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Datasheet for the decision of 5 November 2019

Case Number: T 0365/16 - 3.4.02

Application Number: 02779650.7

Publication Number: 1440286

IPC: G01B21/04, G01B5/004, G01B7/004, G01B11/00

Language of the proceedings: EN

Title of invention:
CALIBRATION OF A PROBE

Patent Proprietor:
Renishaw plc

Opponent:
Carl Zeiss Industrielle Messtechnik GmbH

Headword:

Relevant legal provisions:
EPC 1973 Art. 56
EPC Art. 123(2)

Keyword:

Amendments - added subject-matter (no)
Inventive step - main request (no) - auxiliary requests (no)
Late-filed auxiliary request - admitted (no)

Decisions cited:

Catchword:

Europäisches Patentamt
European Patent Office
Office européen des brevets

Beschwerdekammern

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Chambres de recours

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Case Number: T 0365/16 - 3.4.02

D E C I S I O N
of Technical Board of Appeal 3.4.02
of 5 November 2019

Appellant: (Opponent)	Carl Zeiss Industrielle Messtechnik GmbH Carl Zeiss Strasse 22 73447 Oberkochen (DE)
Representative:	Witte, Weller & Partner Patentanwälte mbB Postfach 10 54 62 70047 Stuttgart (DE)
Respondent: (Patent Proprietor)	Renishaw plc New Mills Wotton-under-Edge Gloucestershire GL12 8JR (GB)
Representative:	Jackson, John Timothy Renishaw plc Patent Department New Mills Wotton-under-Edge Gloucestershire GL12 8JR (GB)
Decision under appeal:	**Interlocutory decision of the Opposition Division of the European Patent Office posted on 30 November 2015 concerning maintenance of the European Patent No. 1440286 in amended form.**

Composition of the Board:

Chairman	R. Bekkering
Members:	C. Kallinger
	G. Decker

Summary of Facts and Submissions

I. The appellant (opponent) lodged an appeal against the opposition division's interlocutory decision to maintain the European Patent 1 440 286 in amended form and requested to set aside the opposition division's decision and to revoke the patent in its entirety.

II. The respondent (patent proprietor) requested in its reply to the grounds of appeal as a main request to dismiss the appeal (i.e. to maintain the patent on the basis of the claims according to the second auxiliary request filed during the first-instance opposition proceedings held on 9 November 2015) or, in the alternative, to set aside the decision under appeal and to maintain the patent in amended form on the basis of the claims according to the first to third auxiliary requests, all filed with the respondent's letter dated 24 August 2016.

III. By a communication dated 22 July 2019, the parties were summoned to attend oral proceedings on 5 November 2019. In a communication annexed to the summons, the board provided its provisional opinion on the merits of the appeal.

IV. In this decision, the following documents will be referred to:

E1 DE 198 09 589 A
E2 WO 00/25087 A
E8.2 W. Lotze, "Messende Taster mit mehreren Freiheitsgraden", Technische Rundschau, Volume 29/30, 1993, pages 20 to 25

V. With a letter dated 4 October 2019, the opponent filed further arguments with respect to novelty and inventive step in view of document E2.

VI. With a letter dated 4 October 2019, the respondent filed further arguments with respect to inventive step in view of documents E1 and E8.2. In addition, a set of amended claims according to a fourth auxiliary request was filed.

VII. Oral proceedings were held on 5 November 2019.

VIII. The parties' final requests were as follows:

The appellant (opponent) requested that the decision under appeal be set aside and that the patent be revoked.

The respondent (patent proprietor) requested as a main request that the appeal be dismissed or, as an auxiliary measure, that the decision under appeal be set aside and the patent be maintained in amended form on the basis of the claims of the first auxiliary request filed as auxiliary request 4 with the letter dated 4 October 2019, or on the basis of the claims of one of the second to fourth auxiliary requests filed as auxiliary requests 1 to 3 with the letter dated 24 August 2016.

IX. Claim 1 of the main request reads as follows (Amendments in comparison to the patent as granted have been marked and labelled as features 1.2a and 1.8a by the board)

"1. A method of calibrating a probe by determining calibration coefficients which relate the output of the

probe to the output of a coordinate positioning machine on which it is mounted, said calibration coefficients ensuring that the output of the probe is scaled and aligned with the output of the coordinate positioning machine, [1.2a] comprising the steps of:

mounting a calibration artefact (16) on a first part (18) of the coordinate positioning machine;

mounting the probe (10,26) on a second part (8) of the coordinate positioning machine, said second part (8) being movable with respect to said first part (18);

characterised by the steps of moving the probe (10,26) along one or more scan paths (20,22,24,28) around the calibration artefact (16) whilst continuously scanning the surface of the calibration artefact (16) such that the probe (10,26) is exercised through its working range;

and using measurement data from the probe (10,26) and the coordinate positioning machine to determine the calibration coefficients of the probe which ensure that the output of the probe is scaled and aligned with the output of the coordinate positioning machine [1.8a]."

X. To claim 1 of the first auxiliary request the following feature has been added at the end of the claim:

"..., the calibration coefficients defining a non-linear relationship between the output of the probe and the output of the coordinate positioning machine."

XI. Claim 1 of the second auxiliary request reads as follows (Amendments in comparison to the main request have been marked by the board):

"1. A method of calibrating a probe by determining calibration coefficients of a probe transformation matrix which relates the output of the probe to the

output of a coordinate positioning machine on which it is mounted, said calibration coefficients ensuring that the output of the probe is scaled and aligned with the output of the coordinate positioning machine,
comprising the steps of:
mounting a calibration artefact (16) on a first part (18) of the coordinate positioning machine;
mounting the probe (10,26) on a second part (8) of the coordinate positioning machine, said second part (8) being movable with respect to said first part (18);
characterized by the steps of moving the probe (10,26) along one or more scan paths (20,22,24,28) around the calibration artefact (16) whilst continuously scanning the surface of the calibration artefact (16) such that the probe (10,26) is exercised through its working range;
and using measurement data from the probe (10,26) and the coordinate positioning machine to determine the calibration coefficients of the probe transformation matrix which ensure that the output of the probe is scaled and aligned with the output of the coordinate positioning machine."

XII. Claim 1 of the third auxiliary request reads as follows (Amendments in comparison to the main request have been marked by the board):

"1. A method of calibrating a probe by determining calibration coefficients which relate the output of the probe to the output of a coordinate positioning machine on which it is mounted, said calibration coefficients ensuring that the output of the probe is scaled and aligned with the output of the coordinate positioning machine, comprising the steps of:
mounting a calibration artefact (16) on a first part (18) of the coordinate positioning machine;

mounting the probe (10,26) on a second part (8) of the coordinate positioning machine, said second part (8) being movable with respect to said first part (18); characterized by the steps of moving the probe (10,26) along one or more scan paths (20,22,24,28) around the calibration artefact (16) whilst continuously scanning the surface of the calibration artefact (16) such that the probe (10,26) is exercised through its working range;
and using measurement data from the probe (10,26) and the coordinate positioning machine produced during the step of moving the probe to determine the calibration coefficients of the probe which ensure that the output of the probe is scaled and aligned with the output of the coordinate positioning machine."

XIII. Claim 1 of the fourth auxiliary request reads as follows (Amendments in comparison to the main request have been marked by the board):

"1. A method of calibrating a probe by determining calibration coefficients which relate the outputs in three axes (a,b,c) of the probe to the outputs in three axes (X,Y,Z) of a coordinate positioning machine on which it is mounted, said calibration coefficients ensuring that the output of the probe is scaled and aligned with the output of the coordinate positioning machine, comprising the steps of:
mounting a calibration artefact (16) on a first part (18) of the coordinate positioning machine;
mounting the probe (10,26) on a second part (8) of the coordinate positioning machine, said second part (8) being movable with respect to said first part (18); characterized by the steps of moving the probe (10,26) along one or more scan paths (20,22,24,28) around the calibration artefact (16) whilst continuously scanning

the surface of the calibration artefact (16) such that the probe (10,26) is exercised through its working range;
and using measurement data from the probe (10,26) and the coordinate positioning machine to determine the calibration coefficients of the probe in three dimensions which ensure that the output of the probe is scaled and aligned with the output of the coordinate positioning machine."

Reasons for the Decision

1. Main request

1.1 Amendments - Article 123(2) EPC

1.1.1 With respect to the original disclosure of the added features 1.2a and 1.8a in claim 1, the appellant argued that the originally claimed calibration coefficients were restricted to be calibration coefficients of the probe and that the passage cited by the respondent (page 3, lines 20 to 23 and page 6, lines 29 to 32) related to calibration in general and contained no disclosure that the claimed calibration coefficients achieved the general goal referred to in the added features. Also the other passages of the originally filed application which explicitly referred to calibration coefficients (page 9, lines 19 to 22, page 11, lines 27 to 30 and claim 1) failed to disclose that the calibration coefficients ensured that "*the output of the probe is scaled and aligned with the output of the coordinate positioning machine*". Therefore, the amendments extended the subject-matter beyond the content of the application as filed and the requirements of Article 123(2) EPC were not met.

1.1.2 The respondent argued that the amendments concerned a further definition of the calibration coefficients of the probe and that the skilled person would not take the cited passages on pages 3 and 6 alone but read them in the context of the passages on page 2, lines 9 to 13 and page 9, lines 16 to 31, the whole disclosure and their common general knowledge. In view of the skilled person's knowledge that scaling and aligning the output of a probe with the output of a coordinate measuring machine was conventionally achieved via calibration coefficients, the skilled person learned from the application that the claimed calibration coefficients of the probe ensured that "*the output of the probe is scaled and aligned with the output of the coordinate positioning machine*". Thus, the requirements of Article 123(2) EPC were met.

1.1.3 The board is of the opinion that the skilled person learns from the application (page 6, lines 29 to 32) that calibration ensures that the stylus position signals are scaled and aligned with the coordinate measuring machine position signals. Together with their common general knowledge that calibration generally involves calibration coefficients, the application discloses that the calibration coefficients of the probe relate to a probe transformation matrix which relates the output of the probe in a, b, c axes to the machine's X, Y, Z coordinate system and thus ensure that the output of the probe is scaled and aligned with the output of the coordinate positioning machine.

In conclusion, the board is of the opinion that the requirements of Article 123(2) EPC are met.

1.2 Inventive step - Article 56 EPC 1973

The patent as amended according to the decision under appeal does not meet the requirements of Article 52(1) EPC because the subject-matter of claim 1 of the main request does not involve an inventive step within the meaning of Article 56 EPC 1973.

1.2.1 Disclosure of document E1 as closest prior art

The appellant argued that document E1 represented the closest prior art and disclosed a method of calibrating a probe (6) of a coordinate positioning machine involving a calibration artefact (11) mounted on the table (1) of a coordinate positioning machine (see claim 1 and figure 1). E1 further disclosed an improved stylus calibration method where the probe was moved along a scan path around the calibration artefact (see figures 3 to 6) whilst continuously scanning the surface of the calibration artefact such that the probe was exercised through its working range (see column 3, lines 37 to 54 and column 7, lines 48 to 61). The calibration process in E1 determined the position of the center of the stylus ball and its radius in the machine coordinate system (see column 1, lines 3 to 13 and column 3, line 63 to column 4, line 4).

The respondent argued that document E1 was directed at stylus calibration only and thus limited to the determination of the geometry (radius and position) of the probe (see column 1, lines 3 to 13 and column 4, lines 1 to 4). Therefore, E1 did not represent the closest prior art, as it did not address the same problem as the patent, which aimed at determining calibration coefficients of the probe ensuring that the

output of the probe was scaled and aligned with the output of the coordinate positioning machine.

The board is not convinced by the respondent's argument because E1 as well as the patent relate in general to the calibration of a coordinate positioning machine using a calibration artefact with known dimensions. The patent application even explicitly mentions E1 as prior art.

The respondent's argument that E1 (in contrast to the patent) related to active probes only (see also originally filed description page 4, lines 8 to 16) is not convincing either, as E1 discloses active as well as passive probes (see column 4, lines 59 to 64).

The board is therefore of the opinion that E1 represents the closest prior art and is a suitable starting point for an inventive step assessment.

1.2.2 Difference

The appellant argued that document E1 failed to disclose explicitly that calibration coefficients were determined, which ensure that the output of the probe is scaled and aligned with the output of the coordinate positioning machine.

The respondent agreed that E1 did not disclose calibration coefficients of the probe and argued that E1 in addition failed to disclose that such coefficients were derived in the claimed way, i.e. by moving the probe along scan path(s) whilst continually scanning the surface of the calibration artefact in order to exercise the probe through its working range. The variations in sensing force described in E1 were

simply used to determine and correct the effects of stylus bending which varied from stylus to stylus.

The board is not convinced by the respondent's argument because E1 explicitly discloses to use dynamically varying measuring forces during the scanning of the calibration artefact (see column 3, lines 42 to 54 and column 7, lines 48 to 61 and claims 7 and 8). The data gathered during the scanning is then used to calibrate the stylus, e.g. to determine center and radius of the stylus ball (see column 3, lines 63 to column 4, line 4 and column 6, lines 5 to 18) in the machine's coordinate system (see column 1, lines 3 to 13).

The board is therefore of the opinion that, in comparison to claim 1, E1 fails to explicitly disclose calibration coefficients which ensure that the output of the probe is scaled and aligned with the output of the coordinate positioning machine.

1.2.3 Objective technical problem

Starting from this difference, the appellant formulated the objective technical problem to be solved as to provide a concrete implementation of the calculations necessarily performed in the method disclosed in E1.

The respondent argued that this problem was not objective because it contained hints towards the claimed solution and its formulation was based on hindsight. Instead, it argued that the objective technical problem to be solved starting from E1 was to improve the measuring accuracy.

The board is not convinced by the respondent's argument because the problem formulated by the appellant is

based on the above identified difference between claim 1 and document E1. As E1 is silent about the concrete mathematical realisation of the method disclosed therein, the skilled person is faced with the problem how to implement the method in practice.

1.2.4 Combination with document E8.2

The appellant argued that document E8.2 (see page 22, center column) taught the skilled person how to map the output signals of a probe (u_1,u_2,u_3) to coordinate measuring machine's coordinates (x_m,y_m,z_m) using in particular calibration coefficients of a transformation matrix K (see formulas (13) and (14)). In search for a concrete implementation of the calculations needed in E1, the skilled person would apply the procedure for determining the calibration coefficients disclosed in E8.2 in the system disclosed in E1 and thus determine the calibration coefficients for the probe which ensured that the output of the probe was scaled and aligned with the output of the coordinate positioning machine.

The respondent argued in essence that it saw no reason why the teachings of El and E8.2 would have been combined, nor how any such combination of the two documents would have led the skilled person to the claimed invention with the expectation of obtaining improved measurement accuracy. The appellant's combination of documents E1 and E8.2 was a selective combination of very specific teachings contained in the two documents and had only arisen with the benefit of hindsight.

The respondent argued in particular that E1 was a *"stand alone document"*, i.e. that E1 provided a

complete solution for the problem addressed therein and thus the skilled person would have had no need to look for further improvements. In particular no further mathematics for the determination of the calibration coefficients of the probe were necessary in E1.

The board is not convinced by this argument because, as discussed above, E1 fails to disclose a concrete mathematical realisation of the method disclosed therein. In search for a practical implementation of the mapping of probe outputs onto the machine coordinates, the skilled person would look for relevant teachings and consult E8.2 which explicitly relates to the mathematics involved in the calibration of probes of coordinate measuring machines.

The respondent further argued that the skilled person had no reason to consult E8.2 in order to improve the measuring accuracy (i.e. the objective technical problem formulated by the respondent), because document E8.2 included no teachings related to stylus calibration of the type described in E1, contained no hint that the the matrix provided an improved measurement accuracy and lacked any reference to the scanning used in E1.

In view of the above identified objective technical problem, these arguments are moot.

The respondent's argument that E8.2 related to active probes only is not convincing, as E8.2 relates to passive probes (see figure 3 and corresponding description on pages 21, left column, third paragraph: *"Parallelfederführungen", "lineare Federkennlinie"* and *"Führungen sind frei beweglich").*

The respondent further argued that, even if the teachings of E1 and E8.2 were combined, such a combination would not lead to the claimed subject-matter because, with respect to stylus calibration, E8.2 only disclosed to bring the stylus of the probe into contact with a small number of points on its surface from a perpendicular direction, i.e. in a serial manner and not using a continuous scanning process (see page 23, right column to page 24, left column).
Furthermore, the mathematics of E8.2 did not establish a stylus ball position, because in E8.2 the centre of the calibration standard was found.
If anything, the technique of E8.2 would have been used by a reader of E1 to determine a sensor matrix (i.e. to calibrate the probe) before the stylus calibration of E1 was subsequently performed.

The board is not convinced by these arguments because E8.2 discloses the use of a transformation matrix in order to map the probe outputs to the outputs of the coordinate system of the coordinate measuring machine in the context of calibration. E8.2 (see page 22, center column formulas (13) and (14)) discloses the general principle of calibrating such a probe-machine system by combining the machine output (x_m) with the probe output (u) via a probe matrix (K) containing calibration coefficients (k_{ii}). This aims at ensuring that the output of the probe is scaled and aligned with the output of the coordinate positioning machine. E8.2 also discloses that the coefficients of matrix K (and thus all relevant radii and positions) can be determined in a calibration process using a calibration standard (see page 23, right column: "Prinzip der Kalibrierung"). E8.2 therefore contains the clear teaching how to concretely realise the calculations

which are necessary (but not explicitly disclosed) in document E1.

The board therefore comes to the conclusion that the subject-matter of claim 1 of the main request lacks an inventive step within the meaning of Article 56 EPC 1973.

2. First auxiliary request - Admissibility

Claim 1 of the first auxiliary request (filed with the letter dated 4 October 2019 as fourth auxiliary request) comprises the following additional feature:

"... the calibration coefficients defining a non-linear relationship between the output of the probe and the output of the coordinate positioning machine."

2.1 The respondent requested that the first auxiliary request be admitted because the amendment was
- originally disclosed on page 6, line 34 to page 7, line 12 of the application as filed and paragraph 22 of the patent as granted;
- in response to the negative preliminary opinion of the board,
- not complex and narrowed the scope of the claim to a specific example and
- sufficiently disclosed for the skilled person.

2.2 The appellant requested that the first auxiliary request not be admitted into the proceedings because it was late filed and the amendment was
- not originally disclosed;
- not in response to new facts or arguments;
- taken from the description;

- not sufficiently disclosed for it to be carried out by a skilled person.

2.3 The amended claims according to the first auxiliary request have been filed in response to the summons to oral proceedings. The board is of the opinion that the amendments introduce new complex problems with regard to Article 123(2) EPC, as the passage of the description which was given as a basis for the original disclosure discloses that the relationship between the probe output and the output of the coordinate measuring machine could be non-linear but is silent about the calibration coefficients.
Furthermore, it would have to be discussed whether the application is sufficiently clear and complete for the skilled person to determine the calibration coefficients as claimed. Therefore, also the requirements of Article 83 EPC would have to be discussed.
In view of the complexity introduced by the late filed amendment of claim 1 the board exercises its discretion under Article 13(1) RPBA and does not admit the first auxiliary request into the proceedings.

3. Second to fourth auxiliary requests

3.1 Amendments - Article 123(2) EPC

In the independent claims of these requests in essence the following marked features have been added and as a basis for the original disclosure the passages as indicated in brackets have been given by the respondent:

- Second auxiliary request:

Calibration coefficients of a probe transformation matrix (page 3, lines 20 to 28).

- Third auxiliary request
  Measurement data from the probe and the coordinate positioning machine produced during the step of moving the probe (minor and implicitly disclosed clarification).

- Fourth auxiliary request
  Calibration coefficients relate the outputs in three axes (a,b,c) of the probe to the outputs in three axes (X,Y,Z) of a coordinate positioning machine and are determined in three dimensions (pages 2 to 3 and page 6, lines 23 to 32).

The appellant did not object to the original disclosure of these amendments.

The board is of the opinion that the requirements of Article 123(2) EPC are met.

3.2 Inventive step - Article 56 EPC 1973

3.2.1 The respondent argued that these amendments further defined and clarified the function of the calibration coefficients but did not provide any further arguments with respect to the presence of an inventive step.

3.2.2 The appellant argued that the amendments would not change the substantive content of the claimed subject-matter and that therefore, as discussed with respect to the main request, the subject-matter of the claims 1 of these auxiliary requests also lacked an inventive step.

3.2.3 The board is of the following opinion:

- Second auxiliary request:
  E8.2 also discloses that the calibration coefficients are arranged in a probe transformation matrix (see page 22, center column: matrix K in formulas (13) and (14) and page 23, right column: "Prinzip der Kalibrierung");

- Third auxiliary request:
  E1 discloses that the calibration is based on measurement data which is produced during the step of moving the probe (see column 6, lines 5 to 18);

- Fourth auxiliary request:
  E8.2 discloses that the calibration is done in three dimensions (see page 22, figure 3: "3F-Taster", formulas (13) and (14) and page 23, right column: "Prinzip der Kalibrierung").

The board is of the opinion that the added features do not substantially change the claimed subject-matter and are in addition already disclosed either in E1 or E8.2. Therefore, the subject-matter claimed in the second to fourth auxiliary requests also lacks an inventive step within the meaning of Article 56 EPC 1973 with respect to a combination of documents E1 and E8.2.

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:

M. Kiehl R. Bekkering

Decision electronically authenticated