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D E C I S I O N
of 15 December 1994

Case Number: T 0297/94 - 3.4.2

Application Number: 89117742.0

Publication Number: 0361388 .

IPC: G01F 1/84

Language of the proceedings: EN

Title of invention:

Coriolis mass flow meter adapted for low flow rates

Applicant:

ABB K-FLOW INC.

Opponent:

-

Headword:

-

Relevant legal provisions:

EPC Art. 54, 56, 84, 123(2)

Keyword:

"Main request: additional subject-matter (yes)"

"First auxiliary request: additional subject-matter (yes)"

"Second auxiliary request: additional subject-matter (no);
clarity (yes); novelty (yes); inventive step (yes)"

Decisions cited:

G 0001/93, T 0187/91

Catchword:



Case Number: T 0297/94 - 3.4.2

DECISION
of the Technical Board of Appeal 3.4.2
of 15 December 1994

Appellant: ABB K-FLOW INC.
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Representative: Frohwitter, Bernhard, Dipl.-Ing.
Patent- und Rechtsanwälte
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Decision under appeal: Decision of the Examining Division of the European
Patent Office dated 14 December 1993, written
decision posted on 11 January 1994 refusing
European patent application No. 89 117 742.0
pursuant to Article 97(1) EPC.

Composition of the Board:

Chairman: E. Turrini
Members: M. Chomentowski
B. J. Schachenmann

Summary of Facts and Submissions

- I. European patent application No. 89 117 742.0 (publication No. 0 361 388) was refused on the grounds that there was additional subject-matter, that the claims on file were not concise, lacked clarity and support by the description, and that their subject-matter did not involve an inventive step having regard to D6 = WO-A-8 706 691 and D5 = FR-A-2 598 801.
- II. The Appellant (Applicant) lodged an appeal against this decision.
- III. During the oral proceedings of 15 December 1994 which the Appellant had requested auxiliarily, he filed three amended sets of claims as main, first and second auxiliary requests, and requested that the decision under appeal be set aside and that a patent be granted on the basis of the main, or of the first or second auxiliary request. Claims 1 and 13 of the main request read as follows:
 - "1. A Coriolis mass flow meter (10) comprising:
 - a) a continuous flow tube (12) adapted to receive and exhaust a fluid flow;
 - b) a base (22, 38) to which said flow tube (12) is fixedly mounted at its ends (28, 30) to form an unsupported length therebetween;
 - c) driver means (14) oscillating the unsupported length of said flow tube comprising one driver positioned at the center of said flow tube (12) or two drivers positioned on opposite sides of the center of said flow tube;

- d) flexible brace means (72; 72') attached at one end (76) to said base (22, 38) and at the opposite end (140) to the center of said unsupported length of said flow tube (12), said brace means (72; 72') limiting the lateral displacement of said unsupported length of said flow tube (12) transverse to the direction of the applied oscillation and limiting the amplitude of oscillation of said unsupported length of said flow tube (12) at the attachment position with respect to the remaining portions of said unsupported length of said flow tube (12) in the oscillation direction of said driver means (14), without substantially restricting the motion of said flow tube (12) due to the Coriolis reaction of said fluid on said flow tube (12);
- e) sensor means (16, 18) positioned on or adjacent to said flow tube (12) equidistantly on opposite sides of said center of said unsupported length of said flow tube (12) for the generation of signals being proportional to the motion of said flow tube (12);
- f) resonant weights (100, 102) attached to said unsupported length of said flow tube (12) about said sensor means (16, 18) on opposite sides of the center thereof;
- g) the combination of said unsupported flow tube length (12), said sensors (16, 18), said driver means (14), said brace means (72; 72'), and said resonant weights (100, 102) forming a sensing portion of said flow meter (10);
- h) said driver means (14) oscillating said sensing portion of the flow meter (10) substantially at the second resonant vibrational frequency thereof

perpendicular to said fluid flow for creating a local maximum of amplitude of vibration of the flow tube (12) on each of the opposite sides of the flow tube (12), said maximums moving in the same direction;

- i) said resonant weights (100, 102) having masses adjusted for tuning the overall oscillation pattern of said sensing portion of said flow tube (12) to the Coriolis reaction of said fluid."

"13. A method of operating a Coriolis mass flow meter (10) comprising the steps of:

- a) adapting a continuous flow tube (12) to receive and exhaust a fluid flow;
- b) fixedly mounting said flow tube (12) at its ends (28, 30) to a base (22, 38) such that an unsupported length is formed therebetween;
- c) driving said unsupported length perpendicular to the flow therein at the center of said flow tube (12) or on opposite sides of the center of said flow tube to oscillate said unsupported length;
- d) limiting the lateral displacement of said unsupported length transverse to the direction of the oscillation and limiting the amplitude of oscillation of said unsupported length with respect to the remaining portions of said unsupported length in the oscillation direction without substantially restricting the motion of said unsupported length due to the Coriolis reaction of said fluid on said unsupported length, by attaching flexible brace means (72; 72') at one end (76) to

said base (22, 38) and at the opposite end (140) to the center of said unsupported length;

- e) positioning sensor means (16, 18) equidistantly on opposite sides of the center of said unsupported length to generate signals proportional to the motion of the flow tube (12);
- f) attaching resonant weights (100, 102) to said unsupported length of said flow tube (12) about said sensor means (16, 18);
- g) driving said unsupported length and its attached brace means (72, 72'), positioned sensor means (16, 18), and attached resonant weights (100, 102) substantially at the second vibrational resonant frequency thereof for creating a local maximum of amplitude of vibration of the flow tube (12) on each of the opposite sides of the flow tube (12), said maximums moving in the same direction; wherein
- h) the overall oscillation pattern of said unsupported length of said flow meter (10) is tuned to that of the Coriolis reaction of said fluid by adjustment of the mass of said resonant weights (100, 102) attached to said unsupported length of said flow tube (12) about said sensor means (16, 18)."

Claims 2 to 12 are dependent claims.

Claim 1 of the **first auxiliary request** comprises additionally, at the end of feature (f), the words "and resonant weight (104) attached to said driver means (14)" and, at the beginning of feature (i), after "said resonant weights (100, 102)", the words "about said sensor means (16, 18)"; moreover, in the bracket of

"said resonant weights (100, 102) of feature (g), the signs ", 104" have been added. In addition to Claim 13 of the main request, Claim 13 of the **first auxiliary request** comprises, at the end of feature (f), the words "and resonant weight (104) to said driver means (14)". Claims 2 to 12 are the same as in the main request. The **second auxiliary request** consists of 12 claims which are identical with Claims 1 to 12 of the first auxiliary request.

The Appellant submitted the following arguments in support of his requests: The skilled person would understand from the original application that resonant weights (104) about the driver means are not always necessary since the resonant weights (100, 102) positioned about the sensors (16, 18) are stressed separately in parts of the original description for tuning the segment of the unsupported flow tube length adjacent thereto or for accentuating the deflection of the flow tube between the driver and the fixed ends; thus taking into account the conclusions of the decisions G 1/93, OJ EPO 1994, 541, and T 187/91, OJ EPO 1994, 572, Claim 1 of the **main request** does not comprise additional subject-matter. The method claim of the main and **first auxiliary requests** do not extend beyond the content of the original application because they correspond in substance to the teaching therein and in particular comprise those features related to the operation of the flow meter which, when inserted in an apparatus claim, might be objected but are necessary for defining the invention. The **second auxiliary request** does not comprise any method claim; Claim 1 is an apparatus claim corresponding to the embodiments disclosed in the original application and comprising in combination resonant weights (100, 102; 104) about the sensors (16, 18) and about the driver means (14), together with flexible braces (72, 72'). These means

define clearly the flow meter and its operation. With said means, the claimed flow meter achieves the creation of a vibrational pattern according to Fig. 14D within the unsupported length of the flow tube, said pattern having two maximum amplitudes of vibration, one on each side of the center of the flow tube, and a local limitation of the amplitude of vibration at the center; each of the maximums move in the same direction; this vibrational pattern in turn creates a Coriolis reaction pattern having two maximums close to the maximums of the amplitude of vibration and, thus, flow tube vibration and Coriolis reaction on the flow tube are in resonance; this results in a more accurate measurement of said Coriolis reaction. D5 does not show an apparatus with resonant masses and does not teach to form two local maximum amplitudes of vibration which are in resonance with the local maximum amplitudes of rotation of the flow within the flow tube, i.e. with the local Coriolis maximums. The Coriolis reaction pattern of D6 has a maximum at the center of the flow tube length, at the same position as the central node within the vibration pattern achieved by the driver means, i.e. results in a symmetrical pattern and an asymmetrical pattern respectively, and this is contrary to the relation of the patterns intended in present Claim 1; this implies that although masses are attached to the flow tube about the driver means and a blade spring may additionally be attached to the center of the flow tube of the known flow meter, these features are for another purpose and are thus distinguished from the present ones. Therefore, D5 and D6 do not lead towards the present flow meter in an obvious way, so that present Claim 1 involves an inventive step.

Reasons for the Decision

1. The appeal is admissible.

2. *Main request*

2.1 Allowability of the amendments

Present Claim 1 differs in many respects from the main claims having formed the basis for the decision under appeal so that the objections of the Examining Division are not relevant any more. Contrary to the original claims, wherein the Coriolis flow meter is not mentioned as comprising resonant weights or resonant control weights either about the driver means or about the sensors, present Claim 1 refers to resonant weights about the sensors (16, 18). It is to be noted that none of the embodiments of the Coriolis flow meter described in the original application (see in particular Fig. 1 to 4) comprises resonant weights or resonant control weights about the sensors without also comprising resonant weights about the driver means. Present Claim 1, with resonant weights only about the sensors (16, 18), results from the addition of a feature which, alone, is not disclosed as such in the original disclosure. The Appellant has argued that the skilled person would understand from the original application that the further resonant weights, i.e. those about the driver means, are not always necessary since the resonant weights (100, 102) positioned about the sensors (16, 18) are stressed separately in parts of the original description (see page 16, lines 24 to 26; page 20, lines 17 to 23) for tuning the segment of the unsupported flow tube length adjacent thereto or for accentuating the deflection of the flow tube between the driver and the fixed ends; thus taking into account the conclusions of the decisions G 1/93 and T 187/91,

present Claim 1 concerning a Coriolis flow meter with resonant weights positioned about the sensor means but without any indication about resonant weights about the driver means, although not disclosed originally, does not comprise additional subject-matter.

Indeed, according to G 1/93, (see Headnote II), a feature which has not been disclosed in the application as filed but which has been added to the application and which, without providing a technical contribution to the subject-matter of the claimed invention, merely limits the protection conferred by the patent as granted by excluding protection for part of the subject-matter of the claimed invention as covered by the application as filed, is not to be considered as subject-matter which extends beyond the content of the application as filed within the meaning of Article 123(2) EPC. However, in the present case, adding resonant weights to the sensor means of the device according to its broadest original definition, i.e. according to the original claims, indeed restricts the protection which was conferred by said original claims, but, already by taking into account the text locations of the original application stressing separately the technical importance of the resonant weights of the sensor means and indicated by the Appellant himself, this additional feature which, alone, was not disclosed originally, yet cannot be considered prima facie as providing no technical contribution to the subject-matter of the claimed invention; therefore, the conclusions of Headnote II of decision G 1/93 of the Enlarged Board of Appeal cannot be applied directly to the present case. Thus, this first argument of the Appellant is not convincing.

The decision T 187/91 states that a specific example within a generic disclosure forming part of the description of the invention in an application as filed

is part of the content of the application as filed for the purpose of Article 123(2) EPC if the skilled reader would seriously contemplate such specific example as a possible practical embodiment of the described invention, having regard to its context in the remainder of the application as filed, and subject to any understanding of the skilled reader to the contrary. However, in the present original description and drawings (see page 5, lines 1 to 8; page 15, line 34 to page 16, line 31; page 20, lines 8 to 23; page 21, line 21 to page 22, line 13; page 23, line 13 to page 24, line 12; Fig. 1, 3, 4, 9, 11, 12 and 15), the embodiments disclosed with resonant weights (100, 102) positioned about the sensors also comprise resonant weights (104) positioned about the driver means, and the text locations mentioned here above concerning the particular tuning function of the resonant weights about the sensors are comprised in broader text passages stressing the importance of all the resonant weights, also those about the driver means, especially for tuning the flow meter slightly out of resonance to provide a more stable oscillation (see page 23, lines 13 to 30; Fig. 15). Therefore, contrary to the condition stressed in the decision T 187/91, in the present case, the skilled reader cannot seriously contemplate a specific example of a Coriolis flow meter with resonant weights about the sensors but without resonant weights about the driver means as a possible practical embodiment of the described invention within the generic disclosure of such flow meters in the application as filed; on the contrary, taking into account the whole information derivable from the original application and in particular the teaching about the specific function of each type of resonant weights, the understanding of the skilled reader can only direct him towards a flow meter comprising both types of resonant weights. Therefore, Claim 1 referring to only one type of resonant weights

does not satisfy the requirement of Article 123(2) EPC that a European patent application may not be amended in such a way that it contains subject-matter which extends beyond the content of the application as filed. Thus, the main request is not allowable (Art. 97(1) EPC).

3. *First auxiliary request*

3.1 Allowability of the amendments

The original application indeed comprises information concerning the method of operating the Coriolis flow meter. This information is formed of a plurality of text passages concerning the different device features disclosed by using a functional definition thereof whereby particular steps of the method of operating the device are stressed in relation to Fig. 13D and 14D. However, a method comprising all the steps listed in present Claim 13 can only result from a combination of selected information concerning method steps and apparatus features which is not directly and unambiguously derivable from the application as filed. Therefore, Claim 13 does not satisfy the requirement of Article 123(2) EPC that a European patent application may not be amended in such a way that it contains subject-matter which extends beyond the content of the application as filed and, thus, the first auxiliary request is not allowable (Art. 97(1) EPC).

4. *Second auxiliary request*

4.1 Allowability of the amendments

As compared to Claim 1 of the main request, present Claim 1 additionally comprises the feature that a resonant weight (104) is positioned about the driver

means (14) and, thus, the above-mentioned objection does not apply any more. Present Claim 1 is based on the teaching of the original application (see in particular page 20, line 8 to page 24, line 30) concerning Coriolis flow meters with one or two drivers wherein the device can be operated so as to obtain a vibrational flow pattern according to Fig. 14D by in particular tuning the vibrational pattern of the flow tube to that of the Coriolis reaction pattern as a function of the brace (72, 72') and of the resonant weights (100, 102; 104) about the sensors and the driver means, respectively. The dependent Claims 2 to 12 comprise specific features which are derivable from the original application. Therefore, the European patent application satisfies the requirement of Article 123(2) EPC that a European patent application may not be amended in such a way that it contains subject-matter which extends beyond the content of the application as filed.

4.2 Clarity

Present Claim 1 is the only main claim. It is in the one-part form, without "characterised in that", because, as convincingly argued by the Appellant, the alternative forms of the driver means in the invention, comprising one or two drivers, would result in a complicated text for distinguishing the new features from those known from the closest prior art. Indeed, with respect to some of the features, the claim attempts to define the invention in terms of a result to be achieved (the form of the vibration pattern), but this in the present case is justified because it is adequate for covering the different possible corresponding apparatus features. Moreover, the further technical details in the claim also help to provide, in accordance with the description and drawings, the means for achieving this result, and

the wording of the claim leads to an unambiguous definition of the flow meter. Therefore, the claim is clear in the sense of Article 84 EPC.

4.3 Novelty

No Coriolis flow meter comprising all the features of present Claim 1 is known from the prior art. Therefore, the subject-matter of present Claim 1 is novel in the sense of Article 54 EPC.

4.4 Inventive step

A Coriolis mass flow meter is known from D5 (see page 1, lines 2, 3 and 16 to 20; page 3, line 5 to page 4, line 19; page 4, line 33 to page 8, line 13; Fig. 6 to 10); the flow meter comprises in particular:

- (a) a continuous flow tube (12) adapted to receive and exhaust a fluid flow;
- (b) a base (14, 29) to which said flow tube (12) is fixedly mounted at its ends to form an unsupported length therebetween;
- (c) driver means (16) oscillating the unsupported length of said flow tube comprising one driver positioned at the center of said flow tube (12);
- (d) flexible brace means (32) attached at one end to said base (29) and at the opposite end to the center of said unsupported length of said flow tube (12; (e) sensor means (26) positioned on or adjacent to said flow tube (12) equidistantly on opposite sides of said center of said unsupported length of said flow tube (12) for the generation of signals being proportional to the motion of said flow tube (12).

However, contrary to the presently claimed flow meter, the flexible brace means (32) of the known flow meter, which are in the form of blade springs and are for bringing the fundamental frequency of vibration of the flow tube (12) and the second mode of vibration thereof closer together, are thus not, as the present flexible brace means, for limiting the amplitude of oscillation of said unsupported length of said flow tube at the attachment position with respect to the remaining portions of said unsupported length of said flow tube in the oscillation direction of said driver means without substantially restricting the motion of said flow tube due to the Coriolis reaction of said fluid on said flow tube; therefore, a difference of structure of the flexible brace means is derivable as corresponding to the difference of the intended effects. It is also to be noted that, in the known device, no resonant weights are attached to the unsupported length of the flow tube (12) about the sensor means (26) or the driver means (16). Moreover, from the whole content of D5, there is no information that the means of the flow meter have the features for creating a local maximum of amplitude of vibration of the flow tube on each of the opposite sides of the flow tube, said maximums moving in the same direction and, since there are no resonant weights about said sensor means (26) of the known flow meter, there is no adjustment means for tuning the overall oscillation pattern of said sensing portion of said flow tube (12) to the Coriolis reaction of said fluid.

According to the Appellant and as derivable from the application as filed (see page 1, lines 9 to 12; page 3, lines 14 to 19; page 15, line 34 to page 16, line 31; page 20, lines 8 to 32; page 21, line 21 to page 22, line 13; page 23, line 13 to page 24, line 30; Fig. 14D and 15), the present flow meter is for providing an increased sensitivity of the measurements of flow rates,

in particular low flow rates, by increasing the ability of the flow tube to flex in response to the Coriolis reaction of the fluid; this aim is achieved in the presently claimed flow meter by tuning the flow meter by adjustment of the flexible brace (72, 72') and adjustment of the mass of the resonant weights about the driver means and the sensor means.

It is first to be noted that the spring means (32) in the device known from D5 (see page 7, line 21 to page 8, line 13) are for bringing the fundamental mode and the second mode of vibration of the flow tube closer together, but that, as mentioned here above, there is no indication that said blade spring (32) achieves this function without substantially restricting the motion of said flow tube (12) due to the Coriolis reaction of said fluid on said flow tube. Moreover, there is no indication derivable from D5 about resonant weights about the driver means and the sensor means.

Another Coriolis flow meter is indeed known from D6 (see page 1, lines 12 to 14; page 19, line 13 to page 21, line 13; page 22, lines 25 to 28; page 23, line 19 to page 38, line 21; Fig. 1, 3A to 3E, 4 to 6 and 9) which comprises masses (29, 30) attached to the flexible flow tube (1) about the driver means, but these are used for reducing one of the mode frequencies of the flow tube. The flow meter of D6 may also comprise a spring such as a blade spring attached to the flow tube which will influence the fundamental mode natural frequency of the flow tube. However, there is no indication derivable from D6 that this blade spring may be such that it achieves its function without substantially restricting the motion of the flow tube due to the Coriolis reaction of the fluid on said flow tube. It is also to be noted that neither D5 nor D6 teach that the Coriolis flow meter has apparatus means,

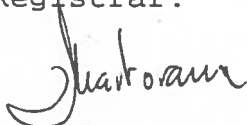
and in particular flexible brace means, such that the pattern of vibration of the flow tube created by said means are for creating a local maximum of amplitude of vibration of the flow tube on each of the opposite sides of the flow tube, said maximums moving in the same direction, as required by the present flow meter. Moreover, neither D5 nor D6 teaches the use of resonant weights about the sensor means. Therefore, the presently claimed Coriolis flow meter is not obvious having regard to the state of the art represented in particular by D5 and D6 and, thus, the subject-matter of present Claim 1 involves an inventive step in the sense of Article 56 EPC. Therefore, Claim 1 and the dependent Claims 2 to 12, which only relate to particular embodiments of the flow meter defined in Claim 1, are allowable in the sense of Article 52(1) EPC and a patent may be granted (Art. 97(2) EPC).

Order

For these reasons it is decided that:

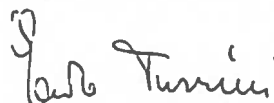
1. The decision under appeal is set aside.
2. The case is remitted to the Examining Division with the order to grant a patent on the basis of Claims 1 to 12 presented as auxiliary request 2 at the oral proceedings of 15 December 1994 and with description and drawings to be adapted.

The Registrar:



P. Martorana

The Chairman:



E. Turrini

M/H

0229.D

B. Sch.

