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Bezeichnung der Erfindung:
Title of invention:
Titre de l'invention : Methods of producing image information from objects

Klassifikation / Classification / Classement : G01N 24/08

ENTSCHEIDUNG / DECISION

vom / of / du 1 March 1990

Anmelder / Applicant / Demandeur :

Patentinhaber / Proprietor of the patent /
Titulaire du brevet : National Research Development Corporation

Einsprechender / Opponent / Opposant :

Stichwort / Headword / Référence :

EPÜ / EPC / CBE Articles 52(4), 56; R 60(2) second sentence

Schlagwort / Keyword / Mot clé : " Diagnostic method (no);
Inventive step (yes);
Proceedings continued by the Board of its own motion "

Leitsatz / Headnote / Sommaire

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Case Number : T 400/87 - 3.4.1

D E C I S I O N
of the Technical Board of Appeal 3.4.1
of 1 March 1990

Appellant : (Proprietor of the patent)
National Research Development Corporation
101 Newington Causeway
London SE1 6BU (GB)

Representative :
Davis, Norman Norbridge
Patent Department
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101 Newington Causeway
London SE1 6BU (GB)

Respondent : (Opponent)

Representative :

Decision under appeal : **Decision of the Opposition Division of the European Patent Office dated 9 September 1987 revoking European patent No. 0 046 782 pursuant to Article 102(1) EPC**

Composition of the Board :

Chairman : K. Lederer
Members : H. Reich
G.D. Paterson

Summary of Facts and Submissions

I. European patent No. 0 046 782 was granted on the basis of European patent application No. 81 900 564.6.

II. The company "Siemens AG" filed a notice of opposition against the patent on the grounds of lack of inventive step (Art. 100a EPC), in view of prior art, which was supplemented by the Patentee in the public interest to the following list of documents:

D1 : DE-A-2 833 800;
D1' : GB-A-1 601 970;
D2 : US-A-4 070 611;
D2' : DE-A-2 611 497;
D2" : Journal of Magnetic Resonance, Vol. 18, 1975, pages 69-83;
D3 : DE-A-2 755 956;
D3' : GB-A-1 596 160;
D3" : Journal of Magnetic Resonance, Vol. 29, 1978, pages 355-373;
D4 : Journal of Magnetic Resonance, Vol. 26, 1977, pages 165-167;
D5 : Proceedings of IEEE Electro/78 Conference Record, Session 30, paper 2, pages 1-15;
D6 : A. Abragram: "The Principles of Nuclear Magnetism" At the Clarendon Press, Oxford, 1978, page 66.

III. The Opposition Division pursued on the basis of Article 114(1) EPC an objection made by the Opponent in the course of the opposition proceedings, i.e. that the subject-matter of Claim 1 including a diagnostic method

practised on the human or animal body would need a disclaimer, and revoked the patent on the basis of Articles 100a and 52(4) EPC.

IV. The Patentee lodged an appeal against this decision, drawing the Board's attention inter alia to the Board's earlier decision T 385/86, OJ EPO 1988, 308.

V. During appeal proceedings observations by a third party were filed, citing new documents to be taken into account in a review of inventive step. According to Art. 115(2) EPC these observations were communicated to the Appellant (Patentee) who commented on them.

VI. The Respondent (Opponent) withdrew his opposition. The pending proceedings were continued by the Board according to Rule 60(2), second sentence, EPC.

VII. In response to a communication under Art. 110(2) EPC, wherein the Board inter alia expressed its preliminary view, that the subject-matter of Claim 1 might be regarded as satisfying Art. 52(4) EPC but obvious in view of the state of the art known from documents D1 and D2, the Appellant (Patentee) filed a new set of claims and requested that the decision under appeal be set aside and that the patent be maintained in amended form on the basis of the following documents:

Claims : 1 to 6 received 4 January 1990 with letter dated 28 December 1989, and with the amendment on claim page 11, line 1, as requested on 10 January 1990.

Description: Column 1, line 1, to column 4, line 65, received 4 January 1990 with letter dated 28 December 1989; replacement text A for

column 3, lines 4-30, received 4 January 1990 with letter dated 28 December 1989 and with the amendment in line 11 as requested on 10 January 1990;
column 5, line 1, to column 7, line 14 according to EP-B-0 046 782.

Figure : Sheet 1 according to EP-B-0 046 782.

VIII. Claim 1 reads as follows:

"1. A method of deriving image information from an object using nuclear magnetic resonance signals comprising subjecting the object to a continuous magnetic field along an axis and carrying out the following steps:

1) selectively exciting nuclear spins in a selected plane in the presence of a first gradient (Gy^+) of the static magnetic field, the direction of said first gradient being perpendicular to said plane;

2) applying the said first gradient of the magnetic field in the reverse direction after step 1) to rephase the excited nuclear spins across the thickness of the selected plane;

3) applying a second gradient (G_X-) to the static magnetic field during the period of time of step 2), the direction of the second gradient being orthogonal to the direction of the first gradient, to dephase the spins along the direction of the said second gradient as a preliminary to the subsequent read-out step;

4) applying a third gradient (G_Z) to the static magnetic field, the direction of the third gradient being orthogonal to the directions of both the first and second gradients;

5) reversing the direction of the second gradient after step 3) and maintaining said reversed gradient (G_x^+) while reading out the resultant free induction decay signal from the object;

and then successively repeating the above sequence of steps, there being a recovery interval between said successive repetitions of the above sequence of steps characterised in that

the said step 4) is applied during the period of time (4) of said steps 2) and 3) to phase encode the excited nuclear spins, and in that the above sequence of steps 1) to 5) is repeated at different values of the amplitude of the third gradient (G_Z) while keeping constant the period of time (4) in which step 4) is applied."

Claims 2 to 6 are referred back to Claim 1.

Reasons for the Decision

1. The appeal is admissible.

2. There is no formal objection under Articles 123(2) or 123(3) EPC to the current version of the claims, specification and drawings. In particular, present Claim 1 comprises the subject-matter of as well Claims 1, 2 and 3 of the published patent specification which subject-matter correspond to the technical features of originally filed Claims 1, 2 and 3, as characteristics disclosed in the original description, page 5, lines 10-15.

3. **Diagnostic method practised on the human or animal body**

3.1 The method claimed in Claim 1 provides a spatial spin-density distribution which only after a comparison with

normal values allows to localise an eventual pathological deviation. A further step would be necessary in order to attribute a localized deviation to a particular clinical picture and to decide thereupon the particular course of medical treatment. Hence, Claim 1 only comprises the examination and data gathering phase of a diagnosis. Methods which provide only interim results, are not regarded as diagnostic methods in the meaning of Art. 52(4) EPC, even if they can be utilized in making a diagnosis.

3.2 The effects of the continuous static magnetic field and the magnetic gradient fields which are applied according to Claim 1, so far as is known, do not leave any harmful side-effects in the living matter. Therefore, the claimed method can be implemented without specialist medical knowledge or skills.

3.3 The measures claimed in Claim 1 result in diagrams which show a two-dimensional spin-density-distribution in selected planes. A possible deviation from the norm is discerned from these diagrams and not from the human or animal body itself.

3.4 For the above reasons, the Board is convinced that the object of Claim 1 represents no diagnostic method in the meaning of Art. 52(4) EPC, first sentence; see also the Board's earlier decision T 385/86, OJ EPO 1988, 308, points 3.2, 3.5 to 3.5.2, and 4.3. In particular, no disclaimer of human or animal objects in Claim 1 is necessary in order to guarantee in the overall range of possible uses the susceptibility of industrial application in the sense of Art. 52(1) EPC.

4. Novelty

4.1 Documents D1 and D1' ("selection excitation" of Hutchison et al.) describe a method which applies the measures defined in only the precharacterising part of Claim 1, in particular the selective excitation and rephasing of nuclear spins in a selected plane perpendicular to a first gradient and the claimed read-out procedure in direction of the second gradient, see periods 3 to 5 of the figure in document D1. However, in this known method the third gradient is not applied directly before read-out as claimed in step 4 of Claim 1 in order to discriminate the read-out signals in direction of the third gradient by phase coding the excited nuclear spins (i.e. by "spin warp"). It is rather applied prior to the excitation of the nuclear spins in the selected plane - i.e. prior to the claimed step 1 - together with a 180° high frequency pulse in order to selectively invert the spins within a selected line (frequency coding); see period 1 of the figure in document D1 and page 5, paragraph 3.

4.2 The teaching of document D4 is limited to the fact that rephasing the selectively excited spins before read-out increases the intensity of the read-out free induction decay signal as used in the methods of document D1 and Claim 1.

4.3 The method described in documents D2, D2' and D2" ("Fourier zeugmatography" of Ernst et al.) starts with exciting the nuclear spins not in a selected plane like in Claim 1 but all over the volume to be imaged; see document D2, figure 2 and column 5, paragraph 2. It uses signal discrimination by phase coding the excited nuclear spins in the direction of the first gradient instead. In direction of the third gradient signal discrimination is provided by phase coding like in the method acording to Claim 1. However, in

repeating both phase coding steps before subsequent read-outs by applying the second gradient not the amplitudes but the pulse lengths of the gradient fields are varied for a complete scan; see document D2, column 5, lines 39 to 59. The first gradient for phase coding, the third gradient for phase coding and the second gradient for read-out are switched on in succession. The excited spins are neither rephased in the direction of the first gradient nor dephased in the direction of the second gradient as a preliminary to the subsequent read-out step.

4.4 Document D5 gives a survey on prior art methods for medical imaging and mentions on page 5, left column, paragraph 3, inter alia an adaption of the known method described in point 4.3 above for analyzing chemical samples to the imaging of living tissue. Due to the fact that it is technically difficult to achieve fast gradient switching in a coil system of large dimensions such as necessary to house a human body, document D5 teaches that the phase coding gradients of constant magnitude and variable duration may be replaced by a pulse of any convenient shape and linearly varying pulse amplitude.

4.5 A further method of deriving image information from excited nuclear spin signals is described in documents D3, D3' and D3" ("echoplanar" of Mansfield et al.). This method again starts with exciting spins in only a selected plane and discriminates the signals in the direction of the third gradient by phase coding like the method of Claim 1. However, diverging from the method claimed in the patent under appeal, the third gradient is applied not before read-out but during read-out. This results in a continuous phase shift during read-out. Furthermore, during read-out the direction of the second gradient is not kept constant like in the method of Claim 1 but alternatingly switched into opposite directions; see document D3, figure 2. The simultaneous application of the coding and the read-out

gradients results in a zig-zag scan of the selectively excited plane. Moreover, also this known method uses no dephasing or rephasing in the directions of the first and second gradients.

4.6 Document D6 described the theory of the adiabatic fast passage as claimed in Claim 4.

4.7 The documents cited by the third party are partially identical to the above indicated documents or describe identical technical facts. Hence, the Board saw no reason to introduce one of these documents into the pending proceedings on the basis of Article 114(1) EPC.

4.8 For the reasons given above, the subject-matter of Claim 1 is considered novel (Art. 54(2) EPC).

5. Inventive Step

5.1 In the Board's opinion, the method known from document D1 represents the prior art which comes closest to the invention. It covers all the measures defined in the precharacterising part of Claim 1. Starting from this art, the objective problem underlying the invention is to avoid that inhomogeneities of the static magnetic field mask and destroy some of the information contained in the read-out signals; see also the description, column 1, lines 19-25.

5.2 This problem is solved by the following measure contained in the characterising part of Claim 1; "that the sequence of steps 1) to 5) is repeated at different values of the amplitude of the third gradient" while keeping constant the period of time which step 4) is applied.

5.3 In order to arrive from the prior art according to document D1 at the subject-matter of Claim 1 a skilled person would have to replace line switching of the nuclear spins in the

direction of the third gradient (i.e. the gradient pulse and the 180° high frequency pulse of varying frequency for each read-out in period 1 of document D1) by a read-out preparing gradient pulse of constant length and varying amplitude for each read-out, such as known from document D5. The Board is convinced that it is not obvious for a skilled person to replace in the direction of the third gradient a selective spin inversion by a selective phase shift of the nuclear spins in order to increase the resolution of the image. Document D5 teaches phase encoding via amplitude variation clearly as a measure to overcome the technical difficulties of realising a fast gradient switching in large systems for medical imaging, i.e. as a measure to allow a complete scan with any technically feasible pulse shape. However document D5 does not mention that a scan via amplitude variation instead of pulse length variation has an influence on the properties of the image. In the Board's view, it is not obvious to a skilled person that by keeping constant the pulse length of the third gradient when repeating claimed steps 1) to 5), the additional phase shift due to the inhomogeneities of the static magnetic field may be kept constant, so that after the Fourier analysis the value of the spin density is imaged in an x-z plane at a given x-value for each z with the identical local displacement Δ z. This results in only a distortion of the image structure but not in its smearing, so that no image information is lost.

5.4 For the resons set out in point 5.3 above the Board finds that the subject-matter of Claim 1 involves an inventive step in the meaning of Art. 56 EPC.

6. Hence, it follows that Claim 1 is allowable.

7. Since granted Claims 4-8 relate to preferred embodiments of the method according to Claim 1, their allowability follows

from that of Claim 1. They can therefore be maintained as Claims 2 to 6.

Order

For these reasons, it is decided that:

1. The Decision of the Opposition Division is set aside.

2. The case is remitted to the first instance with the order to maintain the patent in amended form on the basis of the following documents:

Claims : 1 to 6, received 4 January 1990 with the the amendment on claim page 11, line 1, as requested 10 January 1990

Description : column 1, line 1 to column 4, line 65, received 4 January 1990;
replacement text A for column 3, lines 4-30, received 4 January 1990 with the amendment in line 11 as requested on 10 January 1990,
column 5, line 1, to column 7, line 14 according to EP-B-0 046 782.

Figure : Sheet 1 according to EP-B-0 046 782.

The Registrar: The Chairman:

M. Beer K. Lederer