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Datasheet for the decision of 4 March 2010

Case Number: T 1025/07 - 3.4.02

Application Number: 04781128.6

Publication Number: 1654514

IPC: G01B 5/00

Language of the proceedings: EN

Title of invention:
Improved protable coordinate measurement machine

Applicant:
FARO TECHNOLOGIES INC.

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 54(3), 56

Relevant legal provisions (EPC 1973):
-

Keyword:
-

Decisions cited:
-

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 1025/07 - 3.4.02

D E C I S I O N
of the Technical Board of Appeal 3.4.02
of 4 March 2010

Appellant: FARO TECHNOLOGIES INC.
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 13 February 2007 refusing European application No. 04781128.6 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: A. G. Klein
Members: A. Maaswinkel
C. Rennie-Smith

Summary of Facts and Submissions

I. The appellant lodged an appeal, received on 12 April 2007, against the decision of the examining division, dispatched on 23 February 2007, refusing the European patent application 04781128.6. The fee for the appeal was paid on 12 April 2007 and the statement setting out the grounds of appeal was received on 8 June 2007.

II. In the examining proceedings the following documents were cited:

D1: WO-A-03/069266
D2: US-A-5 402 582
D3: US-A-4 676 002.

According to the decision under appeal, document D1, being comprised within the state of the art within the definition of Art. 54(3) EPC 1973 for all designated contracting states except PL and RO, anticipated the subject-matter of claim 1 then on file.

III. With the statement of grounds of appeal the appellant filed amended sets of claims according to a new main and an auxiliary request and also filed an auxiliary request for oral proceedings.

IV. In a Communication of the board under Rule 100(2) EPC 2000 the board pointed to remaining minor deficiencies in the application documents.

V. With a letter dated 12 February 2010 and received by facsimile on 15 February 2010 the appellant filed a new set of claims for all designated contract states except

PL and RO and a further set of claims for the contracting states PL and RO and also amended description pages. The documents now comprising the appellant's request include:

Claims: for all designated contract states except PL and RO: claims 1 to 47 as received with the letter of 12 February 2010;
for designated contract states PL and RO: claims 1 to 48 as received with the letter of 12 February 2010;

Description: pages 6 to 11, 13, 17, 18, 20, 22 to 24, 26 to 28, 30 to 39 as published;
pages 1 to 3, 3a, 3b, 4 (*deleted*), 5, 12, 14 to 16, 19, 21, 25, 29 and 40 as received with the letter of 12 February 2010;

Drawings: sheets 1/19 to 19/19 as published.

The wording of independent claim 1 for all designated contract states except PL and RO reads as follows:

" A portable coordinate measurement machine (CMM) (10) for measuring the position of an object in a selected volume, comprising:

a manually positionable articulated arm (14) having opposed first and second ends, said arm (14) inc1uding a plurality of joints (18, 30, 32, 34, 36, 46, 48);

a measurement probe (28) attached to a first end of said articulated arm;

an electronic circuit (172) which receives the position signals from transducers (610, 608, 608, 610)

in said arm and provides a digital coordinate corresponding to the position of the probe in a selected volume; and

wherein at least one of said joints (18, 30, 32, 34, 36, 46, 48) further comprises:

a shaft (602) surrounded, at least in part, by a housing (606), said shaft (602) and said housing (606) being adapted to rotate relative to one another;

a periodic pattern (608) of a measurable characteristic;

at least one read head (610) spaced from and in communication with said pattern;

said pattern (608) and said read head (610) being positioned within said joint (18, 30, 32, 34, 36, 46, 48) so as to be rotatable with respect to each other, wherein one of said pattern (608) and said at least one read head (610) is fixed to an end of said shaft (602) and the other of said pattern (608) and said at least one read head (610) is fixed within said housing (606), said read head (610) reading the rotary movement of said pattern (608); and

at least one sensor (S1, S2, S3, S4, S5) which measures relative movement in said articulated arm (14) with respect to said at least one read head (610) so as to improve the measurement accuracy of said at least one read head (610), said at least one sensor (S1, S2, S3, S4, S5) measuring the relative movement between the shaft (602) and housing (606) to determine movements other than the rotary movement of the pattern (608) ".

Claims 2 to 47 are dependent claims.

The wording of independent claim 1 for designated contract states PL and RO reads as follows:

" A portable coordinate measurement machine (CMM) (10) for measuring the position of an object in a selected volume, comprising:

a manually positionable articulated arm (14) having opposed first and second ends, said arm (14) inc1uding a plurality of joints (18, 30, 32, 34, 36, 46, 48);

a measurement probe (28) attached to a first end of said articulated arm;

an electronic circuit (172) which receives the position signals from transducers (610, 608, 608, 610) in said arm and provides a digital coordinate corresponding to the position of the probe in a selected volume; and

wherein at least one of said joints (18, 30, 32, 34, 36, 46, 48) further comprises:

a periodic pattern (608) of a measurable characteristic;

at least one read head (610) spaced from and in communication with said pattern;

said pattern (608) and said read head (610) being positioned within said joint (18, 30, 32, 34, 36, 46, 48) so as to be rotatable with respect to each other; and

at least one sensor (S1, S2, S3, S4, S5) which measures relative movement in said articulated arm (14) with respect to said at least one read head (610) so as to improve the measurement accuracy of said at least one read head (610) ".

Claims 2 to 48 are dependent claims.

VI. The appellant's arguments may be summarised as follows:

Compared to original claim 1, the present independent claim for all contracting states except PL and RO includes the additional features:
- "a shaft surrounded, at least in part, by a housing, said shaft and said housing being adapted to rotate relative to one another"; this feature finds its support in original claim 8;
- "wherein one of said pattern and said at least one read head is fixed to an end of said shaft and the other of said pattern and said at least one read head is fixed within said housing" is the last feature of claim 34 as filed;
- "said read head reading the rotary movement of said pattern" derives directly and unambiguously from the application as filed, see the paragraphs [0099] and [0108];
- "said at least one sensor measuring the relative movement between the shaft and housing to determine movements other than the rotary movement of the pattern" appears in paragraph [0108], page 23, lines 1 to 4. The description has been amended to delete the expressions "incorporated by reference" and the term "spirit", furthermore the prior art has been acknowledged. Therefore the above amendments should be allowable.

The decision under appeal considered that document Dl disclosed a portable coordinate measurement machine (CMM) comprising all the features of the preceding claim 1 on file and concluded that this claim was not novel with regard to D1. This document was filed on 13.02.2003 before the priority date of the present

application (15.08.2003) and published on 21.08.2003. Document D1 entered the regional phase before the European Patent Office for the following states: AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, Fl, FR, GB, GR, HIJ, JE, IT, LI, LU, MC, NL, PT, SE, SI, SK, TR. Therefore, document D1 is a state of art according to Article 54(3) EPC 1973 for all designated contracted states except PL and RO (Article 54(4) EPC 1973). However, document Dl fails to describe the following feature of amended claim 1 "at least one sensor which measures relative movement in said articulated arm with respect to said at least one read head so as to improve the measurement accuracy of said at least one read head, said at least one sensor measuring the relative movement between the shaft and housing to determine movements other than the rotary movement of the pattern".

In particular, the document Dl discloses (see figure 1) a portable coordinate measurement machine (CMM) 10 for measuring the position of an object in a selected volume, comprising:
a manually positionable articulated arm 14 having opposed first and second ends, said arm including a plurality of joints;
a measurement probe 28 attached to a first end of said articulated arm;
an electronic circuit which receives the position signals from transducers in said arm and provides a digital coordinate corresponding to the position of the probe in a selected volume; and
wherein at least one of said joints further comprise;
a periodic pattern (94, see figure 9) of a measurable characteristic;
at least one read head (92) spaced from and in

communication with said pattern (94); said pattern (94) and said read head (92) being positioned within said joint so as to be rotatable with respect to each other. The read heads are photodetector arrays (see page 14, line 15) and the periodic pattern is a grating disk (see page 13, line 5). The aim of the read heads, associated to the grating disk, is to measure, for each joint, the rotation of the shaft 60 on which is fixed the grating disk 94 (see figure 9). The working of the read heads associated with the grating disk 94 is detailed on page 14, lines 10-18. Therefore, when the joint is submitted to a rotation, the shaft and the disk will rotate with regard to the read heads 92, fixed to a housing 64 by means of a plate 100.
The read heads 92 are only able to measure the rotary movement of said grating disk 94.

In the decision it was argued that the read heads are also able to measure movement along the X or Y axis, that is to say movement other than the rotary movement. This assertion is not correct: For instance, in the embodiment of the invention represented in Figure 41, the CMM comprises a read head 610 measuring the rotation of the grating disk and additional sensors, notably S1 and S2 sensors measuring respectively the displacement of the grating disk along the Y and X axis. The aim of the additional sensors S1 and S2 is to correct the errors that occur during the measurement of the rotation of the corresponding joint. Indeed, in use, the grating disk is submitted to a displacement along these axes. Such displacements of the grating disk induce errors when measuring its rotation because the total displacement of the grating disk is a combined displacement comprising a Z axis rotation and X and Y

translation. The dimensions of the meshes of the grating disk are sufficiently small to diffract the light of a collimated size beam (see page 14, lines 11-13) and to provide a good precision of the measurement. When the rotation of the grating disk occurs, each read head 92 produces an output signal when the beam is displaced with regard to the meshes, thereby giving an indication of the rotation of the grating disk. If the grating is displaced along the X or Y axis, the beam is also displaced with regard to the mesh. Such displacement will induce errors because the read head will "read" not only the information relating to the Z axis rotation but also the information relating to the X and Y axis translations, these movements thereby causing errors. Therefore, contrary to the assertion in the decision, the read heads 92 disclosed in Dl are not able to measure other movements (for example X and Y translation) than the rotary movement (Z-rotation) of the pattern (grating disk) but are only able, if the joint is submitted to such other movements, to measure an erroneous Z rotation. Such erroneous measurement by the read heads 92 also occurs in the CMM of the invention. In order to compensate such error, the CMM of the invention comprises an additional sensor (S1 and S2 for example) notably dedicated to the measurement of X and Y axis displacement of the grating disk. For example, the sensor S1 only measure Y axis displacement and the signal produced by S1 is not affected by the Z-rotation of the grating disk. It follows that the document D1 does not disclose the following feature of amended claim 1 "at least one sensor which measures relative movement in said articulated arm with respect to said at least one read head so as to improve the measurement accuracy of said at least one read head,

said at least one sensor measuring the relative movement between the shaft and housing to determine movements other than the rotary movement of the pattern". Amended claim 1 is therefore new with regard to D1, which is only relevant for the question of novelty. As far as inventive step is concerned, documents D2 and D3 do not teach or suggest any structures to make measurement corrections caused by deformities caused by a load to a joint and in particular do not teach or suggest employing at least one sensor which measures relative movement in the arm with respect to the read head so as to improve the measurement accuracy of that read head.

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments*

The board is satisfied that the amended claims meet the requirements of Art. 84 and 123(2) EPC.

3. *Patentability*

3.1 *Novelty - Claim 1 for all designated contract states except PL and RO*

3.1.1 The board concurs with the appellant that document D1 is a state of art according to Article 54(3) EPC 1973 for all designated contracted states except PL and RO (*Article 54(4) EPC 1973*). As was pointed out by the examining division in point 3.2 of its Communication of

26 July 2006, the description in this document D1 is identical to that of the present application except for the additional paragraphs [0106] to [0111] and the Figures 41 to 43. Therefore the following features of claim 1 defining the "portable coordinate measuring machine (CMM)", the "manually positionable articulate arm", the "measurement probe", the "electronic circuit", and the joints comprising a "shaft", a "periodic pattern", the "at least one read head" and the features relating to "the pattern and the read head" are known from D1. In its analysis of the features of the claim the appellant came to the same assessment.

3.1.2 Document D1 does not disclose the last feature of claim 1 defining the at least one sensor measuring relative movement in the articulated arm with respect to the read head: this feature is only disclosed in the paragraphs [0106] to [0111] and the Figures 41 to 43 which, however, are not part of the disclosure in document D1.

3.1.3 In the decision under appeal it had been argued that document D1 disclosed four "sensors" in Figure 9B "for measuring X-axis or Y-axis displacement of the pattern in the articulated arm". However, present claim 1 defines that the sensor measures relative movement in the articulated arm with respect to the at least one read head. Since the "sensors" (*in fact: the read heads*) 92 in the assembly of Figure 9B and 9C in document D1 are fixed together on the mounting plate 100 there is no relative movement between these respective read heads. Furthermore there is no teaching whatsoever in document D1 that the signals of these read heads are

processed "to determine movements other than the rotary movement of the pattern".

3.1.4 It is concluded that the subject-matter of claim 1 for all designated contract states except PL and RO is novel over the disclosure in document D1.

3.2 *Novelty - Claim 1 for designated contract states PL and RO*

3.2.1 Claim 1 filed for contract states Pl and RO substantially corresponds to claim 1 of the published patent application. For claim 1 of these contract states document D1 does not form prior art. The other documents cited in the decision, D2 and D3, disclose coordinate measurement machines (CMMs) which include the features common to this type of measurement devices, i.e. articulated arms including joints; measurement probes; electronic circuits; and read heads. However, the CMMs disclosed in D2 and D3 do not include at least one sensor which measures relative movement in an articulated arm with respect to at least one read head so as to improve the measurement accuracy of this read head.

3.2.2 Therefore the subject-matter of claim 1 for the designated contract states PL and RO is novel.

3.3 *Inventive step*

3.3.1 For the issue of inventive step the only documents on file to be considered are D2 and D3. It is observed that, apart from their citation as D2 and D3, in the decision these documents have not been addressed. In

the Communication of 26 July 2006, point 4.3, reference was made to D2, stating that the measuring arm of this CMM employed encapsulated encoders; and to D3 in which CMM device the measuring arm had displacement sensors for measuring deformations.

3.3.2 As discussed in point 3.2.1 *supra*, both documents D2 and D3 disclose CMMs of the generic type as the CMM of the present patent application. Therefore either of these documents may be considered as the closest prior art.

3.3.3 More in particular, document D2 discloses a portable CMM which includes an optimizing or calibrating step to account for any measured imperfections in assembly or machining, see col. 10, l.20 to 25 and, for instance, claim 1 of this document. The calibration is carried out by using a calibration or testing jig 320, see Figure 19 and the description of this Figure in column 10 of D2. By collecting a set of data at plural predetermined positions a calibration file is produced. A further optimization may be carried out by using a reference ball 192 (Figures 5, 14 and 15, and col. 11, first paragraph). Therefore, whereas in document D2 the problem of misalignment of a CMM and the need to calibrate the device is recognised, the solution of including at least one sensor which measures relative movement in an articulated arm with respect to at least one read head so as to improve the measurement accuracy of this read head is not offered. Rather, as is discussed in the context of Figures 6 and 7 in col. 5, l. 10, the device includes a single transducer/encoder 80 on a mounting plate 82.

3.3.4 Document D3 discloses a CMM in which the problem of deflection or deformation of a robot arm under load is addressed by designing the system with a structural system of interconnected structural members having a respective measuring beam system suspended at their inside (see Figure 2 and col. 5, l.29 to 62). In this device the deformations of the measuring arm are measured, however, the device does not include at least one sensor which measures relative movement in an articulated arm with respect to at least one read head so as to improve the measurement accuracy of this read head as defined in claim 1 for the designated contract states PL and RO.

3.3.5 Since neither D2 nor D3 teach or give a hint towards the solution in this claim, its subject-matter is not obvious and meets the requirements of Art. 52(1) and 56 EPC.

3.3.6 Claim 1 for the other designated contract states is even further restricted and, hence, equally defines patentable subject-matter.

3.3.7 This similarly applies to the further appended claims which are equally allowable.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the department of first instance with the order to grant a patent on the basis of the following documents:

Claims:	for all designated contract states except PL and RO: claims 1 to 47 as received with the letter of 12 February 2010; for designated contract states PL and RO: claims 1 to 48 as received with the letter of 12 February 2010;
Description:	pages 6 to 11, 13, 17, 18, 20, 22 to 24, 26 to 28, 30 to 39 as published; pages 1 to 3, 3a, 3b, 4 (*deleted*), 5, 12, 14 to 16, 19, 21, 25, 29 and 40 as received with the letter of 12 February 2010;
Drawings:	sheets 1/19 to 19/19 as published.

The Registrar: The Chairman:

M. Kiehl A. G. Klein

BESCHWERDEKAMMERN DES EUROPÄISCHEN PATENTAMTS

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Datasheet for the decision of 14 April 2010

Case Number: T 1025/07 - 3.4.02

Application Number: 04781128.6

Publication Number: 1654514

IPC: G01B 5/00

Language of the proceedings: EN

Title of invention:
Improved protable coordinate measurement machine

Applicant:
FARO TECHNOLOGIES INC.

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC R. 140

Relevant legal provisions (EPC 1973):
-

Keyword:
-

Decisions cited:
-

Catchword:
-

Case Number: T 1025/07 - 3.4.02

D E C I S I O N
of the Technical Board of Appeal 3.4.02 of 14 April 2010 correcting errors in the decision of 4 March 2010

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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 13 February 2007 refusing European application No. 04781128.6 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: A. G. Klein
Members: A. Maaswinkel
C. Rennie-Smith

Summary of Facts and Submissions

In application of Rule 140 EPC 2000 the decision of 4 March 2010 is corrected as follows:

In point V of the Summary of Facts and Submissions and in point 2 of the Order the lines

"Drawings: sheets 1/19 to 19/19 as published."

should be corrected as:

"Drawings: sheets 1/50 to 50/50 as published.".

The Registrar: The Chairman:

M. Kiehl A. G. Klein