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**Datasheet for the decision  
of 27 October 2011**

**Case Number:** T 0269/08 - 3.4.01

**Application Number:** 05256359.0

**Publication Number:** 1650577

**IPC:** G01R 33/385, G01R 33/422

**Language of the proceedings:** EN

**Title of invention:**  
Gradient bore cooling and rf shield

**Applicant:**  
GENERAL ELECTRIC COMPANY

**Opponent:**  
-

**Headword:**  
-

**Relevant legal provisions:**  
EPC Art. 123(2)

**Relevant legal provisions (EPC 1973):**  
EPC Art. 84, 54, 56

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

**Decisions cited:**  
-

**Catchword:**  
-



Case Number: T 0269/08 - 3.4.01

**D E C I S I O N**  
of the Technical Board of Appeal 3.4.01  
of 27 October 2011

**Appellant:**  
(Applicant)

GENERAL ELECTRIC COMPANY  
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NY 12345 (US)

**Representative:**

Goode, Ian Roy  
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**Decision under appeal:**

Decision of the Examining Division of the  
European Patent Office posted 7 September 2007  
refusing European application No. 05256359.0  
pursuant to Article 97(2) EPC.

**Composition of the Board:**

**Chairman:** H. Wolfrum  
**Members:** P. Fontenay  
T. Bokor

## **Summary of Facts and Submissions**

- I. The appeal is from the decision of the examining division to refuse European patent application No. 05 256 359.0. The decision followed a request of the applicant to have a decision according to the status of the file and referred accordingly to three preceding communications of the examining division. It was dispatched on 7 September 2007.

In their communications, the examining division had raised various objections regarding lack of clarity and support of the claims (Article 84 EPC 1973) and the introduction of fresh subject-matter in the application by amendments made to the claims (Article 123(2) EPC). In their third communication, the examining division had also reiterated their view that the claimed subject-matter lacked an inventive step (Articles 52(1) and 56 EPC 1973) in view of document JP-A-64-068 248 (D1).

- II. The appellant (applicant) filed an appeal against said decision by notice received on 16 November 2007 and paid the prescribed appeal fee on the same day. A written statement setting out the grounds of appeal was filed on 16 January 2008. The appellant requested that the contested decision be set aside and a patent be granted on the basis of claims 1 and 2 annexed to the statement of grounds.

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

- III. The appellant was summoned to attend oral proceedings, due to take place on 27 October 2011.
- IV. In preparation of these proceedings, the Board issued a communication pursuant to Article 15(1) of the Rules of Procedure of the Boards of Appeal (RPBA) on 30 June 2011, expressing its provisional opinion with regard to the request on file. In the Board's view, a first aspect to be addressed during the oral proceedings concerned the clarity and support of the claims under Article 84 EPC 1973. The attention of the appellant was, more specifically, drawn to various discrepancies between the claims' wording and the content of the application. These inconsistencies applied to the terminology used in the claims as well as to the fact that some embodiments in the description appeared to be in contradiction with the definition of the claimed subject-matter in claim 1.

Concerning the issues of novelty and inventive step, particular attention was drawn to documents JP-A-64-068 248 (D1) and JP-A-06-269 422 (D2). In this respect, the Board expressed its doubts as to the analyses carried out by the examining division by taking into consideration the actual content of these prior publications as reflected by their respective translations into English (D1a, D2a), introduced into the proceedings by the Board.

- V. Taking into account some of the observations made by the Board in its previous communication, the appellant filed, with a letter dated 20 September 2011, a new request which replaced the previous request on file. In

its reply, the appellant also indicated its wish to have any outstanding issues discussed over the phone.

The appellant was therefore informed, during a phone conversation with the Rapporteur on 20 October 2011, that the Board was of the opinion that the amended request did not meet the requirements of the EPC with regard to clarity (Article 84 EPC 1973) and added subject-matter (Article 123(2) EPC). Moreover, as a consequence of the amendments made, the question whether the claimed invention implied an inventive step had to be reassessed.

VI. The appellant was also informed during this conversation over the phone that the oral proceedings were accordingly maintained. They took place on 27 October 2011 in presence of the appellant.

As a result of the debate, the appellant requested to grant a patent on the basis of the following documents:

- claims 1 and 2;
- description pages 1-10; and
- drawing sheets 1/4 - 4/4; all filed during the oral proceedings.

VII. Claim 1 of the appellant's request reads:

"1. A magnetic resonance imaging (MRI) device (200) for imaging a volume (20) comprising:  
a main magnet with a cylindrical bore for generating a homogeneous static magnetic field parallel to the main axis of the bore;

a hollow cylindrical gradient coil (50) for manipulating the magnetic field generated by said main magnet to image said volume (20) within said bore;  
a cylindrical RF coil (72) arranged within said gradient coil (50) and surrounding said volume (20);  
and  
a plurality of cooling circuits (302) for feeding and returning a cooling medium;

wherein:

- an electrically insulating sheet (140) is provided which is formed into a tube extending along said axis;
- said gradient coil (50) is formed on the radially outermost cylindrical surface of said tube;
- said plurality of cooling circuits (302) comprises in combination
  - an electrically conductive heat spreader (110) configured as a conduction cooled cylindrical array of fins with slits being formed between the fins, the heat spreader having a first surface disposed on the radially innermost cylindrical surface defining said tube and an opposite second surface, and
  - a plurality of electrically conductive cooling ducts (120) mounted to the said second surface of said heat spreader (110) with a thermally and electrically conductive joint and arranged with the pattern of slits in the heat spreader (110);
- said heat spreader (110) and said plurality of cooling ducts (120) are fabricated of a non-magnetic, thermally and electrically conductive

material and act as an RF shield surrounding said cylindrical RF coil (72);  
- said cooling ducts (120) of said plurality of cooling ducts (120) are contiguous and electrically isolated from one another and extend along the said axis from one end of the gradient coil (50) to the opposite end thereof; and  
- said cooling ducts (120) of said plurality of cooling ducts (120) are electrically connected and grounded at said one end and are non-electrically connected at said opposite end."

Claim 2 depends on claim 1.

### **Reasons for the Decision**

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".

1. The appeal meets the requirements of Articles 106 to 108 EPC and Rule 99 EPC. It is thus admissible.

2. *Clarity - Article 84 EPC 1973*

The Board is satisfied that claims 1 and 2 of the sole request on file meet the requirements of Article 84 EPC 1973 as to clarity and support by the description.

It is stressed, in this respect, that claim 1 defines a specific configuration for a magnetic resonance imaging device which solves the problems of efficient RF shielding of the gradient coil from the RF coil while optimally cooling the gradient coil (cf. paragraphs [0005] to [0008] of the published application). This problem is solved by the provision of an electrically conductive heat spreader (110) in association with a plurality of electrically conductive cooling ducts (120) mounted on a surface of said heat spreader (cf. paragraphs [0020] to [0024]). Claim 1 was further amended so as to reflect the actual geometry of the MRI system disclosed in the present application and therefore incorporates all the structural limitations necessary for the heat spreader and associated cooling ducts to effectively guarantee shielding and cooling. Claim 1, thus, includes all essential features in order to solve the problem underlying the present invention.

In addition, claim 1 has been further amended so as to include all features which contribute to limiting the eddy currents in the cooling/shielding circuit, such currents directly influencing the homogeneity of the magnetic fields generated inside the magnet bore and accordingly prejudicing the quality of the obtained images. Claim 1 thus specifies that the cooling ducts are contiguous and electrically isolated from one another, extend along the main axis of the bore from



one end of the gradient coil to the opposite end thereof, and are electrically connected and grounded at said one end and non-electrically connected at said opposite end.

The wording of the claims is thus consistent with the terminology used throughout the description as well as with the actual technical teaching provided therein (cf. e.g. Figure 3). In particular, the wording of claim 1 now specifies that there is a single tubular insulator sheet common to the plurality of cooling circuits and that there is a single heat spreader to which the cooling ducts are mounted.

3. *Basis of disclosure - Article 123(2) EPC*

Claim 1 results, primarily, from a combination of original claims 1 to 5, wherein the terminology used in the claim has been adapted for reasons of consistency with the description. The embodiment of Figure 3 also provides support for the amended claim's wording. This embodiment discloses, namely, cooling ducts which are contiguous and electrically isolated from one another (cf. paragraph [0027], original claim 3), which extend along the main axis of the bore from one end of the gradient coil to the opposite end thereof (cf. Figure 3), and which are electrically connected and grounded at said one end and non-electrically connected at said opposite end (cf. paragraph [0028], original claim 5). In this context, the omission from present claim 1 of a reference to manifolds connected to the opposite ends of the cooling ducts, as specified in original claim 5 and described in paragraph [0028] of the description as filed, does not constitute an

unallowable intermediate generalisation since it is apparent from the application documents as a whole (cf. in particular Figure 4 and paragraph [0030]) that such manifolds are as such not instrumental in suppressing eddy currents.

#### 4. *Patentability*

##### 4.1 *Novelty*

4.1.1 Document D1 discloses a magnetic resonance imaging device for imaging a volume comprising: a main magnet with a cylindrical bore for generating a homogeneous static magnetic field parallel to the main axis of the bore; a hollow cylindrical gradient coil (2) for manipulating the magnetic field generated by the main magnet to image said volume within said bore; and a cylindrical RF coil arranged within said gradient coil and surrounding said volume (cf. Figure 5 - although relating to a conventional MRI device, Figure 5 defines the background of the invention disclosed in D1). The MRI device of D1 further comprises a plurality of cooling circuits for feeding and returning a cooling medium (cf. D1a, claim 1; page 3, lines 25-41). The cooling circuits of D1 comprise an electrically insulating sheet (fluorine resin sheet) formed into a tube extending along the bore axis. Moreover, the gradient coil is formed on the radially outermost cylindrical surface of said tube (cf. D1a, page 3, line 42 - page 4, line 5; page 4, lines 15-17). In this context, the fact that the insulator sheet is configured as a cylindrical tube is inferred from the association of Figure 4 with the indication on page 4,

lines 3-5, according to which the air regulating device is mounted in the gradient magnetic field coil.

The cooling circuits of D1 comprise an electrically conductive heat spreader configured as a conduction cooled cylindrical array of fins (cf. D1, Figures 1 and 3; D1a, claim 5) having a first surface disposed on said radially innermost cylindrical surface of the tube formed by the insulator sheet (fluorine resin sheet). A plurality of electrically conductive cooling ducts, which extend along the bore axis from one end of the gradient coil to the opposite end thereof, are mounted with a thermally and electrically conductive joint (solder 23) on an opposite second surface of the heat spreader (cf. D1a, page 3, line 42 - page 4, line 3).

Furthermore, the heat spreader and the plurality of cooling ducts disclosed in D1 are fabricated of copper, i.e. a non-magnetic, thermally and electrically conductive material (cf. D1a, claims 3, 4, 6 and 7). Although the problem associated to the need of shielding the RF coil is not addressed in D1, the structure and material of the cooling ducts and heat spreader disclosed in D1 render them fully adapted to perform the function of an effective RF shield.

The claimed device is, however, distinguished from the MRI device of document D1 in that:

- (i) slits are formed between the fins of the heat spreader;
- (ii) the cooling ducts are electrically isolated from one another; and in that

(iii) the cooling ducts are electrically connected and grounded at one end and non-electrically connected at the opposite end.

4.1.2 Document D2 is less relevant. In particular, no mention is made in D2 of the actual spatial relationship between the gradient coils, the cooling ducts and the RF coil which form part of the disclosed MRI device. Moreover, document D2 does not disclose a plurality of electrically conductive ducts associated with a heat spreader as recited in claim 1. There is also no indication in document D2 according to which the cooling circuit would be adapted to act as an RF shield.

4.1.3 Since neither document D1 nor document D2 anticipate the combination of features recited in claim 1 under consideration, the subject-matter of claim 1 is new within the meaning of Article 54 EPC 1973.

4.2 Inventive step

4.2.1 Document D1 is considered to constitute the closest prior art as it has more features in common with the claimed subject-matter than any other document of the available prior art. Furthermore, the MRI device known from document D1 is adapted to solve the problem of RF shielding addressed by the claimed invention, although in D1 this aspect is not addressed as such.

The claimed MRI device differs from this known prior art by features (i), (ii) and (iii) identified above under section 4.1.1. The principal effect achieved by these distinguishing features consists in limiting the

propagation of eddy currents in the cooling/shielding structure.

The claimed invention seeks thus to address the objective problem of reduced quality of the images. In fact, this reduced quality indirectly results from the presence of eddy currents in the structure surrounding the volume to be imaged, since such currents directly deteriorate the homogeneity of the magnetic fields generated by the main and gradient magnets in said imaging volume.

Document D1 focuses on the need to control the temperature in the imaging volume and does not address the problems resulting from the presence of eddy currents in the cooling circuits. There is, in particular, no indication in D1 whether the cooling ducts (21a, 21b) are electrically connected or not. The indication according to which the fins of the heat spreader do not need to overlap (cf. D1a, page 4, lines 12-14) is, in this respect, not sufficient to establish that the fins of the heat spreader and the cooling ducts are indeed isolated from each other. On the contrary, Figures 3 and 4 of D1 suggest that a full coverage of the cylindrical structure is intended. A full coverage of that kind indeed permits to obtain an optimal temperature distribution as a result of the increased contact surfaces between the fins and the ensuing improved conduction. These embodiments would thus lead away from a configuration with cooling ducts being electrically isolated from one another.

4.2.2 Neither document D2 nor any other document of the available prior art teaches the claimed features for eddy current suppression. Moreover, the Board is not convinced by the analysis of document D2 made by the examining division in the course of the examination proceedings. In its communication dated 27 November 2006 (cf. Search opinion), the examining division held, namely, that even if claim 1, then pending, was to be amended so as to specify that the cooling circuits also electrically shield the gradient coil from the RF coil, the claim would lack inventive step, since integration of a conventional RF shield in one of the layers 36 in Figure 1 of D2 was considered an obvious design possibility.

It is observed, in this respect, that Figure 6, which defines the background of the invention disclosed in document D2, suggests that the RF coil is remote from the gradient coils so that an RF shield could well be positioned between the cooling ducts and said RF coil while still guaranteeing high coil field performance. There is accordingly, contrary to the view held by the examining division, no incentive for the skilled person to incorporate said shield in "one of the layers 36".

Moreover, the Board notes that the reference signs 36 in the drawings of D2 are actually defining a crack screening member formed, for example, of glass fibre-reinforced plastic (cf. D2a, [0025]) which is placed in the interior of a mould during the manufacturing process of the gradient magnetic field coil. It appears, therefore, that the integration of an RF shield in said member (36) is incompatible with these functionalities.

Finally, even if the skilled person had considered incorporating, in the embodiment illustrated in Figure 1 of D2, an RF shield in layer 36 between the cooling ducts and the gradient coil and had accordingly been able to design an RF shield not interfering with the required crack screening properties of member 36, he would have most probably embedded said RF shield in the layer 36. The claimed features of the conductive heat spreader being disposed on the inner surface of the insulator and of the conductive ducts being mounted to the second surface of the heat spreader would thus have been absent from such a configuration.

4.2.3 For these reasons, the MRI device of claim 1 meets the requirements of Article 56 EPC 1973.

5. In summary, the Board has come to the conclusion that the application documents on file meet the requirements of the EPC and that the appellant's request is therefore allowable.

**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 the following documents:

- Description pages 1-10;
- Claims 1-2;
- Drawing sheets 1/4 - 4/4;

all filed during the oral proceedings before the Board.

The Registrar

The Chairman

R. Schumacher

H. Wolfrum