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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:

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Catchword:
DECISION of Technical Board of Appeal 3.4.02 of 5 February 2018

Appellant: Micro Motion, Inc.
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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 off (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 off 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.


4.1 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