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Datasheet for the decision
of 5 February 2018

Case Number: T 0992/15 - 3.4.02

Application Number: 01904979.0

Publication Number: 1266191

IPC: G01F1/84, G01F15/02

Language of the proceedings: EN

Title of invention:
A METHOD AND APPARATUS FOR OPERATING CORIOLIS FLOWMETERS AT
CRYOGENIC TEMPERATURES

Applicant:
Micro Motion, Inc.

Headword:

Relevant legal provisions:
EPC 1973 Art. 56

Keyword:
Inventive step - after amendment (yes)

Decisions cited:

EPA Form 3030

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It can be changed at any time and without notice.

Catchword:

Beschwerdekammern

Boards of Appeal

Chambres de recours

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Case Number: **T 0992/15 - 3.4.02**

D E C I S I O N
of Technical Board of Appeal 3.4.02
of 5 February 2018

Appellant: (Applicant)	Micro Motion, Inc. 7070 Winchester Circle Boulder, CO 80301 (US)
Representative:	Vossius & Partner Patentanwälte Rechtsanwälte mbB P.O. Box 86 07 67 81634 München (DE)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 18 December 2014 refusing European patent application No. 01904979.0 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	R. Bekkering
Members:	H. von Gronau
	T. Karamanli

Summary of Facts and Submissions

I.   The appeal of the applicant is directed against the
        decision of the examining division to refuse the
        European patent application No. 01904979.0. The
        examining division refused the application on the
        ground that the subject-matter of claim 1 did not
        involve an inventive step over document

        D1: US 5 027 662 A

        as closest prior-art document in combination with
        document

        D5: US 5 907 104 A.

II.   With the statement setting out the grounds of appeal
        dated 22 April 2015, the appellant requested that the
        decision of the examining division be set aside and a
        patent be granted on the basis of the claims according
        to a main request filed with letter dated
        23 October 2014 and subject to the contested decision
        or the claims according to an auxiliary request filed
        with the statement setting out the grounds of appeal.

        As an auxiliary measure oral proceedings were
        requested.

III.   In a communication accompanying the summons to oral
        proceedings, the board expressed its provisional
        opinion that the subject-matter of claim 1 of the main
        request and of the auxiliary request did not involve an
        inventive step in view of document D1 as closest prior-
        art document in combination with the common general
        knowledge as exemplified in document D5.

IV.   With letter dated 5 January 2018 the appellant filed claims according to auxiliary requests 1, 3 and 4. The auxiliary request filed with the grounds of appeal became auxiliary request 2. The appellant put forward arguments in support for these requests.

V.   Oral proceedings took place on 5 February 2018. After having discussed the main request and auxiliary requests 1 and 2 on file and a new main request filed during the oral proceedings, the appellant filed as sole request amended claims 1 - 14 and description pages 1 to 3, 3a, 4 to 26, and 26/1 replacing all previously filed claims and description pages.

Appellant's final request:

The appellant requested that the decision under appeal be set aside and that a patent be granted in the following version:

- Claims: Nos. 1 to 14 according to the Sole Request filed during the oral proceedings of 5 February 2018;
- Description: Pages 1 to 3, 3a, 4 to 26, and 26/1 filed during the oral proceedings of 5 February 2018;
- Drawings: Sheets 1/8 to 8/8 as published.

At the end of the oral proceedings the chairman of the board announced the decision.

VI.   The independent claims 1 and 8 of the Sole Request filed during the oral proceedings read as follows:

"1. A method of operating a Coriolis flowmeter having a
fluid flow to derive non-linear temperature compensated
fluid flow output information for said Coriolis
flowmeter, said method comprising the steps of:
measuring the operating temperature T of a flow tube
means of said Coriolis flowmeter,
characterized in that said method includes the further
steps of:
storing measured values of Young's modulus E for a
plurality of measured operating temperatures T of said
flow tube means,
curve fitting said measured values of E to obtain a
non-linear expression for E expressed as a function of
T,
defining an expression relating said fluid flow output
information to said operating temperature T and to non-
linear temperature compensation information,
using said non-linear expression for Young's modulus E
as said non linear temperature compensation information
in said defined expression,
solving said defined expression to generate said non-
linear temperature compensated fluid flow output
information for said Coriolis flowmeter at said
operating temperature T."

"8. A Coriolis flowmeter comprising:
flow tube means (102, 103) adapted to be vibrated while
receiving a fluid flow,
meter electronics (125) that receives signals from pick
offs (RPO, LPO) coupled to said vibrating flow tube
means,
said signals indicating a phase difference between two
points on said flow tube means to which said pick offs
are coupled,

said meter electronics also receives signals indicating
an operating temperature T of said flow tube means from
a temperature sensor (RTD),
characterized in that said meter electronics further
includes:
compensation apparatus (608, 609, 610) that relates
said operating temperature T to measured values of
Young's modulus E (710) for a range of operating
temperatures of said flow tube means,
apparatus (706) that curve fits said measured values of
E to obtain said non-linear expression for E expressed
as a function of T,
apparatus (614) that receives non-linear temperature
compensation information, receives said pick offs
signals (608), and applies said non-linear temperature
compensation information for said flow tube means to a
defined fluid flow expression, and
apparatus (714) that uses said non-linear expression
for E as said non-linear temperature compensation
information in said defined expression to generate non-
linear temperature compensated fluid flow output
information for said Coriolis flowmeter."

Reasons for the Decision

1.   Amendments (Article 123(2) EPC)

1.1   Independent claim 1 of the Sole Request filed during
        the oral proceedings is based on claims 1 and 13 as
        originally filed, and independent claim 8 of that
        request is based on a combination of claims 23 and 35
        as originally filed. The appellant only amended the
        wording of the combined claims to avoid involved
        definitions.

1.2   The board assesses that the independent claims 1 and 8
        on file do not contain subject-matter which extends
        beyond the content of the application as filed.
        Accordingly, claims 1 and 8 as amended meet the
        requirements of Article 123(2) EPC.

2.   Clarity (Article 84 EPC 1973)

        The board considers the wording of the amended
        independent claims fulfilling the clarity requirements
        of Article 84 EPC 1973.

3.   Claims 1 and 8 - novelty (Article 54(1) EPC 1973)

        Lack of novelty was not an issue in the contested
        decision.
        None of the cited prior-art documents discloses in
        combination all the features of present claims 1 and 8.
        The subject-matter of claims 1 and 8 is therefore new
        within the meaning of Article 54(1) EPC 1973 .

4.   Claim 1 - inventive step - (Article 56 EPC 1973)

4.1   Document D1 is the closest prior-art document. It
        discloses a method of operating a Coriolis flowmeter
        (cf. column 1, lines 11 - 15) having a fluid flow to
        derive temperature compensated fluid flow output
        information for said Coriolis flowmeter (cf. e.g.
        column 25, lines 1 - 25), said method comprising the
        steps of:

        measuring the operating temperature T of a flow tube
        means of said Coriolis flowmeter (cf. column 25, lines
        20 - 21),

storing temperature compensation information for said
flow tube means (it is implicit that at some time the
characteristics of the flow tube have been measured in
dependence of the temperature),

relating information for said fluid flow to said
operating temperature T and to said temperature
compensation information, and

generating temperature compensated fluid flow output
information for said Coriolis flowmeter at said
operating temperature T (cf. column 25, lines 21 - 25;
the temperature compensation logic comprises the
measured characteristic that allows to provide a
temperature-compensated elastic spring constant k(T)).

4.2   The method of claim 1 therefore **differs** from the
        disclosure of document D1 in that measured values of
        Young's modulus E for a plurality of measured operating
        temperatures are stored, that said measured values of E
        are curve fitted to obtain a non-linear expression for
        E expressed as a function of T, and that this non-
        linear expression is used to generate non-linear
        temperature compensated fluid flow output information
        for said Coriolis flowmeter at the operating
        temperature T.

4.3   The differing feature has the **effect** of increasing the
        accuracy of the temperature compensation over a wide
        range of temperatures ranging from 4k to 473k (cf. page
        3, lines 12 - 28, of the present application).

4.4   The objective technical **problem** to be solved starting
        from document D1 is therefore providing an operating
        method of a Coriolis flowmeter with high measuring

accuracy over a wide range of temperatures ranging from
4k to 473k.

4.5   It is generally known that in Coriolis flowmeters the
        temperature of the flow conduit typically has to be
        measured and a compensation value added to the flow
        signal to minimize the effects of changes in the
        elastic modulus of the flow conduit. For stainless
        steel the theoretical tensile elastic modulus versus
        temperature relationship is nearly linear in the range
        of 0°F and 350°F. It is also generally known in the art
        that this elastic modulus becomes increasingly non-
        linear as the temperature becomes colder and hotter
        which necessitates adding more complex temperature
        compensation methods to account for non-linear
        temperature relationships (cf. background information
        in document D5, column 1, lines 39 - 67).

4.6   For the person skilled in the art starting from
        document D1 it might be evident with this general
        knowledge in mind that in view of the above problem the
        non-linear characteristic for the hotter and colder
        temperatures needs to be considered in the temperature
        compensation of the Coriolis flowmeter of document D1.
        But neither document D1 nor document D5 suggest that
        the temperature-compensated spring constant is
        determined using a non-linear expression for the
        Young's modulus E as a function of T obtained by curve
        fitting measured values of E.

4.7   The appellant argued that in document D5 the
        relationship between elastic modulus and temperature
        might, as a whole, be non-linear across a wide range of
        temperatures. It might, however, well be divided into
        linear and near linear segments for certain temperature
        ranges. The elastic modulus might have for example a

linear relationship or near linear relationship with a
particular slope between 100°C and 50°C and might have
a different linear relationship or near linear
relationship with a different slope between
temperatures 50°C and -50°C. As a whole, the elastic
modulus and temperature relationship would then be non-
linear between the temperatures of 100°C and -50°C.
However, a correction technique could well involve
using different linear corrections depending on the
operating temperature at issue or interpolating the
values of a look-up table. Accordingly, document D5 did
not implicitly disclose or even suggest using a non-
linear expression correction technique as recited in
the present claim. It simply stated that more complex
temperature methods were needed to account for non-
linear temperature curves and proposed a completely
different approach to compensate for all sorts of
effects. Document D1 failed to disclose non-linear
temperature effects and therefore only disclosed
functionality in the linear temperature range. No
document suggested developing a non-linear expression
by curve fitting. Although curve fitting as a
mathematical method was known, it was not the most
obvious way to prepare the temperature compensation for
a Coriolis flowmeter. Therefore, it was only with
hindsight that a person skilled in the art would
consider curve fitting to develop a non-linear
expression for compensating the temperature effects in
the Coriolis flowmeter.

4.8   The board concurs with the aspect raised by the
        appellant that although curve fitting as such is known
        in the art to develop a non-linear expression from
        measuring points, the person skilled in the art
        starting from document D1 and having in mind the common
        general knowledge as summarized in document D5 would

not consider curve fitting and the development of a
non-linear expression to compensate for temperature
changes in the fluid flow output information.

4.9   The board comes therefore to the conclusion that the
        subject-matter of claim 1 involves an inventive step.

5.   Claim 8 - inventive step (Article 56 EPC 1973)

        Independent apparatus claim 8 defines a Coriolis
        flowmeter which allows performing the method steps of
        claim 1. The subject-matter of claim 8 therefore also
        involves an inventive step.

6.   Claims 2 - 7 and 9 - 14 are dependent on claims 1 and 8
        respectively and therefore their subject-matter also
        meets the inventive step requirement of Article 56 EPC
        1973.

7.   In the description the relevant prior-art documents are
        cited and the invention is disclosed as claimed in the
        present amended claims. The board concludes that the
        description meets the requirements of Rule 27(1) EPC
        1973.

8.   In summary, the board is of the opinion that the
        amended application documents according to the Sole
        Request meet the requirements of the EPC.

Order

For these reasons it is decided that:

1.   The decision under appeal is aside.

2.   The case is remitted to the department of first
        instance with the order to grant a patent in the
        following version:

        Claims: Nos. 1 to 14 according to the Sole Request
        filed during the oral proceedings of 5 February 2018;

        Description: Pages 1 to 3, 3a, 4 to 26, and 26/1 filed
        during the oral proceedings of 5 February 2018;

        Drawings: Sheets 1/8 to 8/8 as published.

The Registrar: The Chairman:

M. Kiehl   R. Bekkering

Decision electronically authenticated