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Datasheet for the decision of 6 February 2018

Case Number: T 2170/13 - 3.4.03

Application Number: 05075600.6

Publication Number: 1577927

IPC: H01J37/28, H01J37/317, H01J37/02

Language of the proceedings: EN

Title of invention:
Charged particle beam system

Patent Proprietor:
FEI COMPANY

Opponent:
Carl Zeiss Microscopy GmbH

Headword:

Relevant legal provisions:
EPC 1973 Art. 54
EPC Art. 52(1)

Keyword:
Novelty - main request (no) - auxiliary request (no) - implicit disclosure (yes)
Functional feature of method claim (no)

Decisions cited:
G 0002/88, G 0006/88, T 0910/98, T 1049/99, T 1343/04, T 1179/07, T 0304/08, T 2215/08, T 1822/12

Catchword:

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Case Number: T 2170/13 - 3.4.03

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 6 February 2018

Appellant: (Opponent)	Carl Zeiss Microscopy GmbH Carl-Zeiss-Promenade 10 07745 Jena (DE)
Representative:	Gnatzig, Klaus Carl Zeiss AG Patentabteilung 73446 Oberkochen (DE)
Respondent: (Patent Proprietor)	FEI COMPANY 5350 NE Dawson Creek Drive Hillsboro, Or 97124 (US)
Representative:	DeltaPatents B.V. Fellenoord 370 5611 ZL Eindhoven (NL)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted on 2 August 2013 rejecting the opposition filed against European patent No. 1577927 pursuant to Article 101(2) EPC.**

Composition of the Board:

Chairman	G. Eliasson
Members:	S. Ward
	T. Bokor

Summary of Facts and Submissions

I. This is an appeal by the opponent against the decision of the Opposition Division rejecting the opposition against European patent EP 1 577 927.

II. In the notice of opposition the grounds of lack of novelty and lack of inventive step were cited, and it was mentioned that an objection on the ground of insufficient disclosure (Article 100(b) EPC) might also arise.

III. At the oral proceedings held before the Board the appellant-opponent (hereinafter, the opponent) confirmed its request that the decision under appeal be set aside and the patent revoked. The request that the Board hear a witness, and the request for reimbursement of the appeal fee, both submitted in the written procedure, were not maintained.

The respondent-proprietor (hereinafter, the proprietor) confirmed its requests that the appeal be dismissed, i.e. that the opposition be rejected, or alternatively that the decision under appeal be set aside and the patent be maintained in an amended form on the basis of the auxiliary request filed with letter dated 5 January 2018. Non-admission of chapter 3.5.2 of the document D3 was also requested.

IV. The following document cited in the notice of opposition is referred to in this decision:

D1: WO 02/05309 A1

V. Claim 1 of the main request (i.e. claim 1 of the granted patent) reads as follows:

"A charged particle beam system (100, 150, 200), comprising, a charged particle beam column (102, 104, 152, 154, 202, 204) for generating a charged particle beam;
a work piece vacuum chamber (110, 160, 206) for containing a work piece to which the charged particle beam is directed;
a charged particle detector, and an imaging system for generating an image signal based on information from the charged particle detector, characterized by
said charged particle detector including an ionization chamber (1000, 1100) having an opening (1005, 1105) for allowing charged particles from the work piece vacuum chamber to enter the ionization chamber, the ionization chamber including:
ionization chamber walls (1004) defining an ionization chamber interior region (1010, 1110);
a gas inlet (1003) for supplying gas to the ionization chamber interior region (1010); and
an electrode (1007, 1107) within the ionization chamber for accelerating the charged particles from the work piece vacuum chamber;
the opening being sufficiently small to maintain within the ionization chamber a working pressure significantly greater than the pressure in the work piece chamber and sufficiently high to promote gas ionization cascades within the ionization chamber, and
the imaging system (1019) generating an image signal based upon currents at the electrode, the current at the electrode being related to particles emitted from the work piece upon impact of primary particles in the particle beam, characterized in that the ionization chamber, in working, has a voltage applied to eject

ions from the ionization chamber to neutralize some or all of the electrical charge on the sample."

Claim 1 of the auxiliary request reads as follows:

"A method for neutralizing electrical charge on a work piece, the method comprising:
providing a charged particle beam system (100, 150, 200), comprising,
- a charged particle beam column (102, 104, 152, 154, 202, 204) for generating a charged particle beam;
- a work piece vacuum chamber (110, 160, 206) for containing the work piece;
- a charged particle detector, and
- an imaging system for generating an image signal based on information from the charged particle detector;
said charged particle detector including an ionization chamber (1000, 1100) having an opening (1005, 1105) for allowing charged particles from the work piece vacuum chamber to enter the ionization chamber, the ionization chamber including:
- ionization chamber walls (1004) defining an ionization chamber interior region (1010, 1110);
- a gas inlet (1003) for supplying gas to the ionization chamber interior region (1010); and
- an electrode (1007, 1107) within the ionization chamber for accelerating the charged particles from the work piece vacuum chamber;
the method further comprising:
providing the work piece in the work piece vacuum chamber (110, 160, 206);
providing a sufficiently small opening (1005, 1105) to maintain within the ionization chamber a working pressure significantly greater than the pressure in the

work piece chamber and sufficiently high to promote gas ionization cascades within the ionization chamber;
generating the charged particle beam and directing the beam to the work piece;
generating an image signal with the imaging system (1019) based upon currents at the electrode,
the current at the electrode being related to particles emitted from the work piece upon impact of primary particles in the particle beam,
characterized by
- applying a voltage to the ionization chamber to eject ions from the ionization chamber to neutralize some or all of the electrical charge on the work piece."

VI. The opponent argued essentially as follows:

It was undisputed that D1 disclosed all structural features of claim 1 of the main request. The detector of D1 would also operate in essentially the same way as that claimed.

Regarding the final claimed feature, it was undisputed that positive ions would be created in the detection (ionization) chamber of D1, and the skilled person would appreciate that these ions would move with a drift velocity in the direction of the field. In this way ions would be ejected from the chamber in the direction of the negatively charged sample which was shown in Fig. 4 to lie very close to the aperture. It was inevitable that at least some of the ions would impinge directly on the sample, where they would, at least to some extent, neutralise the negative charge.

VII. The proprietor argued essentially as follows:

Although D1 disclosed high pressure embodiments where a gas cascade was generated, it did not disclose that "the ionization chamber, in working, has a voltage applied to eject ions from the ionization chamber to neutralise some or all of the electrical charge on the sample."

Hence, for D1 to be novelty destroying, it had to disclose a mode of operation, with appropriate settings in combination, which inevitably resulted in the above neutralisation occurring. However, D1 did not disclose voltage conditions on the electrodes which made such a consequence inevitable. Nor did D1 provide any clear instructions with regard to the dimensions of the aperture or the gas flow/pressure.

In Fig. 4 of D1 the gas cascade would be located close to the needle electrode (24) or the scintillator electrode (26), which were far removed from the aperture (21). There was a region of gas between the gas cascade and the aperture making it unlikely that ions would escape the detector chamber. Ions, being much heavier than electrons, would accelerate much more slowly, and were likely to be neutralised or scattered before reaching the aperture. The outer electrode, being at a positive voltage, would tend to repel positive ions away from the detector aperture back towards the needle electrode.

Regarding the opponent's contention that the sample was in the immediate vicinity of the aperture, nowhere was it suggested that the schematic drawings were to scale, and nowhere in D1 was the distance between the sample and the opening of the detection chamber specified.

A skilled person would only consider charge neutralisation to have occurred if a sufficient number of ions were to reach the sample at a sufficient rate. The flux of ions would need to be in the same order of magnitude as the electron beam current in order to have a significant charge neutralisation effect.

For an electron beam current I, the secondary electron flux/current would generally be of the same order of magnitude as I. Even if the same order of magnitude of ions managed to escape from the detector (if it were argued that many ions were created inside the detector per incoming electron but only a small fraction would escape) then the fact that these ions would strike a large area away from the collector meant that their flux on the sample would be orders of magnitude smaller than the beam current - too low for meaningful charge neutralisation.

D1 only concerned itself with a detector for variable pressure, and was completely silent about sample charging problems and any measures taken to mitigate such problems.

Reasons for the Decision

1. The appeal is admissible.

2. *Procedural issues*

2.1 The opponent confirmed at oral proceedings that it was not maintaining the request that the appeal fee be

refunded, nor the request that Mr Essers be heard as a witness at oral proceedings before the Board (Mr Essers attended as an accompanying person and was heard by the Board in this capacity).

2.2 The proprietor's request that chapter 3.5.2 of document D3 be not admitted into the proceedings is considered moot: no copy of this chapter was submitted with the grounds of appeal or subsequently.

3. *Novelty: Main Request*

3.1 The Board sees the embodiment of Fig. 4 of D1 as being the most relevant prior art. It is not disputed that this embodiment discloses the structural features of claim 1 of the disputed patent, and that it further discloses, according to some modes of operation, gas cascades being produced in the detection chamber (which is therefore also an ionization chamber), as in claim 1 of the main request. The sole point of dispute is whether document D1 discloses the final claimed feature:

"the ionization chamber, in working, has a voltage applied to eject ions from the ionization chamber to neutralize some or all of the electrical charge on the sample."

3.2 No such neutralisation is explicitly disclosed in D1, but the opponent argues that the high pressure arrangements disclosed in D1 would, in operation, give rise to this effect in the same manner as described in the disputed patent.

The proprietor denies this, arguing that in the arrangements of D1, either no ions at all would reach

the sample, or at most the sample would be reached by a very small number of ions incapable of producing a noticeable charge neutralisation.

3.3 The Board accepts that a very small number of stray ions impinging on the sample and having a negligible effect on the measurable charge would not constitute charge neutralisation within the meaning of claim 1.

On the other hand, the proprietor's argument that the "flux of ions will need to be in the same order of magnitude as the electron beam current in order to have a significant charge neutralisation effect" is, even if true, not relevant. What is claimed is not a "significant charge neutralisation", but only that the ejected ions "neutralise some or all of the electrical charge on the sample".

The relevant question for evaluating novelty is whether the arrangement of Fig. 4 of D1 would, in operation, result in ions being ejected from the chamber and reaching the sample in sufficient numbers to produce some detectable change in the electrical charge on the sample.

3.4 The argument of the opponent in this regard may be briefly restated as follows. It is not disputed that the embodiment of Fig. 10B of the contested patent would give rise to the technical effect of charge neutralisation of the sample, as defined in claim 1. It is argued, however, that the arrangement of Fig. 4 of D1 is sufficiently similar to that of Fig. 10B of the patent, both structurally and functionally, that it must be expected that a broadly similar charge neutralisation effect would arise when operating the prior art detector. The Board will therefore review the

points of similarity between the detector of Fig. 4 of D1 and that of the Fig. 10B of the contested patent.

3.5 In terms of basic structure (conical shape, electrode layout, aperture, gas inlet) the detector of Fig. 4 of D1 is clearly very similar to the detector of Fig. 10B of the contested patent. In terms of function, they both operate by attracting into the chamber secondary electrons generated by primary electrons impacting the sample, and in both cases (at least according to some variants disclosed in D1) ionization cascades in the chamber serve to amplify the number of detected electrons.

3.6 The detector of D1 has an aperture (21) facing the sample with a "diameter between 0.5 and 5 mm", which the proprietor states (correctly, according to the Board) "is configured to allow electrons to enter detection chamber and to maintain a pressure difference with the sample chamber" (letter of 5 January 2018, point 2.5). The disclosed aperture is thus configured to serve precisely the two functions explicitly mentioned in claim 1 of the contested patent in relation to the claimed "opening".

3.7 As stated in the final paragraph of page 12 of D1, in high pressure operation the needle electrode may serve both to generate the cascade and as a detector/ collector electrode, so that with a current amplifier connected to the needle electrode, the secondary electron current can be detected (the light guide and photodetector can then be dispensed with). Again, this exactly mirrors the operational arrangement of the embodiment of Fig 10B of the contested patent (see paragraph [0081], first and second sentences).

3.8 Concerning the applied potentials disclosed in D1:

(a) the potential U1 of the outer electrode (20) is adjustable in a range of 0-500 V positive with respect to the sample (over 200 V being preferred - see page 11, second paragraph). The outer electrode (20) serves *inter alia* to attract secondary electrons from the sample to the aperture (page 11, paragraph 1), thereby having the same function as the forward portion 1004 in Fig. 10B of the patent (paragraph [0078]);

(b) the potential U2 of the middle electrode (22) is 30-500 V positive with respect to the potential of the outer electrode (page 12, second paragraph); and

(c) the potential U3 of the needle electrode (24) when the sample chamber is at high pressure (above 500 Pa) is at least 200 V positive with respect to the potential of the middle electrode (page 13, second paragraph).

Thus, the electrode potentials satisfy U3>U2>U1, and given the cylindrical symmetry, the electric field - at least on or near the axis - would point in a right to left direction towards the aperture. Thus the electrons generated in the cascades will be drawn towards the needle (detector electrode) while the ions will be drawn in the opposite direction towards the aperture, as in the contested patent.

The potential U3 of the needle electrode is set at a level sufficient to induce gas cascades, as is the potential of the detector electrode (1007).

3.9 Hence, in the embodiment of Fig. 4, not only does D1 explicitly disclose all of the features of claim 1 apart from the technical effect of the final paragraph, but it also discloses an arrangement having what must

be described as a very close structural and functional similarity to one of the described embodiments of the present invention.

3.10 The Board accepts that these two arrangements are not absolutely identical, and it is therefore not to be expected that they will provide absolutely identical technical effects. It is further not disputed that the arrangements of Fig. 4 of D1 have not been *optimised* for the ejection of positive ions or charge neutralisation.

However, it is the proprietor's position that the detector of Fig. 10B of the contested patent would eject a sufficient quantity of ions onto the sample to effect partial or even complete neutralisation, whereas in the case of the detector of Fig. 4 of D1, the number of ions which would be ejected from the chamber onto the sample would either be zero, or would be so tiny that it would have an absolutely negligible effect on the sample charge.

3.11 In the judgement of the Board, these two detectors are sufficiently structurally and functionally similar, that it is reasonable *a priori* to expect that they would provide at least broadly similar technical effects, including some measurable degree of charge neutralisation of the sample (even if smaller in the case of D1). Consequently, it is considered that the burden of proof falls upon the proprietor to provide a persuasive explanation why this would not be the case, and why the effects produced would be fundamentally different.

3.12 The proprietor's arguments in this respect appear to fall into two groups: firstly that in the arrangements

of D1 an insufficient number of ions would be ejected from the aperture, and secondly that even if a significant number of ions were ejected, the number actually reaching the sample would be insufficient to effect charge neutralisation. These will be looked at in turn.

3.13 In the high pressure embodiments of D1, in which the needle is used as the collector (detector electrode), there is no dispute that the gas cascade will arise predominantly in the region close to the needle. Similarly in high pressure embodiments using the scintillator, the gas cascade will arise predominantly in the region close to the scintillator electrode. In either case, although the potentials on the electrodes will tend to accelerate the positive ions in the direction of the aperture, they would have to pass through a significant quantity of gas at relatively high pressure to reach it.

It is not disputed that the ions will suffer collisions with gas molecules, but the Board is not persuaded by the proprietor's argument that this would prevent them from ever reaching the aperture. More plausible is the opponent's analysis that the ions would undergo multiple collisions, and multiple periods of acceleration between collisions, thereby acquiring on average a more or less constant drift velocity in the direction of the aperture.

Any neutralisation events occurring would involve the transfer of an electron from a gas molecule to a positive ion, resulting in ionization of the molecule. The newly created ion would then itself partake of the drift velocity towards the aperture, and so the opponent's argument that this type of neutralisation

event would not significantly reduce the ion flow is also seen as plausible.

However, the decisive argument in this respect may be derived from the contested patent itself. According to the claimed invention, sufficient ions are ejected from the ionization chamber to neutralize some or all of the electrical charge the sample. In the embodiment of the invention depicted in Fig. 10B, these ions are generated by gas cascades which, according to paragraph [0081], are induced by the detector electrode (1007). It was accepted by the proprietor at oral proceedings that this implies that the cascade ionization would arise predominantly in the region of the detector electrode. Since the interior of ionization chamber contains "a volume of high pressure gas" (paragraph [0080]), it follows that generating the cascade in a region of the chamber remote from the aperture, with high pressure gas located between the cascade and the aperture, does not prevent the ejection from the aperture of a significant number of ions.

3.14 The Board is also not persuaded by the arguments based on the size of the aperture. Whilst the aperture clearly should not be too large in view of the need to maintain the interior of the chamber at high pressure, the stated purpose of the aperture in D1 is to allow secondary electrons to pass into the interior of the detector. It is reasonable to conclude that an aperture dimensioned to allow the passage of electrons (with an aperture diameter between 0.5 and 5 mm - see page 10, fourth paragraph) would also be suitable for the passage of positive ions, and the Board can identify no persuasive argument from the proprietor that would establish the contrary.

3.15 The proprietor also pointed to the special forms of the channel electrode (1008) mentioned in paragraph [0082] of the patent. These refinements of the basic embodiment of Fig. 10B are provided since it is "normally desirable that proximal to the detector electrode 1007, charged particles are influenced more by the electric field created by the detector electrode 1007 than by the electric field coming from the channel electrode 1008."

There is nothing in this passage indicating that these features are provided to ensure that ions reach the aperture, and nothing suggesting that they are in any way critical to the fundamental operation of the device. The Board does not see the cited paragraph as having any bearing on the novelty argument.

3.16 Consequently, the Board can see no plausible reason why the number of ions reaching the aperture in the embodiment of Fig. 4 of D1 would not be broadly comparable to the number of ions reaching the aperture in the embodiment of the claimed invention depicted in Fig. 10B.

3.17 The proprietor argues that even if this is the case, the ions would either not reach the sample, or they would only reach it very small numbers such that charge neutralisation would not occur.

3.18 Fig. 4 of D1 depicts the sample (6) placed close to the aperture and essentially aligned with the axis of the detector. The Board accepts the argument of the proprietor that exact dimensions and ratios cannot be derived from schematic drawings. However, the proximity of the sample to the aperture depicted in Fig. 4 is clearly not a random artifact of a schematic drawing,

but a confirmation of what would be implicit to the skilled person, namely that the sample would be placed as close as possible to the aperture to maximize the number of secondary electrons from the sample entering the device.

3.19 This is also confirmed in the text. The tapered form of the outer electrode ensures that only secondary electrons which are situated at not too great a distance from the aperture pass through it, i.e. only secondary electrons from a narrowly limited volume are admitted (page 11, first paragraph). Since it is secondary electrons from the sample which produce the signal to be detected, it is implicit that the sample should be situated at not too great a distance from the aperture within the said narrowly limited volume.

In view of this, the Board considers it inevitable that a significant fraction of the ions ejected from the aperture would impinge on the sample.

3.20 The arrangement of Fig. 10B of the patent includes "an electrode 1014 (which may be annular) to control the number and/or concentration of ions that ultimately impinge on the imaged area of the work piece". In the case of the arrangement of D1, it is certainly conceivable that a portion of the ions ejected from the aperture would miss the sample, even taking into account the negative potential on the sample, and that an electrode arrangement such as element 1014 of Fig. 10B of the patent might reduce the number of ions missing the sample (although the opponent disputed this).

However, this is a question of optimisation, and the absence of such an electrode in the arrangement of Fig.

4 of D1 cannot, in the view of the Board, plausibly be invoked to argue that no charge neutralisation effect would arise at all.

3.21 In the light of the above, the Board is led to the conclusion that a sufficient number of the ions generated in the cascade in the embodiment of Fig. 4 of D1 would reach the sample and would neutralise at least some of the charge on it.

The final claimed feature is therefore implicitly disclosed in D1, and hence the subject-matter of claim 1 of the main request is not new within the meaning of Article 52(1) EPC and Article 54 EPC 1973.

4. *Auxiliary Request*

4.1 The auxiliary request was filed approximately one month before the oral proceedings. In response to a question from the Chairman, the opponent stated that it had no objection to this request being admitted into the proceedings, and hence the Board sees no reason not to admit it.

4.2 The sole issue to decide in relation to novelty is whether the re-drafting of claim 1 as a method claim, in particular having a first line reading "A method for neutralizing electrical charge on a work piece ...", alters the conclusion reached in the case of the main request.

4.3 In this respect, the findings in decision T 1822/12 appear to the Board to be particularly pertinent. In that case, claim 1 of the main request started as follows:

"A method for reducing acrylamide formation in thermally processed foods, said method comprising the steps of ..."

In arguing that the claimed subject-matter was novel, the appellant-proprietor acknowledged that the actual steps recited in the claim were known in the prior art, but cited the following passage from G 2/88 and G 6/88:

"A claim to the use of a known compound for a particular purpose, which is based on a technical effect which is described in the patent, should be interpreted as including that technical effect as a functional technical feature, and is accordingly not open to objection under Article 54(1) EPC provided that such technical feature has not previously been made available to the public" (G 2/88, Order, point (iii); G 6/88, Order).

The appellant argued that the provisions of G 2/88 and G 6/88 were general and were not linked to any specific claim category, and that novelty should therefore be acknowledged, since the cited prior art documents did not disclose the functional technical feature of reducing acrylamide.

4.4 The deciding Board did not agree, noting that the order in G 2/88 related "**only** to a use claim, namely to a claim for the new use of a known compound" (T 1822/12, Reasons, point 3.1.1, emphasis in the original). Under point 3.1.2, the Board stated the following:

"Furthermore the case law has constantly interpreted G 2/88 in a very restrictive manner, i.e. in a manner that only claims related to the use of a known compound for a particular purpose, based on a technical effect

described in the patent, should be interpreted as including that technical effect as a functional technical feature, provided that such technical feature has not previously been made available to the public."

Numerous cases were cited in T 1822/12 in support of this restrictive approach (T 1343/04, points 2.1 and 2.2 of the reasons; T 304/08, section 3.3.2 of the reasons; T 1179/07, section 2.1.3 of the reasons; T 1049/99, section 8.5 of the reasons; T 2215/08, section 2.4.1 of the reasons and T 910/98, section 2.2.2 of the reasons).

The Board concluded (Reasons, point 3.1.3) that there was "no possibility to expand the ruling in G 2/88 and G 6/88 to a claim worded otherwise, namely a claim relating to a known method for a new purpose", and hence that the undisclosed purpose of reducing acrylamide formation could not be considered to be a distinguishing functional technical feature of the claim.

The wording of claim 1 had to be "construed as concerning a method 'suitable' for reducing acrylamide formation", and since it was not disputed that the prior art methods would be thus suitable, this feature did not confer novelty (Reasons, point 3.1.4).

4.5 The Board in the present case endorses this approach, and therefore interprets the opening wording of claim 1 to define a method *suitable* for neutralizing electrical charge on a work piece.

4.6 Document D1 discloses a particle beam device including a detector. Also disclosed, at least implicitly, is a method of operating the disclosed device (including the

provision of the disclosed concrete features, the voltages to be applied, the pressure levels in the chamber, creation of gas cascades etc.).

The Board has already concluded that the detector of Fig. 4 of D1, when used for the disclosed purpose of detecting secondary electrons from the sample, would also have the effect of ejecting ions from the ionization chamber thereby neutralizing at least some of the electrical charge on the work piece. The method of operating the detector in D1 would therefore be suitable to provide the effect of neutralising the sample. In the light of the considerations set out above, neither the opening statement of purpose in claim 1 nor the final feature defining the effect establish novelty over document D1.

The remaining features of claim 1 of the auxiliary request are essentially the corresponding features of claim 1 of the main request, adapted to a method claim. The proprietor has not argued that these features further distinguish the claimed subject-matter over the prior art, and the Board judges them to be disclosed in D1.

4.7 The subject-matter of claim 1 of the auxiliary request is therefore not new within the meaning of Article 52(1) EPC and Article 54 EPC 1973.

5. Thus, in the absence of an allowable claim set, the patent must be revoked (Articles 101(2) and 101(3)(b) in conjunction with Article 111(1), second sentence, EPC).

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The patent is revoked.

The Registrar: The Chairman:

S. Sánchez Chiquero G. Eliasson

Decision electronically authenticated