Internal distribution code:

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

Datasheet for the decision of 20 November 2013

Case Number: T 0995/09 - 3.4.01

Application Number: 00927186.7

Publication Number: 1095289

IPC: G01R 33/563

Language of the proceedings: EN

Title of invention:
MR elastography method

Applicant:
Koninklijke Philips N.V.
Philips Intellectual Property & Standards GmbH

Headword:

Relevant legal provisions:
EPC 1973 Art. 56

Keyword:
Inventive step - (no)

Decisions cited:

Catchword:

Europäisches Patentamt
European Patent Office
Office européen des brevets

Beschwerdekammern
Boards of Appeal
Chambres de recours

European Patent Office
D-80298 MUNICH
GERMANY
Tel. +49 (0) 89 2399-0
Fax +49 (0) 89 2399-4465

Case Number: T 0995/09 - 3.4.01

D E C I S I O N
of Technical Board of Appeal 3.4.01
of 20 November 2013

Appellant: (Applicant 1)	Koninklijke Philips N.V. High Tech Campus 5 5656 AE Eindhoven (NL)
Appellant: (Applicant 2)	Philips Intellectual Property & Standards GmbH Steindamm 94 20099 Hamburg (DE)
Representative:	Verweij, Petronella Danielle Philips Intellectual Property & Standards P.O. Box 220 5600 AE Eindhoven (NL)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 22 December 2008 refusing European patent application No. 00927186.7 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairwoman: F. Neumann
Members: P. Fontenay
J. Geschwind

Summary of Facts and Submissions

I. European patent application No. 00 927 186.7 was published under the PCT as WO-A-00/70362. The application was refused by a decision of the examining division dispatched on 22 December 2008

The decision relied on the finding that the requests on file did not meet the requirements of the EPC with regard to clarity, novelty and inventive step, and added subject-matter.

II. The appellant (applicant) lodged an appeal against this decision by notice filed on 23 January 2009, requesting that the decision under appeal be set aside. The appeal fee was paid on the same day. In the written statement setting out the grounds of appeal, received on 24 April 2009, the appellant requested the grant of a patent on the basis of a set of claims 1 to 8 according to a main request or, as an alternative, on the basis of a set of claims 1 to 3 according to an auxiliary request. A copy of both sets of claims was annexed to the statement of grounds.

III. In a communication dated 3 September 2013 pursuant to Article 15(1) RPBA, the Board expressed its provisional opinion with regard to the requests filed on 24 April 2009. In the Board's view, the wording and unclear terminology used in the claims according to both requests led to some confusion as to the actual sequence of steps which were to be carried out according to the claimed methods and as to the various parameters or units which were to be controlled to collect all required data. It was further observed, insofar as the issue of inventive step was concerned, that the claimed methods appear to result in a

straightforward manner from the teaching of document EP-A-708 340 (D6) and general knowledge regarding the physics of wave propagation in visco-elastic media.

IV. The appellant did not react to the communication of the Board.

V. Oral proceedings before the Board were held on 20 November 2013 in the absence of the appellant, as had previously been announced in a letter dated 18 November 2013.

VI. Claim 1 of the main request reads:

"*1. A magnetic resonance elastography method, which includes the steps of:*
a) generating mechanical oscillations causing propagating waves in an object to be examined,
b1) RF exciting nuclear magnetization in conjunction with a periodic magnetic gradient field (G1, G2) to change the phase of the nuclear magnetisation deflected by the propagating waves and
- which periodic gradient field (G1,G2) which is synchronized with the mechanical oscillations in that the period of the periodic magnetic gradient field corresponds to the period of the mechanical oscillations,
b2) receiving MR signals arising in the object to be examined due to the RF excitation and form an MR phase image from the MR signals,
c) changing the direction of the gradient of the gradient field and the phase difference between the mechanical oscillations and the gradient field,
d) repeating the steps a to c) a number of times,
e) deriving from the MR phase images, the deflection of nuclear spins which is caused by the mechanical

oscillations of the nuclear spins from their state of equilibrium,
f) determining for individual voxels, on the basis of the MR phase images, the amplitude and the phase of the deflection (U) for three mutually perpendicular directions and in a three-dimensional examination volume, and
g) calculating at least one mechanical parameter of the object to be examined from (1) these values of the deflection and (2) their second order spatial derivatives in at least a of the three-dimensional part examination volume [sic] characterized in that
- the generation of mechanical oscillations involves excitation of essentially longitudinal oscillations in the object to be examined and
- the at least one mechanical parameter is elasticity-tensor (E) or attenuation coefficient (γ) is determined on the basis of the MR phase images and taking into account both shear and compression effects, represented by second order mixed spatial derivatives of the deflection, in the propagation of the waves."

Independent claim 5 of the main request relates to "*An arrangement including an MR apparatus, a mechanical oscillation generator, an evaluation unit, a generator which determines the variation in time of magnetic gradient fields, and a control unit which controls the MR apparatus, the generator, the oscillation generator and the evaluation unit and is programmed so as to execute the following steps: [...]*", wherein the steps actually recited reproduce, in essence, the method defined in claim 1.

Independent claim 8 of the main request relates to "*A computer program for a control unit which acts on an MR apparatus, an oscillation generator and an*

evaluation unit in order to carry out the method claimed in Claim 1 as follows: [...]", wherein the rest of the claim's wording reproduces, in essence, the sequence of steps recited in claim 1.

According to the main request, claims 2 to 4 depend on claim 1 whereas claims 6 and 7 depend on claim 5.

Independent claim 1 of the auxiliary request reads:

"*1. A magnetic resonance elastography method, which includes the steps of:*
a) generating mechanical oscillations causing propagating waves in an object to be examined,
b1) RF exciting nuclear magnetization in conjunction with a periodic magnetic gradient field (G1, G2) to change the phase of the nuclear magnetisation deflected by the propagating waves and
- which periodic gradient field (G1,G2) which is synchronized with the mechanical oscillations in that the period of the periodic magnetic gradient field corresponds to the period of the mechanical oscillations,
b2) receiving MR signals arising in the object to be examined due to the RF excitation and form an MR phase image from the MR signals,
c) changing the direction of the gradient of the gradient field and the phase difference between the mechanical oscillations and the ***periodic*** *gradient field,*
d) repeating the steps a to c) a number of times,
e) deriving from the MR phase images, the deflection of nuclear spins which is caused by the mechanical oscillations of the nuclear spins from their state of equilibrium,

f) determining for individual voxels, on the basis of the MR phase images, ***of*** *the amplitude and the phase of the deflection (U) for three mutually perpendicular directions and in a three-dimensional examination volume, and*
g) calculating at least one mechanical parameter of the object to be examined from (1) these values of the deflection and (2) their second order spatial derivatives in at least a of the three-dimensional part examination volume [sic] characterized in that
- the generation of mechanical oscillations involves excitation of essentially longitudinal oscillations in the object to be examined and
- the at least one mechanical parameter is elasticity-tensor (E) or attenuation coefficient (γ) is determined on the basis of the MR phase images and taking into account both shear and compression effects, represented by second order mixed spatial derivatives ~~of the deflection~~, in the propagation of the waves
- the RF excitation includes the excitation of mutually parallel slices by a way of a multi-slice method in which MR phase images are acquired for these parallel slices, the excitation of a slice being followed by the excitation of other slices before the relevant slice is excited again
- this multi-slice method being repeated as a nesting of
- repetitions of the multi-slice method are carried out for successive values of the phase difference between the mechanical oscillations and the periodic gradient field within repetition of the multi-slice method carried-out for successive values of the direction of the periodic gradient field." with emphasis on the differences to claim 1 of the main request added by the Board in bold.

Claims 2 and 3 of the auxiliary request depend on independent claim 1.

Reasons for the Decision

1. *Applicable law*

This decision is issued after the entry into force of the EPC 2000 on 13 December 2007 whereas the application was filed before this date. Reference is thus made to the relevant transitional provisions for the amended and new provisions of the EPC, from which it may be derived which Articles and Rules of the EPC 1973 are still applicable to the present application and which Articles and Rules of the EPC 2000 are to apply. When Articles or Rules of the former version of the EPC are cited, their citations are followed by the indication "1973" (cf. EPC, Citation practice).

2. *Admissibility of the appeal*

*T*he notice of appeal and the corresponding statement of grounds comply with the requirements of Articles 106 to 108 EPC and Rule 99 EPC. The appeal is, thus, admissible.

3. *Main request - Inventive step (Article 56 EPC 1973)*

3.1 Document D6 is considered to illustrate the closest prior art since it appears to constitute a realistic starting teaching when deciding on the inventive merits of the invention as defined in claims 1, 5 and 8 of the main request. In particular, document D6 shares with the claimed inventions the common purpose of

determining mechanical parameters of an object to be examined and achieves this by relying on the same fundamental principles (cf. D6, page 2, line 58 - page 3, line 6). Concretely, document D6 discloses a magnetic resonance elastography method which employs the same steps as those recited in the preamble of claim 1 of the main request as interpreted in the light of the embodiment of Figures 4 and 5 and the corresponding passages of the description (cf. D6, page 9, lines 1-17; page 10, line 47 - page 11, line 12, Figures 4 and 5). Moreover, in document D6, the generation of mechanical oscillations involves excitation of longitudinal oscillations of the object to be examined (cf. D6, page 6, lines 26-27; page 7, lines 16-19; page 13, lines 51-55).

3.2 The method of claim 1 according to the main request differs thus from the method known from document D6 in that the at least one mechanical parameter is the elasticity tensor or the attenuation coefficient and that these parameters are determined on the basis of the MR phase images, taking into account both shear and compression effects, as represented by second order mixed spatial derivatives in the propagation of the waves.

3.3 The problem solved by the invention consists therefore in providing more complete and reliable results as to the mechanical properties pertaining to the viscoelastic nature of the medium (cf. published application, page 2, lines 13-16).

3.4 As acknowledged in the description on page 2, lines 21-24 of the application, as published under the PCT, "*The invention is based on the recognition of the fact that the propagation of mechanical waves in visco-*

elastic media can be described by a partial differential equation whose solution for each voxel is determined by the amount and phase of the deflection in three mutually perpendicular directions as well as by the spatial derivatives of the deflection". This principle finds its general expression in equation (2) on page 9 or, when restricted to one single component of the deflection and assuming that the modulus of elasticity is an isotropic quantity, in equation (9) on page 10. In that latter case, equation (9) is sufficient to determine the value of the modulus of elasticity E which is then reduced to a scalar quantity.

However, neither the principle relied upon on page 2 nor the fact that the elasticity properties of a medium are more generally represented by way of a second order Hermitian tensor with real entries, i.e. a 3*3 symmetrical matrix, may be considered to represent any contribution to the art attributable to the present invention. As a matter of fact, these two aspects, as expressed by equation (2), reflect common knowledge as to the physics of viscous, elastic media. The Board thus fully concurs with the examination division in its finding that equation (2) or (9) would have certainly been considered in order "*to properly describe the propagation of mechanical waves in visco-elastic media*". This finding further implies that any attempt to provide complete and reliable results for the components of the elasticity tensor or attenuation coefficient would have led the skilled person to consider any non-negligible elements appearing in equation (6). More concretely, it would have been a normal approach for the skilled person to decide which terms in equation (6) were to be taken into account and which ones were to be dropped as negligible, depending

on the intended accuracy of the measurements to be carried out for the given purpose. Departing from the teaching of document D6, it would then have been obvious to decide on additional processing steps to be carried out in order to calculate any non-negligible terms so identified to finally solve said equation.

3.5 Under the present circumstances, taking due account of the fact that the claimed method may be implemented by a physician in order to make a diagnosis of body tissues and that the reliability of such a diagnosis depends directly on the accuracy of the measured elasticity parameters and attenuation coefficient, it would have been obvious to take all the terms of equation (6) into account. This finding implies that all the data representative of the second order mixed spatial derivatives of the deflection be determined and that, accordingly, all the data required for this determination be collected thus leading to a process as set out in claim 1. It is stressed, in this respect, that this analysis would also imply the repetition of the claimed sequence for a plurality of parallel slices since otherwise no derivative of the deflection in the third direction could be obtained. Although not recited in claim 1, these additional steps are indeed essential for the claimed method to be performed (cf. published application, page 11, lines 3-9).

3.6 In the appellant's opinion, the inventive contribution of the invention would reside in the insight that the elasticity modulus can not be reduced to a scalar quantity and that mode conversion influences measurements carried out according to the method of D6.

It is agreed that mode conversion effects are disregarded in document D6 and that the tensor

character of the elasticity modulus is not acknowledged therein. In D6, inaccuracies and inconsistencies of the results are attributed to various sources such as transient effects or differences between excitation amplitudes in different directions instead of recognising the role of attenuation and compression effects which are simply neglected in D6.

However, as expounded above, the theory underlying the dynamics of visco-elastic media is part of the general knowledge. This fact has not been challenged by the appellant. The Board can recognise no inventive activity in returning to the fundamental mathematical principles which describe the behaviour of visco-elastic media and in applying these principles in order to obtain a more complete solution, even if it was previously deemed unnecessary to provide a solution with the accuracy of the present invention. Moreover, the appellant's argument according to which the skilled person is a specialist in the medical field or a radiologist is rejected since the claimed method is in no way limited to medical applications but refers, more generally, to an "*object to be examined*". The fact that the claimed method is to be used for examination of the mamma only appears in dependent claim 4.

In the Board's judgement, the skilled person is a physicist specialised in the dynamics of wave propagation in viscous, elastic media. This results from the introductory statement in the description according to which "*The invention relates to a method of determining mechanical parameters of an object to be examined...*" (cf. published application, page 1, lines 1,2) and from the very purpose of the claimed invention which is to determine elasticity components

of an object to be examined by analysing changes in MR phase images due to mechanical oscillations.

In this regard, it is noted that the same finding would have applied even if the claim had somehow been amended so as to specify that the method is to be used for diagnostic purposes, for example, by specifying that it is for use in the examination of the mamma as recited in claim 4. It is emphasized that the objective problem to be solved relates to the way in which the data shall be collected and processed. These aspects do not require any medical qualification. The role of the medical practitioner is namely limited to specifying which parameters are actually relevant in order for him to make a diagnosis, this diagnosis having been based previously on mere palpation of the tissue (cf. published application, page 3, lines 18-22).

While it is acknowledged that a simplified model of wave propagation, neglecting second order derivatives for the deflection as is the case in document D6, might provide useful results under certain circumstances, the Board is convinced that the skilled person would attempt to improve such methods insofar as the results to be obtained can be expected to be of significance for a diagnosis to be made. Since the present invention indeed relies on the premise that the diagnostic accuracy will be increased, (a different finding would imply that no technical problem is actually solved), it is thus to be expected that the skilled person would indeed try to further develop the method disclosed in document D6.

3.7 Consequently, the magnetic resonance elastography method of claim 1 would result in a straightforward manner from an adaptation of the method of D6 in view

of general knowledge. For the same reasons, the subject-matter of independent claims 5 and 8 would also be obvious in view of Document D6.

3.8 Independent claims 1, 5 and 8 are therefore not inventive in the sense of Article 56 EPC 1973.

4. *Auxiliary request - Inventive step (Article 56 EPC 1973)*

4.1 Claim 1 incorporates features regarding the necessity to repeat the steps of claim 1 of the main request for a plurality of parallel slices. As indicated above, under section 3.5, these additional steps have already been taken into account when deciding on the inventive merits of claim 1 of the main request.

For these reasons, the analysis made above applies *mutatis mutandis* to the subject-matter of claim 1 of the auxiliary request which is therefore not inventive in the sense of Article 56 EPC 1973.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairwoman:

R. Schumacher F. Neumann

Decision electronically authenticated