification of 0,5 ppm (i.e. the specification applying to the smaller volume).

3.2 Dependent claims 2 to 4 find a basis in the general statement concerning the invention in paragraph [0004] of the published application (claims 2, 3) and paragraphs [0013] and [0015] (claim 4). Dependent claims 5 and 6 derive from original claim 7 while dependent claims 7 to 9 find their basis in original claims 8 to 10, respectively.

4. Patentability

4.1 The following documents were relied on during the appeal procedure:

D1: US-A-5 485 088;

D2: Article of E. Bobrov et al.: "A 60 cm Bore 2.0 Tesla High Homogeneity Magnet for Magnetic Resonance Imaging" in IEEE Transactions on Magnetics, Vol. MAG-23, No. 2, March 1987, pages 1303-1308 - XP2229095;

D3: Article of J. Williams et al.: "NMR Magnet Technology at MIT" in IEEE Transactions on Magnetics, Vol. 28, No. 1, January 1992, pages 627-630 - XP258057;

D4: EP-A-823 641;

D5: WO-A-88/08126;

D6: Article of F. Russel Huson et al.: "A High-Field Superferric NMR Magnet" in Magnetic Resonance in Medicine, Vol. 29, No. 1, 1993, pages 25-31; XP345556;

D7: Article of M. Souza et al.: "Optimal design of a self shielded magnetic resonance imaging magnet" in Journal de physique, Vol. 3, No.11, November 1993, pages 2121-2132, - XP409328;

D8: US-A-5418462.

Document D8 was cited in the European search report.

4.2 Novelty

4.2.1 Document D8 discloses a method of shimming an imaging volume of a magnetic resonance imaging magnet with a central bore and an axis. The disclosed method comprises a first step of measuring the magnetic field strength in said central bore at a predetermined number of points on a surface defining a first spherical imaging volume around the axis of the magnet

(cf. column 3, lines 18-27; column 6, lines 29-45; column 7, lines 43-45). Mapping of the magnetic field inhomogeneity is then carried out by determining harmonic coefficients based on these measured magnetic field strengths (cf. column 3, lines 28-47; column 7, lines 46-56).

In document D8, the magnetic field measurements and harmonic coefficients thus obtained are then used to calculate the placement and thickness of passive magnetic shims to be positioned on the surface of the bore so as to correct for magnetic field inhomogeneities in the imaging volume on the surface of which the initial measurements have been carried out (cf. column 4, lines 15-29; column 8, lines 36-44; column 10, lines 11-16). Passive shims are then installed at the calculated positions (cf. column 5, lines 9-12; column 10, lines 18-20) and homogeneity of the shimmed magnet is checked (cf. column 5, lines 9-12, lines 27-29; column 10, lines 23-30). These steps are also reiterated in the method of D8 when required, i.e. as long as the desired homogeneity in the first imaging volume has not been achieved (cf. column 10, lines 24-36).

The claimed method differs from this known method in that the homogeneity requirements are defined in relation with a volume different from the first imaging volume on the surface of which measurements are carried out, namely in relation with a volume smaller than said first imaging volume.

4.2.2 Document D5 discloses a method similar to the method of shimming disclosed in document D8 in which the location

and thickness of the shim pieces are determined on the basis of theoretical considerations so that the equation reflecting the "goodness" of the flux density is made acceptably small over the specified volume. Document D5 does not resort to any iterative process of measuring and checking. There is also no teaching that the specified volume for which the specifications should be met would differ from the volume in which measurements are carried out.

4.2.3 Document D1 discloses a further method of shimming an imaging volume in a magnetic resonance imaging magnet having a central bore and an axis (cf. D1, column 1, lines 6-31; Figure 4). The method of shimming actually put into practise in the system of D1 includes the use of passive magnetic shims (20) (cf. D1, column 8, lines 23-31) and comprises a first step of measuring the magnetic field strength in said central bore of said magnet at a predetermined number of points on a first imaging volume around the axis of said magnet (cf. D1, column 2, lines 36-46). Although referring to the prior art, this passage of D1 defines the general context underlying the system and method of D1 whose purpose is to facilitate homogeneity adjustments (cf. D1, column 3, lines 5-9).

The method underlying document D1 further comprises the steps of installing passive shims (20) at experimentally determined positions and checking the homogeneity of the shimmed magnet (cf. D1, column 8, lines 27-31).

Contrary to the claimed method, document D1 does not provide details as to the steps actually required in

order to determine the concrete locations for placing the passive shims, but merely refers to experimentation. In this respect, the statement in column 8, lines 27-31, according to which the determination of such locations is carried out so that tesseral field distortions are largely eliminated does not necessarily imply that the harmonic coefficients defining the magnetic field are indeed determined as recited in independent claim 1. Moreover, there is also no indication to be found in document D1 that the specifications concerning homogeneity concern a volume smaller than the volume on the surface of which measurements are carried out.

It follows that the method disclosed in document D1 does not anticipate the claimed method.

4.2.4 Document D2 discloses the principle underlying the present invention of calculating the placement and thickness of passive magnetic shims so as to permit compensation of certain field harmonics and thus improvement of the magnetic field homogeneity. However the method of shimming carried out in D2 relies on the sole basis of constructional and theoretical considerations rather than on measured data. Document D2 does also not provide any detailed information as to the mapping of magnetic field inhomogeneity.

4.2.5 Documents D3, D4 and D7 disclose similar methods, albeit with less details, for shimming a magnet by making use of passive shimming elements or active correction coils. None of these prior publications suggests carrying out measurements on the surface of a

volume not actually corresponding to the volume for which specifications should be met.

4.2.6 In conclusion, the shimming method of claim 1 is new (Article 54 EPC 1973).

5. Inventive step

5.1 Document D8 is considered to illustrate the closest prior art since it is directed to the same purpose as the claimed invention, i.e. shimming an imaging volume in an NMR imaging device. The shimming method disclosed in D8 also appears to have many steps in common with the claimed shimming method (cf. point 4.2.1 above).

As indicated above under section 4.2.1, the claimed method differs from this known method in that the homogeneity specifications referred to in the claims are defined in relation with a volume different from the first imaging volume on the surface of which measurements are carried out, namely in relation with a volume smaller than said first imaging volume.

5.2 The claimed method guarantees that desired homogeneity requirements, higher than those achievable according to conventional shimming methods, be obtained in the smaller imaging volume.

The technical problem solved by the claimed method may thus be defined in shimming an imaging volume in an NMR magnet so that it meets homogeneity specifications which would not be achievable, due to measurement equipment limitations, by measuring the magnetic field

strength directly on the surface of said imaging volume (cf. published application, paragraph [0008]).

5.3 The principle on which the current invention elaborates in order to solve the above problem is admittedly evoked in D8. It is namely reminded in column 6, lines 45-53, that: "*In measuring the magnetic field strength, it is acceptable to take magnetic field measurements only at the surface of the DSV 14 because, as is well known in electromagnetics, the inhomogeneity of the magnetic field inside the DSV 14 is typically less than at the surface. Thus, if the inhomogeneity at the surface of the DSV 14 is within the desired levels, the inhomogeneity within the DSV 14 should also be within desired levels*". In the Board's judgement, these indications are however not sufficient for the skilled man to actually consider two different volumes in the elaboration of a better performing shimming process. At best, these indications would have led the skilled person to define a first volume, larger than the actual imaging volume in which imaging should be performed, for which the shimming method disclosed in D8 would have been carried out. The Board cannot find in D8 any additional incentive for the skilled person to consider a volume for measurements purposes while verifying homogeneity requirements in a second volume smaller than the first one.

Such a hint can also not be found in any of the other documents presently available so that the claimed method cannot be considered to derive in a straightforward manner from the prior art.

For these reasons, the shimming method of claim 1 meets the requirements of Article 56 EPC 1973 as to the presence of an inventive step.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the first instance with the order to grant a patent with:

- claim 1 attached to the minutes of the phone conversation of 2 November 2010 and approved by the appellant with the letter of 8 November 2010;
- Claims 2 to 9 as filed with the letter of 26 October 2010;
- Description pages 1, 2, 2a, 2b, 3 to 11 as filed with the letter of 26 October 2010;
- Drawing sheets 1/2 - 2/2 as filed with the letter of 26 October 2010.

The Registrar The Chairman

R. Schumacher B. Schachenmann