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Boards of Appeal

Chambres de recours

Case Number: T 0335/95 - 3.4.3

D E C I S I O N
of 25 September 2000 correcting error in the decision
of the Technical Board of Appeal 3.4.3
of 29 June 2000

Appellant:

HITACHI, LTD.
6, Kanda Surugadai 4-chome
Chiyoda-ku
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Representative:

Altenburg, Udo, Dipl.-Phys.
Patent- und Rechtsanwälte
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Galileiplatz 1
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Decision under appeal:

Decision of the Examining Division of the
European Patent Office posted 1 December 1994
refusing European patent application
No. 89 122 906.4 pursuant to Article 97(1) EPC.

Composition of the Board:

Chairman: R. K. Shukla
Members: G. L. Eliasson
A. C. G. Lindqvist

In application of Rule 89 EPC, the following corrections are made in the Decision in the appeal case T 0335/95 - 3.4.3:

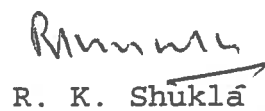
On page 14, point 2 of the Order: "sheets 1/5 to 5/5"
is replaced by
"sheets 1/15 to 15/15".

The Registrar:



D. Spigarelli

The Chairman:



R. K. Shukla

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D E C I S I O N
of 29 June 2000

Case Number: T 0335/95 - 3.4.3

Application Number: 89122906.4

Publication Number: 0376045

IPC: H01L 21/30

Language of the proceedings: EN

Title of invention:
Method and apparatus for processing fine pattern

Applicant:
HITACHI, LTD.

Opponent:
-

Headword:
Magnetic focusing means/HITACHI

Relevant legal provisions:
EPC Art. 56, 123(2)

Keyword:
"Generalization of a feature in a claim - allowed"
"Inventive step (yes) - second auxiliary request"

Decisions cited:
-

Catchword:
-



Case Number: T 0335/95 - 3.4.3

D E C I S I O N
of the Technical Board of Appeal 3.4.3
of 29 June 2000

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Summary of Facts and Submissions

- I. European patent application No. 89 122 906.4 was refused in a decision of the examining division dated 1 December 1994. The ground for the refusal was that the application as amended according to the applicant's main request and auxiliary request did not comply with Article 123(2) EPC, since some features present in the claims as filed were omitted in the amended claims of the requests.

According to the decision, there was no basis in the application as filed for the generalization resulting from the replacement of the feature "processing the fine pattern to correct the fine pattern by effecting at least one of removal, repositioning, annealing and film formation of at least one of individual atoms and individual molecules" present in the claims as filed by "scanning and/or processing a surface of a sample" in the independent claims of both the requests.

Regarding the auxiliary request, it was held in the decision that the application as filed, and in particular the embodiment of Figure 6, disclosed a focusing arrangement employing only a combination of a magnetic pole (618) and magnetic lenses. Claim 1 based on the embodiment of Figure 6, however, was not restricted to such a focusing arrangement, but included within its scope a combination of the magnetic pole (618) with an electrostatic lens, for which there was no basis in the application as filed.

Furthermore, the examining division held that even if the claims were amended to meet the requirements of Article 123(2) EPC, such amended claims of the main and auxiliary requests would not be new and not involve an inventive step, respectively. The following prior art documents were cited in the decision under appeal:

D1: Journal of Vacuum Science and Technology, vol. A6, no. 2, March/April 1988, pages 540 to 543; and

D7: JP-A-63-26 936.

II. The appellant (applicant) lodged an appeal on 2 February 1995, paying the appeal fee the same day. A statement of the grounds of appeal was filed on 11 April 1995 together with three sets of claims forming main, first and second auxiliary requests, respectively. Additionally oral proceedings were requested in case the Board intended to dismiss the appeal.

III. In a communication annexed to summons to oral proceedings, the Board introduced into the proceedings an abstract in English of document D7 from the publication

Patent Abstracts of Japan, vol. 12, no. 234 (E-629)
5 July 1988,

hereinafter referred to as document D7a, and informed the appellant of its provisional view that the requirements of Article 123(2) and 52(1) EPC did not appear to be met.

IV. With the letter dated 26 May 2000, the appellant filed four sets of claims forming a main request, and first to third auxiliary requests, respectively.

V. At the oral proceedings held on 29 June 2000, the appellant filed three sets of claims together with amended description pages and requested that the decision under appeal be set aside and a patent be granted according to one of the following requests:

Main request:

Claims: Nos. 1 to 30 according to the main request filed during the oral proceedings

Description: Pages 1 to 4, 4a, 5 to 25 filed during the oral proceedings

Drawings: Sheets 1/15 to 15/15 as originally filed

First auxiliary request:

Claims: Nos. 1 to 11 according to auxiliary request 1 filed during the oral proceedings

Description and Drawings as for the main request

Second auxiliary request:

Claims: Nos. 1 to 13 according to auxiliary request 2 filed during the oral proceedings

Description and Drawings as for the main request

VI. Independent claims 1 and 16 of the main request read as follows:

"1. A method for processing a fine pattern on the surface of a sample (107) by effecting removal, repositioning, annealing and/or film formation of individual atoms and/or individual molecules, comprising the steps of:

disposing a needle (105) having a sharpened tip (108) in opposed relation to the surface with a gap therebetween;

applying a voltage between the needle (105) and the surface so as to enable a tunnel current and/or a field emission current to flow therebetween;

focusing the tunnel current and/or the field emission current on the surface by applying a magnetic field or an electrostatic field to the tunnel current and/or the field emission current wherein the step of focusing comprises applying the magnetic field of a magnetic pole (618) without a hole positioned in front of the needle (105) and aligned with the axis thereof, but on the opposite side of the sample (107) cooperating with at least one controllable magnetic lens (606, 607; 610, 611) or electrostatic lens."

"16. An apparatus for processing a fine pattern on the surface of a sample (107), comprising:

an electroconductive needle (105) having a sharpened tip (108) disposed in opposed relation to the sample (107) with a gap therebetween;

means (119) for applying a voltage between the needle (105) and the sample (107) so as to enable a tunnel current and/or a field emission current to flow therebetween;

at least one controllable magnetic or electrostatic lens (606, 607; 610, 611) for applying a magnetic field or an electrostatic field in the region between the tip (108) and the sample (107) and a

magnetic pole (618) without a hole positioned in front of the needle (105) and aligned with the axis thereof, but on the opposite side of the sample (107) for focusing the tunnel current and/or the field emission current on the surface; and means for processing the fine pattern by effecting removal, repositioning, annealing and/or film formation of individual atoms and/or individual molecules."

VII. Claim 1 according to the first auxiliary request differs from that of the main request in that the last paragraph in the latter is replaced by the following:

"focusing the tunnel current and/or the field emission current on the surface by applying a magnetic field of a magnetic pole (618) without a hole positioned in front of the needle (105) and aligned with the axis thereof, but on the opposite side of the sample (107) cooperating with at least one controllable magnetic lens (606, 607; 610, 611) or electrostatic lens."

Claim 6 according to the first auxiliary request has the same wording as claim 16 of the main request.

VIII. Independent claims 1 and 8 according to the second auxiliary request read as follows:

"1. A method for scanning and/or processing a surface of a sample (107), comprising the steps of:

disposing a needle (105) having a sharpened tip (108) in opposed relation to the surface with a gap therebetween;

applying a voltage between the needle (105) and the surface so as to enable a tunnel current and/or a field emission current to flow therebetween;

focusing the tunnel current and/or the field emission current on the surface by applying a magnetic field of at least one magnetic lens (606, 607; 610,

611) and a magnetic pole (618) without a hole positioned in front of the needle (105) and aligned with the axis thereof but on the opposite side of the sample (107) to the tunnel current and/or the field emission current."

"8. An apparatus for scanning and/or processing a surface of a sample (107), comprising:

an electroconductive needle (105) having a sharpened tip (108) disposed in opposed relation to the sample (107) with a gap therebetween;

means (119) for applying a voltage between the needle (105) and the sample (107) so as to enable a tunnel current and/or a field emission current to flow therebetween;

at least one magnetic lens (606, 607; 610, 611) and a magnetic pole (618) without a hole positioned in front of the needle (105) and aligned with the axis thereof but on the opposite side of the sample (107) for applying a magnetic field or an electrostatic field in the region between the tip (108) and the sample (107) for focusing the tunnel current and/or the field emission current on the surface; and

means for scanning (100) and/or processing the surface."

IX. The appellant made essentially the following arguments in support of his requests:

- (a) The independent claims according to all the requests are based on the embodiment of Figure 6 where a magnetic pole is disclosed. Although Figure 6 only depicts magnetic lenses cooperating with the magnetic pole, it is mentioned on page 13, lines 12 to 16 of the application as filed that the magnetic lenses may be replaced by electrostatic lenses. Since the magnetic pole 618 is neither referred to as "deflector" nor as

"lens", the combination of having a magnetic pole together with electrostatic lenses is derivable from the above-mentioned passage of the application as filed.

(b) As to the independent claims according to the second auxiliary request, which are not restricted to processing a fine pattern on the surface of a sample but also for scanning the surface, the step of **scanning** a surface is described in detail on page 9, lines 8 to 11 and page 10, lines 1 to 7 of the application as filed. Thus, it is clear for the skilled person that the method steps of scanning and processing the surface may or may not be combined.

(c) All the independent claims contain "a magnetic pole positioned in front of the needle but on the opposite side of the sample" as additional means for focusing. This feature is considered crucial for achieving an extremely precise focusing. In contrast to the magnetic pole 9 shown in document D7, the magnetic pole of the present invention is not provided with a hole. The combination of a separate lens system together with a magnetic pole allows for a simpler construction than that of document D7, which at the same time allows for precise focusing.

Reasons for the Decision

1. The appeal complies with Articles 106 to 108 and Rule 64 EPC and is therefore admissible.

2. *Main request and first auxiliary request*

2.1 Amendments

The independent claims 1 and 16 according to the main request and independent claims 1 and 6 according to the first auxiliary request all contain the feature that the magnetic pole 618 located in front of the needle but on the opposite side of the sample, is cooperating with at least one magnetic lens 606, 607, 610, 611 or electrostatic lens. A focusing arrangement employing a magnetic pole as set out in claim 1 is disclosed in the application as filed in the embodiment of Figure 6 where the magnetic pole 618 is shown together with two magnetic lenses 606, 607, 610, 611. It is stated on page 7, first paragraph that electrostatic type deflectors, lenses, and power sources may be used in place of the electromagnetic type deflectors, lenses, and power sources in the embodiment of Figure 6. It is however not unambiguously derivable from this statement that the focusing arrangement involved a combination of an electrostatic lens and a magnetic pole in front of the needle.

In this connection, the appellant contended that the above statement on page 7 only referred to a replacement of the magnetic **lenses** or **deflectors** with corresponding electrostatic lenses/deflectors. Since in the entire description, it was argued by the appellant, the magnetic pole 618 is consistently designated as a "pole", the above statement does not suggest a replacement of the magnetic pole 618 by an electrostatic lens when the other magnetic lenses or deflectors are to be replaced by electrostatic lenses or deflectors.

Although the Board accepts that the magnetic pole 618 is consistently termed "pole" in the application as filed, the lenses 606, 607, 610, 611 are interchangeably termed "lens/deflector" or "pole" (cf. page 13, lines 3 and 4), so that there is no consistent terminology for these features of the invention. The above cited statement therefore does not suggest a combination of electrostatic lenses/deflectors with the magnetic pole 618.

Furthermore, it was submitted by the appellant, in support of inventive step of the claimed subject matter that, the **combined** magnetic field produced by the magnetic pole and the magnetic lenses was a crucial feature of the invention in that it simplified the focusing of the tunneling/field emission current. A focusing arrangement involving a magnetic pole and electrostatic field would therefore be completely different from the combined magnetic field focusing, for which there is no clear basis in the application.

For these reasons, claims 1 and 16 according to the main request and claims 1 and 6 according to the first auxiliary request do not meet the requirements of Article 123(2) EPC.

3. *Second auxiliary request*

3.1 Amendments

3.1.1 Claim 1 is based on original claims 1 to 3 and the embodiment of Figure 6 showing the combination of a magnetic pole 618 together with magnetic lenses as the means of focusing the tunnel current or field emission current, but with the generalization in relation to the description of the embodiment of Figure 6 that the method is not restricted

to processing a fine pattern but to a method for scanning and/or processing a surface of a sample. Furthermore, in claim 1 the magnetic pole is specified to be a pole without a hole.

Independent claim 8 is likewise based on original claims 17 to 19 together the embodiment of Figure 6 and a corresponding generalization to encompass scanning and/or processing a surface of a sample, and specifies that the magnetic pole is without a hole.

Claims 2 and 13 correspond to claims 4 and 26 as filed, respectively, and dependent claims 3 and 4 correspond to the above-mentioned omitted feature of claim 1 as filed. Claims 5 to 7 and 9 to 12 are based on the embodiment of Figure 6.

- 3.1.2 In the decision under appeal, the examining division held that there was no basis in the application as filed, contrary to the requirements of Article 123(2) EPC, for the alternative of scanning a surface of a sample, since all the claims as filed were directed to processing a surface of a sample by effecting at least removal, repositioning, annealing and film formation of at least on of individual atoms and individual molecules.

The Board agrees however with the appellant that the passages on page 9, lines 8 to 11 and page 10, lines 1 to 7 of the application as filed indicate that the scanning tunneling microscope described in the application was not only intended to be used as a pattern processing apparatus, but also as microscope. This aspect is in particular brought out in the description accompanying Figure 7 where the scanning tunneling unit 701 is first used to observe the surface which subsequently is processed using the same scanning tunneling unit 701 (cf. in particular the sentence bridging pages 15 and 16 of the application as filed).

Moreover, it is shown in Figure 6 that the pole 618 does not have a hole going through it, in contrast to the corresponding magnetic pole of e.g. the apparatus of document D7, which has a hole directly below the needle.

Therefore, the claims according to the second auxiliary request meet the requirements of Article 123(2) EPC.

3.2 Novelty

3.2.1 Document D7a discloses a scanning tunneling microscope (STM) comprising an electroconductive needle 1 facing the surface of a sample 8, means 16 for applying a voltage between the needle 1 and the sample 8 to enable a tunnel electron current to flow therebetween. In order to focus the tunnel current, a magnetic lens L is provided where a magnetic pole 9 of the lens is placed opposite to the needle 1. Furthermore, means 17, 18 for scanning the surface of the sample are disclosed.

3.2.2 Document D1 describes the use of a scanning tunneling microscope (STM) for depositing atoms on semiconductor and metal surfaces (cf. D1, abstract and page 540, left hand column, last paragraph, Figure 1). The deposition is controlled by using a field emission current emitted from the needle of the STM to excite gas molecules. There is no disclosure of any focusing means for focusing the tunnel current or the field emission current.

3.2.3 The apparatus of independent claim 8 differs from that of document D7a in that firstly the magnetic pole does not have a hole, whereas the magnetic pole 9 of the apparatus of document D7a has a hole directly below the needle; and secondly that the magnetic pole is specified to cooperate with at least one magnetic lens, whereas in the apparatus of D7a, the magnetic pole 9 is part of a single magnetic lens L where the other pole K is surrounding the needle 1 above the sample.

3.2.4 The apparatus of independent claim 8 differs from that of document D1 in that a magnetic pole and a magnetic lens as described above are provided to focus the current emitted from the needle.

3.2.5 The subject matter of the independent apparatus claim 8 is thus new within the meaning of Article 54 EPC. Moreover, since claim 1 relating to a method for scanning and/or processing includes all the features of the apparatus claim 8, claim 1 is also new within the meaning of Article 54 EPC.

3.3 Inventive step

3.3.1 In the light of the above discussion on novelty, it follows that document D7a is the closest prior art.

As submitted by the appellant, the focusing system disclosed in document D7a which consists of a single magnetic lens has the disadvantages that it is complicated to produce, and furthermore does not offer the necessary freedom of adjusting the different parameters that would allow for a precise focusing of the current.

3.3.2 In view of the prior art, therefore, the objective technical problem addressed by the present invention relates to developing improved current focusing means for an apparatus for scanning and/or processing a surface of a sample.

3.3.3 In the scanning tunneling microscope of document D7a, the magnetic field for focusing is produced by the magnetic pole 9 and the other pole K of a magnetic lens L. Moreover, there is a through hole in the magnetic pole 9, which is aligned with the axis of the needle. It would thus appear that because of the hole, the magnetic lines of force would not be converging to a point along the axis of the needle at the surface of the magnetic pole 9 facing the needle.

In the apparatus according to claim 8, on the other hand, as submitted by the appellant, the magnetic lines of force would converge at a point along the axis of the needle at the surface of the magnetic pole. Additionally, a separate magnetic lens is provided, so that the combined magnetic field can be varied so as to focus the current in the vicinity of the surface of the sample. As a result, a simplified focusing arrangement in relation to the focusing arrangement known from document D7a is provided by the claimed invention.

In view of the above, and since the focusing arrangement as set out in claim 8 is not suggested by any of the cited prior art, the focusing arrangement as claimed cannot be regarded as a mere design option available to the skilled person, as held in the decision under appeal.

Consequently, the subject matter of independent claim 8 according to the second auxiliary request involves an inventive step within the meaning of Article 56 EPC, and meets the requirements of Article 52(1) EPC.

3.3.4 The above reasons apply mutatis mutandis to claim 1 of the second auxiliary request. Therefore, claim 1 meets the requirements of Article 52(1) EPC as well.

Dependent claims 2 to 7 and 9 to 13 also therefore comply with the requirements of Article 52(1) EPC.

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 on the basis of the following documents:

Claims: Nos. 1 to 13 according to auxiliary request 2 filed during the oral proceedings

Description: Pages 1 to 4, 4a, 5 to 25 as filed during the oral proceedings

Drawings: Sheets 1/5 to 5/5 as originally filed

The Registrar:



D. Spigarelli

The Chairman:



R. K. Shukla

3, 8, 2000
Gen. Clerk