BESCHWERDEKAMMERN DES EUROPÄISCHEN PATENTAMTS

BOARDS OF APPEAL OF THE EUROPEAN PATENT OFFICE

CHAMBRES DE RECOURS DE L'OFFICE EUROPEEN DES BREVETS

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Publication in the Official Journal ~~Year~~ / No

File Number: T 747/90 - 3.4.1

Application No.: 85 115 653.9

Publication No.: 0 184 810

Title of invention: Method of detecting a focus defect of an electron microscope image

Classification: H01J 37/22

D E C I S I O N
of 5 March 1992

Applicant: FUJI PHOTO FILM CO., LTD.

Headword:

EPC Articles 56 and 111(1)

Keyword: "Inventive step (yes, with respect to the state of the art taken into consideration during the examination procedure);
"Introduction into the examination proceedings of a document which is cited in a document introduced and relied upon by the Appellant";
"Remittal of the case to the first instance for further examination of patentability"

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number : T 747/90 - 3.4.1

D E C I S I O N
of the Technical Board of Appeal 3.4.1
of 5 March 1992

Appellant : FUJI PHOTO FILM CO., LTD.
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Decision under appeal : Decision of Examining Division 047 of the European Patent Office dated 25 April 1990 refusing European patent application No. 85 115 653.9 pursuant to Article 97(1) EPC.

Composition of the Board :

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

Summary of Facts and Submissions

I. European patent application No. 85 115 653.9 was refused by a decision of the Examining Division on the ground that the claimed subject-matter did not involve an inventive step having regard to the disclosure in the prior art documents:

D1: Journal of Physics E: Scientific Instruments, Vol. 8, No. 7 (1975), pages 582 to 587, Dorking, GB; J. Frank: "Controlled Focusing and stigmating in the conventional and scanning transmission electron microscope";

D2: EP-A-0 077 677.

II. The Examining Division took the view that a person skilled in the art of electron microscopy would investigate whether, while carrying out the method of correcting the focus of an electron microscope disclosed in (D1), a phosphor sheet similar to the one known from (D2) can be used in place of a photographic film. Methods of producing and detecting images of X-rays and electron images are indeed very similar and persons skilled in one field also have a knowledge of the other field. This is actually confirmed by document (D2), which mentions that, when exposed to ß-rays, certain kinds of phosphors store a part of the incident energy, and that the stored energy can be discharged through application of stimulating light. Now, it is clear that, in an electron microscope, the image storage sheet must be placed under vacuum. Finally, the necessity of determining and correcting the focus defect is obvious.

III. The Applicant lodged an appeal against the decision of the Examining Division and submitted new claims annexed to his

Statement of Grounds of Appeal, said claims forming the basis of a main and an auxiliary request.

IV. The Board summoned the Appellant to oral proceedings.

V. On 21 February 1992, the Appellant submitted a new set of five claims to be considered during the oral proceedings and replacing those previously on file. The first and last claims of this set were independent ones, whereas Claims 2 to 4 were appended to Claim 1.

VI. Oral proceedings were held on 5 March 1992.

During the oral proceedings, the Appellant submitted i.a. the document

D3: Proceedings of the XIth International Congress of Electron Microscopy, Kyoto, 1986, pages 439 and 440, T. Oikawa et al. "Application of "imaging plate" for recording transmission electron microscope image"

and amended the independent Claims 1 and 5 submitted on 21 February 1992. With the amendments performed by the Appellant, said claims now read:

"1. A method of correcting a focus defect of an image produced by an electron microscope, comprising the steps of

i) exposing a stimulable phosphor sheet under vacuum to an electron beam having passed through a specimen to enable said stimulable phosphor sheet to store the energy of the electron beam;

ii) applying stimulating light to said stimulable phosphor sheet to discharge the stored energy as light, the stimulating light being passed from outside through a

light-transmissive wall member (19a, 61) onto the stimulable phosphor sheet;
iii) photoelectrically detecting the light discharged from said stimulable phosphor sheet to produce an image signal;
iv) computing the focus defect of the image based on said image signal; and
v) correcting the focus defect in compliance with the computed defect by adjusting the objective lens (6) with which the microscope is equipped.

5. A method of correcting astigmatism of an image produced by an electron microscope with a stigmator, comprising the steps of:
i) exposing a stimulable phosphor sheet under vacuum to an electron beam having passed through an amorphous material to enable said phosphor sheet to store the energy of the electron beam;
ii) applying stimulating light to said stimulable phosphor sheet to discharge the stored energy as light, the stimulating light being passed from outside through a light-transmissive wall member (19a, 61) onto the stimulable phosphor sheet;
iii) photoelectrically detecting the light discharged from said phosphor sheet to produce an image signal;
iv) electrically performing the Fourier transform on the discharged light to produce a converted image signal bearing a ring pattern;
v) selecting one ring (R) of the ring patter having zero intensity and counting from the inside of the ring pattern the order of said one ring, determining the lengths of minor (s) and major (l) axes of said one ring, and the angle (ϕ) of inclination of said major axis, based on said converted image signal; and

vi) based on said order, lengths, and angle of inclination computing currents to be passed through said stigmator."

VI. The Appellant requested the impugned decision to be set aside and a European patent to be granted on the basis of the claims submitted on 21 February 1992 and amended during the oral proceedings. In support of his request, he substantially argued as follows:

Document (D1) discloses background art discussed in the application and involving a complex procedure, namely performing a Fourier transform on a signal derived from an image recorded on a fine grain photographic film. Accordingly, to devise the claimed method, it was necessary to know that a stimulable phosphor sheet reproduces an electron microscope image with sensitivity and quality which are at least as high as that obtained with conventional fine grain silver halide photographic films. Document (D2), which pertains to an X-ray imaging system and is silent as regards electron microscopes, discloses of course nothing about that knowledge, nor about placing a stimulable phosphor under vacuum. Therefore, to arrive at the claimed invention while starting from the state of the art revealed by (D1) and (D2), it was necessary to perform the additional steps of exposing a stimulable phosphor sheet to electron bombardment in an electron microscope, using the image signal detected photoelectrically to compute the focus defect of the image and correcting said defect in accordance with its computed value. Furthermore, it should be noted that document (D2) does not disclose the use of a "specimen", since the X-rays propagate through a human body, nor does it disclose computing misadjustments and correction thereof on the basis of their computed values. Finally, neither (D1) nor (D2) discloses or suggests to

transmit the stimulating light through a transparent window, whereby breaking the vacuum is made unnecessary.

VII. After deliberation by the Board, the Chairman gave the decision that the Appellant was to supply the Board with the documents:

D6: Radiology 148 (1983), pages 833 to 838, M. Sonoda et al., "Computed radiography utilizing scanning laser stimulated luminescence";

D7: Journal of Electron Microscopy, Vol. 33, No. 3 (1984), pages 255 to 257, S. Ishihara et al., "Usefulness of a scanning laser stimulated luminescence (SLSL) system for electron microscopy - a new image recording system";

which are referred to in document (D3), and that, if documents (D6) and (D7) were not relevant prior art, the Board intended to grant the patent on the basis of the set of claims filed at the oral proceedings.

Reasons for the Decision

1. Procedural matters

In the present appeal, document (D7) has been examined by the Board of its own motion pursuant to Article 114(1) EPC and, since it is considered to be relevant for the examination of the patentability of the present invention, it is introduced into the proceedings. Document (D3), even though not part of the prior art, is relevant to the assessment of inventive step having regard to the disclosure in (D1) and (D2).

2. Formal requirements

2.1 Independent Claims 1 and 5 respectively replace Claims 1 and 8 of the present application as filed. In view of the disclosure in the part of the description relating to Figures 1 and 2 of the published patent application, in particular in the passages extending from line 21 of page 18 to line 2 of page 19, on lines 5 to 9 of page 20 and on lines 18 to 23 of page 22, the Board is satisfied that the subject-matter of Claim 1 does not extend beyond the content of the application as filed - Article 123(2) EPC. Claims 2 to 4 have the same wording as Claims 2, 6 and 7 of the original file, respectively, which Claims 2, 6 and 7 were appended to the original first one. With regard to the part of the description already considered in relation with Figures 1 and 2, the Board has no objection to raise against Claims 2 to 4 under Article 123(2) EPC. Likewise, taking into account the part of the original description relating to Figures 2 and 6, in particular the passages on lines 19 to 25 of page 33 and from line 26 of page 37 to line 18 of page 38, the Board is also satisfied that Claim 5 too does not offend against Article 123(2) EPC.

2.2 In Claim 5, it may be admitted that "electrically performing the Fourier transform on the discharged light" means that suitable computing means process the image signal output by the photoelectric transducer (55) and convert the corresponding image through Fourier transform, and that the notion of "angle of inclination of the major axis" is clear. The choice of the origin for measuring this angle has indeed no effect upon the result to be found, i.e. "the current to be passed through the stigmator", since taking account of a change in angular origin is an elementary operation.

The Board, therefore, is also satisfied that the claims meet the requirements of Article 84 EPC.

3. Novelty

3.1 The terminology of the claims being kept, document (D1) pertains to methods of correcting astigmatism or a focus defect - i.e. defocusing - of an image produced by an electron microscope - see the title and second sentence of the Abstract. To this purpose, an image of a specimen is formed and a signal representative of the intensity distribution within a selected field of said image is stored in a memory of a computer - see the first sentence of section 2, headed "Interactive adjustment with minimum exposure". The second paragraph of section 7, headed "Conclusions", states that said specimen should have an amorphous structure. The third, fourth and fifth paragraphs of section 6, headed "Sensitivity", reveal that the image of the specimen is formed on a photographic film exposed to an electron beam having passed through the specimen, which implies that said photographic film is placed under vacuum while being exposed to electron bombardment.

For correcting a focus defect, a computation of said defect based on the image signal stored in the computer memory is performed and, thereafter, the focus defect is corrected in compliance with its computed value by adjusting the objective lens with which the microscope is equipped - see: first sentence and third paragraph of section 2; point (iii) of the "Conclusions".

As regards correction of astigmatism, document (D1) reveals that operator interaction can be replaced by some type of computer recognition procedure - see the third paragraph of section 2 - and that the criteria found for

stigmating can readily be incorporated in a computer program - see point (iii) of the "Conclusions". It is, therefore, necessary that currents to be passed through the stigmator be computed while bringing into operation the method of correcting astigmatism referred to in (D1). Finally, though leading somewhat away from the use of the Fourier transformation on the ground that it would require longer processing times, document (D1) also reveals that such a transformation can be performed by a computer, i.e. "electrically", on the image signal to produce a converted signal bearing the well-known phase contrast zone pattern - see the last two paragraphs of section 2.

3.2 The method of correcting a focus defect of an electron microscope image according to Claim 1 is thus distinguished over the prior art method known from (D1) in that the member to be exposed to the electron beam is a stimulable phosphor sheet storing the energy of the electron beam and in that it comprises the steps of:

(ii) applying stimulating light to said stimulable phosphor sheet to discharge the stored energy as light, the stimulating light being passed from outside through a light-transmissive wall member (19a, 61) onto the stimulable phosphor sheet, and

(iii) photoelectrically detecting the light discharged from said stimulable phosphor sheet to produce the image signal.

3.3 The method of correcting astigmatism of an electron microscope image according to independent Claim 5 is distinguished over the disclosure in (D1) by the same features as that covered by Claim 1, in that it further comprises the step of

(v) selecting one ring (R) of the ring pattern having zero intensity and counting from the inside of the ring pattern the order of said one ring, determining the lengths of minor (s) and major (l) axes of said one ring, and the angle (ϕ) of inclination of said major axis, based on said converted image signal,

and in that the computation of currents to be passed through the stigmator is based on said order of selected ring (R), lengths (s, l) and angle (ϕ) of inclination.

3.4 Document (D2) relates to the production of radiographic images and, therefore, its disclosure is more remote from the claimed subject-matter than that of document (D1).

3.5 The Board is furthermore satisfied that the one-part formulation of independent Claims 1 and 5 is appropriate, because if said claims were in two-part form they would be considerably lengthened.

4. Inventive step with respect to the disclosure in (D1) and (D2)

4.1 As is evident from the description on page 9, lines 20 to 25 of the application in suit, the present invention has the advantage over the prior art in that the stimulable phosphor sheet exhibits high sensitivity to an electron beam, so that it is possible to focus an image or select a field without damaging the specimen.

In document (D3) - which was published after the filing date of the application in suit - results of comparative tests using a conventional photo film, namely, FUJI FG film, employed in a conventional transmission electron microscope and an imaging plate (IP) developed by FUJI and comprising a coating of photostimulable phosphor are reported. It is evident from the results that the IP has a

sensitivity to an electron beam about three orders higher than that of a then currently conventional photo film. The document does not explicitly disclose that the FUJI FG film represents a typical or best prior art film in so far as sensitivity to an electron beam is concerned. Nonetheless, for a scientific experimental investigation of the type reported in the document, this is normally the case, so that the Board has no reason to doubt that the FUJI FG film represents the best prior art. In the present invention a stimulable phosphor sheet similar to the one used in document (D3) is employed as an imaging plate, so that the Board accepts that the stimulable phosphor sheet employed in the present invention also exhibits a high degree of sensitivity to an electron beam.

4.2 Starting with the above prior art, the objective problem facing the skilled person can, therefore, be seen as providing a method of recording and reproducing electron microscope images, wherein an imaging or recording means having high sensitivity to an electron beam - such as described in document (D3) - is employed so that specimens are not damaged during focusing or field search.

4.3 Document (D2) relates, in general, to an image read-out method in which a stimulable phosphor sheet is used to record a radiation image. Although various types of radiation, including Beta-rays, are mentioned in connection with certain kind of phosphors in the introduction of the document, the image read-out method specifically described in the document deals exclusively with recording of an X-ray image. In the preliminary image read-out operation, an X-ray image stored in a stimulable phosphor sheet - see page 12, lines 9 to 13 - is scanned with a stimulating radiation to obtain a visible image. The image input information obtained from the preliminary visual image is then used to set the conditions for the

final read-out of the residual image in the phosphor sheet. The stimulating radiation in the final read-out has a higher energy than in the preliminary read-out operation. The X-ray images obtained using this method are stated to exhibit a high contrast, high sharpness and low noise - see page 3, lines 4 to 5. However, the sensitivity of the phosphor sheet to X-rays is not mentioned.

Admittedly, a person skilled in the art would have learnt from document (D2) that certain kinds of phosphors when exposed to Beta-rays store a part of the energy of the incident radiation, and subsequently emit light when stimulated by a suitable radiation. Further, the energy of Beta rays is known to vary over a wide range, for example, between 0.018 MeV - for tritium - and 1.4 MeV - for sodium-24 - so that the energy of an electron beam normally employed in a transmission electron microscope falls within this range. In the Board's view, therefore, the skilled person would have also expected that the stimulable phosphor would be sensitive to an electron beam in a transmission electron microscope. Nevertheless, in the Board's view, the degree of sensitivity reported in document (D3) is about three orders higher than that of a conventional photo film and is truly surprising, and it was not obvious to the skilled person that such a high sensitivity could be achieved by the use of a stimulable phosphor sheet in a transmission electron microscope.

4.4 Thus the ground on which the Examining Division refused the application in suit cannot be supported by the Board of Appeal and, therefore, the impugned decision will be set aside.

5. For the reasons explained in section 4 of the present decision, the Board is satisfied that the inventions

according to independent Claims 1 and 5 are so linked as to form a single general inventive concept - Article 82 EPC.

6. Document (D7) has not been considered by the Examining Division in connection with the application in suit. This document forms part of the state of the art under Article 54(2) EPC and, therefore, may be relevant when considering whether the requirements of Articles 52 to 57 have been met. The Board, in exercise of its power under Article 111(1) EPC, has therefore decided to remit the case to the first instance for further examination in this respect.

Order

For these reasons, it is decided that:

1. The decision of the Examining Division dated 25 April 1990 is set aside.

2. The case is remitted to the first instance for further examination.

The Registrar: The Chairman:

M. Beer G.D. Paterson

13.8.92

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