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File Number: T 202/91 - 3.4.1

Application No.: 83 110 987.1

Publication No.: 0 112 469

Title of invention: Energy subtraction processing method for radiation images,
stimulable phosphor sheet, stimulable phosphor sheet
composite member and stimulable phosphor sheet-filter
composite member used for the method

Classification: G01T 1/29

D E C I S I O N
of 21 October 1992

Proprietor of the patent: FUJI PHOTO FILM CO., LTD.

Opponent: Siemens Aktiengesellschaft

Headword:

EPC Article 56

Keyword: "Inventive step - affirmed"



Case Number : T 202/91 - 3.4.1

D E C I S I O N
of the Technical Board of Appeal 3.4.1
of 21 October 1992

Appellant :
(Opponent)

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Respondent :
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Decision under appeal :

Interlocutory decision of the Opposition Division
of the European Patent Office dated 4 January
1991 concerning maintenance of European patent
No. 0 112 469 in amended form.

Composition of the Board :

Chairman : G.D. Paterson
Members : R.K. Shukla
Y. van Henden

Summary of Facts and Submissions

I. European patent No. 0 112 469 was opposed by the Appellant on the ground that its subject-matter did not comply with the requirements of Articles 52 and 56 EPC having regard to the following prior art documents :

D1: EP-A-0 089 665

D2: US-A-2 906 881

D3: DE-A-2 952 426

D4: " Das Röntgenfernsehen " by A. Gebauer et al, Georg Thieme Verlag Stuttgart, 1974, pages 119 to 123.

II. By its interlocutory decision, the Opposition Division maintained the patent in amended form pursuant to Article 102(3) EPC.

III. Independent Claims 1,10, 15 and 20 forming the basis of the interlocutory decision read as follows:

Claim 1

"An energy subtraction processing method for radiation images comprising the steps of:

i) obtaining at least two X-ray images of an object (7) including a specific structure exhibiting radiation energy absorption characteristics different from the radiation energy absorption characteristics of the other structure in said object to radiation,

ii) extracting an image of said specific structure by subtraction of one of said two X-ray images from the other one,

characterised by

iii) simultaneously exposing a plurality of stimuable phosphor sheets (A, B; A, B, B'; A, B, C) which are overlaid one upon another to provide a composite

member, to the radiation (6) passing through said object (7), to store radiation images in the respective stimuable phosphor sheets (A, B; A, B, B'; A, B, C) so that image information is recorded in a stimuable phosphor sheet (B; B, B'; B, C) positioned farther from said object in such a way that, at least at the area of the record corresponding to said specific structure, a low energy component of the radiation is recorded at a lower intensity than in a stimuable phosphor sheet (A) positioned closer to said object (7),

iv) scanning the respective stimuable phosphor sheets (A, B; A, B, B'; A, B, C) with stimulating rays (11) to sequentially release the radiation energy stored in the stimuable phosphor sheets as light emission,

v) photoelectrically detecting (15) the emitted light (13) and converting it to digital image signals representing the respective radiation images,

vi) providing at least two sets of digital image signals, representing at least two respective radiation images, for use in subtraction processing, and

vii) extracting an image of said specific structure by subtraction processing of said sets of signals, i.e., multiplying digital image signals of corresponding picture elements by weight factors and subtracting said weighted signals, said composite member comprising a plurality of stimuable phosphor sheets comprising at least two stimuable phosphor sheets (A, B; A, B, B'; A, B, C) exhibiting different levels of absorption of the low energy component of said radiation, said stimuable phosphor sheets being positioned in such a manner that a stimuable phosphor sheet (A) exhibiting a higher level of absorption of the low energy component of a radiation is closer to the object (7) than a stimuable phosphor sheet (B; B'; C) exhibiting a lower level of absorption."

Claim 10

"An energy subtraction processing method for radiation images comprising the steps of:

i) obtaining at least two X-ray images of an object (7) including a specific structure exhibiting radiation energy absorption characteristics different from the radiation energy absorption characteristics of the other structure in said object to radiation,

ii) extracting an image of said specific structure by subtraction of one of said two X-ray images from the other one

characterised by

iii) simultaneously exposing a plurality of stimuable phosphor sheets (A, B; A, B, B'; A, B, C) which are overlaid one upon another to provide a composite member, to the radiation (6) passing through said object (7), to store radiation images in the respective stimuable phosphor sheets (A, B; A, B, B'; A, B, C) so that image information is recorded in a stimuable phosphor sheet (B, B, B'; B, C) positioned farther from said object in such a way that, at least at the area of the record corresponding to said specific structure, a low energy component of the radiation is recorded at a lower intensity than in a stimuable phosphor sheet (A) positioned closer to said object (7),

iv) scanning the respective stimuable phosphor sheets (A, B; A, B, B'; A, B, C) with stimulating rays (11) to sequentially release the radiation energy stored in the stimuable phosphor sheets as light emission,

v) photoelectrically detecting (15) the emitted light (13) and converting it to digital image signals representing the respective radiation images,

vi) providing at least two sets of digital image signals, representing at least two respective radiation images, for use in subtraction processing, and

vii) extracting an image of said specific structure by subtraction processing of said sets of signals, i.e., multiplying digital image signals of corresponding picture elements by weight factors and subtracting said weighted signals, said composite member comprising

a) a substrate (2A) made of a material absorbing a low energy component of the radiation, and

b) two stimuable phosphor layers (1A, 1B), one formed on each surface of said substrate (2A),

and said composite member is exposed to the radiation (6) passing through said object (7) to store radiation images in the respective stimuable phosphor layers (1A, 1B) so that image information is recorded in the stimuable phosphor layer (1B) formed on the substrate surface farther from said object (7) in such a way that, at least at the area of the record corresponding to said specific structure, the low energy component of the radiation is recorded at a lower intensity than in the stimuable phosphor layer (1A) formed on the object side surface of said substrate (2A) of said composite member."

Claim 15

"A stimuable phosphor sheet composite member for use in an energy subtraction processing method for radiation images, which comprises at least two stimuable phosphor sheets (A, B; A, B, B'; A, B, C), each exhibiting a different level of absorption of a low energy component of the radiation, said stimuable phosphor sheets being overlaid one upon another in the order of the higher or lower level of absorption."

Claim 20

"A stimuable phosphor sheet for use in an energy subtraction processing method for radiation images, which comprises:

- a) a substrate (2A) made of a material absorbing a low energy component of said radiation, and
- b) stimuable phosphor layers (1A, 1B) formed on both surfaces of said substrate (2A)."

IV. The Appellant (Opponent) lodged an appeal against the above decision and requested that the patent as amended be revoked since its subject-matter did not involve an inventive step.

A further document

D5: DE-A 2 363 995

was cited in the Statement of Grounds of Appeal.

Document D1, which is comprised in the state of the art according to Article 54(3) EPC, was not relied upon in the present appeal proceedings.

V. Oral proceedings took place on 21 October 1992, and at the conclusion thereof the Board announced its decision that the appeal was dismissed.

VI. The Appellant presented essentially the following arguments in support of his request:

In document D4 several energy subtraction processing methods for X-rays are described. In Borgman's method two X- radiographs are scanned with a flying spot light beam to obtain a subtraction video signal. In documents D3 and D5 a stimuable phosphor material is employed for recording an X-ray image and the image is subsequently read using a stimulating beam of radiation as in the

present invention so that the use of a stimulable phosphor, instead of a photographic film, in the Borgman's method, with appropriate modifications in the method, was obvious to a skilled person. Moreover, in an arrangement of photographic emulsion layers described in document D2 absorbent screens made of lead are provided between light sensitive emulsion layers. The document also mentions that the negatives can be subtractively or additively combined so as to obtain a coloured energy subtraction image. The energy subtraction processing method as claimed in independent Claim 10 of the patent in suit employs a substrate absorbing the low energy component of the radiation to a larger extent than the high energy component, and in a preferred embodiment this substrate is made of lead. As the absorbent screen in document D2 is also made of lead, it must be presumed to absorb the low energy component to a larger extent than the high energy component of the radiation. Consequently, the low energy component of the radiation is recorded at a lower intensity in the emulsion layer which is farther from the exposed object than in the emulsion layer located closer to the object, as in the invention claimed in independent Claims 1 and 10. Thus, the claimed subject-matter was derivable from the disclosure in documents D2, D3 and D4 in an obvious manner.

Similarly, the subject-matter of the independent Claim 20 relating to a stimulable phosphor sheet was rendered obvious by the teaching of documents D2, D3 and D4.

- VII. The Respondent requested that the appeal be dismissed and the patent be maintained in amended form in accordance with the decision of the Opposition Division. He supported this request with arguments which can be summarised as follows:

In Borgman's method disclosed in document D4, the light beam used for scanning two X-ray images formed on two photographic films is transmitted through the photographic films so that it is necessary to employ transparent films. Moreover, the X-ray images of an object are obtained at different times, and not simultaneously as in the present invention, so that the object is exposed under different conditions.

Document D2 merely relates to the production of radiographs in contrasting colours, and the analysis of a colour radiograph described in the document involves recording of X-rays of unlike radiation magnitude or intensity on two or more emulsions of preferably different emulsion speed. In the present invention on the other hand the stimuable phosphor sheets exhibit different levels of absorption of the low energy component of X-rays. In document D2 photographic negatives are dyed in contrasting colours and combined, or are projected through filters of contrasting colours and combined to form a density record of contrasting colours. Thus, whereas two or more emulsions are exposed simultaneously in document D2, in the subtraction processing in document D4 the images are taken at different times so that the subtraction processing method of document D4 could not be applied to produce colour radiographs as in document D2.

Reasons for the Decision

1. Inventive step

The only issue to be examined in the present appeal is the question of inventive step.

1.1 Independent method Claims 1 and 10

1.1.1 In the energy subtraction processing method according to independent Claims 1 and 10 a plurality of stimuable phosphor sheets of a composite member are simultaneously exposed to X-rays passing through an object including a specific structure, and a low energy component of the radiation is recorded at a lower intensity in a stimuable phosphor sheet positioned farther from the object than in a stimuable phosphor sheet positioned closer to the object. In the method of Claim 1 this is achieved by employing a composite member comprising at least two stimuable phosphor sheets exhibiting different level of absorption of the low energy component of the radiation and arranged in such a manner that a phosphor sheet exhibiting higher level of absorption of the low energy component is closer to the object than a phosphor sheet exhibiting a lower level of absorption of the low energy component. The method according to claim 10, on the other hand, uses a composite member comprising a substrate made of "a material absorbing the low energy component of the radiation", and a stimuable phosphor layer provided on each of the two sides of the substrate. Referring to the description in column 6, lines 50 to 55 of the contested patent with a view to interpreting the statement " a material absorbing the low energy component" pursuant to Article 69(1) EPC, second sentence, it is evident that the substrate material absorbs the low energy component of the radiation to a larger extent than the high energy component of the radiation. Subsequently, in both the methods, the phosphor sheets are scanned separately with a light beam whereby stimulated emission in the visible wavelength range is obtained from the phosphor sheets and the visible images so obtained are photoelectrically detected and converted into digital image signals. Finally, subtraction processing is carried out on the

digital signals to obtain an image of the specific structure.

- 1.1.2 In document D4 several methods for subtraction X-ray radiography using photographic film are described. In particular, Borgman's flying spot method described on page 119, second column, paragraph 2, with reference to Figure 101b (in combination with the disclosure regarding the signal processing in paragraph 1) appears to be the best starting point for the assessment of inventive step.

In Borgman's method two sheets of X-ray photographic film are exposed to X-rays transmitted through an object under different conditions, that is, the object is irradiated before and after a contrasting substance has been injected into the object. The sheets then are scanned with flying spot light beams whereby the light beams transmitted through the sheets are intensity modulated and correspond to the two X-ray images. The intensity modulated light beams are photoelectrically detected and converted into analog image signals. Finally subtraction is performed on these image signals so as to obtain an image of a specific structure included in the object.

- 1.1.3 In view of the above, the methods according to Claims 1 and 10 of the patent in suit differ, respectively, from Borgman's method by the features contained in their characterising parts.
- 1.1.4 In document D3 it is disclosed that a radiation image recording system employing a stimuable phosphor material is more advantageous in comparison with a recording system using a photographic film, since in the former the image is recorded over a wide range of radiation exposure, which is particularly advantageous in medical diagnosis (see,

page 7, line 26 to page 8, line 5). In view of this, the Board agrees with the Appellant that in document D3 there is a clear incentive to use stimuable phosphor sheets in Borgman's flying spot method with appropriate modifications in the image read-out employed therein according to document D3.

Nevertheless, in the radiation image processing method disclosed in document D3 a composite member comprising a plurality of stimuable phosphor sheets as in features (iii) and (vii) of Claim 1 or 10 of the patent under dispute, is not disclosed, so that the use of stimuable phosphor sheets in Borgman's method, as mentioned above, does not lead to the claimed subject-matters.

- 1.1.5 Document D2 is mainly concerned with producing X-ray radiographs in contrasting colours, and involves recording of X-rays of unlike radiation magnitude or intensity on two or more emulsion layers (1). To this end, absorbent screens (2), preferably of lead, absorbing low-intensity X-rays are provided between the successive emulsion layers (see column 1, lines 15 to 17, 24 to 28, 54 to 57; column 1, line 70 to column 2, line 3). Admittedly, this arrangement of emulsion layers and the absorbent screen of lead resembles the composite member comprising two stimuable phosphor sheets (1A, 1B) each provided on either side of a substrate (2A) as in feature vii) of Claim 10 of the contested patent. Moreover, since according to the basic laws of physics governing absorption of X-rays, any absorbent material exposed to X-rays of a given intensity necessarily absorbs soft X-rays (i.e. the low energy component of X-rays) to a larger extent than the hard X-rays (i.e. the high energy component of X-rays), in the Board's view, the absorbent screen of document D2 must also exhibit the same X-ray absorption characteristic. Also, according to a preferred

embodiment of the composite member as defined in Claim 14, which is dependent on independent Claim 10 of the patent under dispute, the substrate absorbing low energy component of the radiation may be of lead, so that the absorbent screen in document D2, which is also of lead, must also have the same X-ray absorption characteristic as the substrate in Claim 10. In document D2, therefore, the low energy component of the radiation is recorded at a lower intensity in the emulsion layer farther from the object than in the emulsion layer positioned closer to the object as in the claimed invention.

Nevertheless, in document D2, in order to form radiographs of contrasting colours either the photographic negatives are dyed in contrasting colours and combined, or are projected through filters of contrasting colours and combined (see column 2, lines 25 to 28), so that in the Board's view, there is no energy subtraction processing involved in document D2. In this connection, although document D2 mentions that the synthesis of colour radiography may be additive or subtractive (see column 2, lines 28 to 32), as correctly pointed out by the Respondent, this corresponds to the so-called additive or subtractive colour mixing which is normally used in colour photography and cannot be regarded as energy subtraction processing to obtain an image of a specific structure.

In view of the above, in the Board's judgment, the teaching of document D2 does not render obvious the use of the arrangement of emulsion layers employed therein in the energy subtraction processing method disclosed in document D4.

- 1.1.6 Document DE-A-2 363 995 (D5) corresponds to US-A-3 859 527 discussed on page 7 in document D3, and merely discloses the use of a stimuable phosphor material as an

intermediate storage medium, so that the use of a composite member comprising a plurality of stimulable phosphor sheets as in features (iii) and (vii) of Claims 1 and 10 of the patent under dispute, is not rendered obvious by document D5.

1.1.7 For the foregoing reasons, in the Board's judgment, the subject-matters of Claims 1 and 10 involve an inventive step within the meaning of Article 56 EPC.

1.2 Independent Claims 15 and 20

1.2.1 The composite member according to Claim 15 requires at least two stimulable phosphor sheets each exhibiting a different level of absorption of a low energy component of the radiation. As is evident from the discussion of the prior art in items 1.1.4 to 1.1.6 above, such a composite member is not known in the art. Also, there being no motivation in the cited prior art for the use of such a composite member, the subject-matter of Claim 15 is not rendered obvious by the prior art within the meaning of Article 56 EPC.

1.2.2 Referring to item 1.1.5 above, it is evident that the composite member as claimed in Claim 20 differs from the arrangement of emulsion layers and an absorbent screen of document D2 in the use of stimulable phosphor layers.

In document D2 it is stated in column 3, lines 26 to 28 that the invention may be used in connection with fluorescent screens using fluorescent salts. In the Board's view, this statement is to be read in the context of the disclosure in column 1, lines 30, 31 and column 2, lines 52 to 56, so that what is intended is that the

intensifying screen (3), and not the emulsion layers, which is attached to the final absorbent screen, uses fluorescent salts instead of silver salts.

Moreover, documents D3 and D5 do not disclose a composite member comprising stimuable phosphor layers one located above the other, so that for the skilled person there was no hint in these documents that such an arrangement of stimuable phosphor layers would work satisfactorily in obtaining colour radiographs as in document D2.

In view of the above, the Board considers that the subject-matter of Claim 20 involves an inventive step according to Article 56 EPC.

- 1.3 Dependent Claims 2 to 9 and 11 to 14 relate, respectively, to particular embodiments of the energy subtraction processing method according to Claims 1 and 10 respectively. Similarly, dependent Claims 16 to 19 and 21 to 24 relate, respectively, to particular embodiments of a composite member and a stimuable phosphor sheet as set out in Claims 15 and 20 respectively. These dependent claims are also therefore allowable.

Order

For these reasons, it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:

M. Beer

G.D. Paterson