BESCHWERDEKAMMERN DES EUROPÄISCHEN PATENTAMTS | BOARDS OF APPEAL OF THE EUROPEAN PATENT OFFICE | CHAMBRES DE RECOURS DE L'OFFICE EUROPEEN DES BREVETS

Publication in the Official Journal Yes / No

File Number: T 44/90 - 3.4.2

Application No.: 82 300 809.9

Publication No.: 0 083 144

Title of invention: Improved method and apparatus for mass flow measurement

Classification: G01F 1/84

D E C I S I O N
of 31 July 1991

Proprietor of the patent: MICRO MOTION INCORPORATED

Opponent (01) Bopp & Reuther GmbH
(02) Krohne Meßtechnik GmbH & Co KG
(03) Exac Corporation

Headword:

EPC Article 56

Keyword: "inventive step (no)" - indication in the art for using specific sensor means" - "application of said means according to equivalent technique known in the art"

Headnote

Case Number : T 44/90 - 3.4.2

D E C I S I O N
of the Technical Board of Appeal 3.4.2
of 31 July 1991

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Decision under appeal : Decision of Opposition Division of the European Patent Office dated 07.12.89 and posted 05.01.90 rejecting the opposition filed against European patent No. 0 083 144 pursuant to Article 102(2) EPC.

Composition of the Board :

Chairman : C. Black
Members : M. Chomentowski
C.V. Payraudeau

Summary of Facts and Submissions

I. European patent No. 0 083 144 was granted on the basis of European patent application No. 82 300 809.9.

II. The Appellants (Opponents) filed an opposition against the European patent, based in particular on the grounds that the subject-matter of the claims of the opposed patent lacked an inventive step having regard inter alia to the disclosures in

D3 = C. Rohrbach, Handbuch für elektrisches Messen mechanischer Größen, VDI-Verlag GmbH, Düsseldorf, 1967, pages 193-195,
D5 = US-A-3 276 257,
D6 = US-A-3 355 944,
D8 = US-A-4 127 028, and
D9 = US-A-4 187 721.

III. The Opposition Division rejected the opposition.

IV. The Appellants (Opponents) filed an appeal against this decision.

V. In the annex to the invitation to oral proceedings which had been auxiliarily requested by the Appellants and the Respondent, the Board expressed the provisional opinion that Claim 1 was novel but that, however, it was not inventive having regard in particular to D8 and D6.

VI. The main claims read as follows:

"1. A Coriolis force mass flow rate meter comprising a continuous curved conduit (14) through which fluid is to be flowed, the conduit (14) being solidly cantilever mounted at the open ends of leg portions thereof, which

conduit (14) is adapted to oscillate about an axis (W-W) passing substantially through the mounting points of the conduit (14) such that, in use, fluid flow through the conduit gives rise to Coriolis forces tending to deflect the conduit (14) about a deflection axis (O-O), further comprising a pair of magnetic velocity sensors (33 and 33') disposed on opposite sides of the deflection axis, means electronically to detect signals from the sensors and convert them to a mass flow rate value, and mass flow readout means, characterised in that the magnetic velocity sensors (33 and 33') are each adapted to generate analogue signal linearly representative of the actual movement of respective sides of the conduit (14) on opposite sides of the deflection axis over the range of movement thereof and the means to detect and convert the signals are adapted to determine, from comparing the waveforms of the signals, the time delay between passage of the said respective sides of the conduit through a predetermined plane of the oscillation pathway of the conduit and to calculate mass flow rate therefrom."

"8. A method for measuring mass flow rate by detecting deflections caused by Coriolis forces during the resilient oscillation of a continuous curved conduit (14) while fluid is passing through it, wherein the conduit (14) is mounted to a support (26) at its open ends and is caused to oscillate about an axis (W-W) passing substantially through the mounting position, while deflection due to Coriolis force occurs about an axis (O-O) substantially perpendicular to the first axis (W-W) and causes respective sides (18 or 20) of the circuit (14) on opposed sides of the deflection axis to pass through a preselected plane of the oscillation pathway at different times, characterised by; generating, from a pair of magnetic velocity sensors, analogue signals which are linearly representative of the actual movement of the said

respective sides of the conduit (14), over the range of movement thereof,

detecting the respective continuous signals from each of the sensors (33, 33') and comparing their wave forms, determining from the wave forms the time delay between passage of the said respective sides (18, 20) of the conduit through a preselected plane of the oscillation pathway of the conduit,

and calculating mass flow rate as a function of said time delay."

Claims 2 to 7 and 9 and 10 are dependent claims.

VII. The Appellants requested the revocation of the patent. In support of their requests, they submitted the following arguments . Starting from D8, which indicates that the disclosed flowmeter may comprise magnetic velocity sensors, the person skilled in the art would find in D6, already cited in D8, a concrete example of use of such magnetic velocity sensors. Magnetic velocity sensors are generally known, for instance from D3, to be linear sensors outputting analogue signals. The problem of the warpage caused by the changes of ambient conditions is also known from D5. Phase shift, cited in D8, and time delay, as in Claim 1 in dispute, are closely related features in periodically, for instance sinusoidally, moving parts. Taking into account the indications in D8 concerning the relation between mass flow rate and the phase shift measured by the sensors, the person skilled in the art would arrive at the device of Claim 1 in dispute in an obvious way.

VIII. The respondent requested that the appeal be dismissed and that the patent be maintained. In support of his request,

he submitted the following arguments. The person skilled in the art would not take into account the teaching of D6 because it relates to an obsolete technique having the mechanical features of the flowmeter (the bushings, the bellows) which do not correspond to the new technique of D8. In particular, to solve the problem resulting from the influence of the changes of ambient conditions, for instance the temperature, a sensor outputting linear signals under stringent conditions is needed; this is especially important for sensing Coriolis forces, which are generally known to be very small; there is no indication that the magnetic velocity sensors of D6 respond to such conditions. Moreover, if the skilled person were incited to take into account the teaching of D6, he would take the whole teaching of D6, i.e. also that part concerning the measurement means, but these means allow in particular to measure a voltage, and not a time difference. Even by taking into account the indications of D8 concerning the relation between mass flow rate and the phase difference, it is to be noted that the device of Claim 1 uses the time difference and not the phase difference. Since the combination of features of Claim 1 in suit is not suggested by the prior art, Claim 1 is inventive.

Reasons for the Decision

1. The appeal is admissible.

2. Claim 1

2.1 Novelty

2.1.1 A Coriolis force mass flow rate meter is known from D8 (see column 1, line 55 to column 2, line 8; column 2,

line 20 to column 5, line 64; Figs.1-5) which comprises a continuous curved conduit (loops (10, 11); 91; loop (81, 77, 76, 80)) through which fluid is to be flowed, the conduit being solidly cantilever mounted at the open ends of leg portions thereof and being adapted to oscillate about an axis (z-z) passing substantially through the mounting points of the conduit such that, in use, fluid flow through the conduit gives rise to Coriolis forces tending to deflect the conduit about a deflection axis (x-x); the meter further comprises a pair of sensors disposed on opposite sides of the deflection axis; magnetic velocity sensors are mentioned among the sensors which may be used; moreover, it is implicit that the flowmeter of D8 comprises means electronically to detect signals from the sensors and convert them to a mass flow rate value, and mass flow readout means, although such means are not explicitly disclosed. Thus, the statement of Claim 1 in dispute is known from D8.

2.1.2 Moreover, D8 discloses more technical information.

2.1.3 Since the magnetic velocity sensors which may be used in the flowmeter of D8 are mentioned in this document (see column 4, lines 51-54) as being such as known in the art and since D6 (see column 1, lines 45-71; column 7, lines 1-58; Figs.8-10), which is cited in D8 (see column 1, lines 41-45 and column 2, lines 42-47) as representing the state of the art discloses a Coriolis type flowmeter which comprises magnetic velocity sensors, whereby said magnetic velocity sensors are each adapted to generate analogue signals representative of the actual movement of respective sides of the conduit on opposite sides of the deflection axis, the use of such magnetic velocity sensors generating analogue signals should be considered as disclosed in D8. It is to be noted that no

magnetic velocity sensors adapted to generate signals which are not analogue could be detected in the relevant prior art of flowmeters.

2.1.4 Moreover, it is generally known to people skilled in the art (see for instance D3, pages 193-195, in particular paragraph D.6.2.1) that magnetic velocity sensors are adapted to generate analogue signals which are linearly representative of the actual movement of the relevant moving part. Thus, the magnetic velocity sensors of D8, i.e. those of D6 or the other magnetic velocity sensors known in the art, also generate linear signals.

2.2 The respondent has argued that the magnetic velocity sensors of Claim 1 must have particularly good linearity, and that the magnetic velocity sensors of D6 are not adapted for such stringent conditions. However, Claim 1 in dispute does not specify which are these stringent conditions. Thus, the Board is of the opinion that the magnetic velocity sensors of D8, i.e. those of D6 or of the known art, do not differ in linearity from those claimed sensors.

2.2.1 Therefore, the Board is of the opinion that the claimed feature that the magnetic velocity sensors are each adapted to generate analogue signal linearly representative of the actual movement of respective sides of the conduit on opposite sides of the deflection axis, is known from D8.

2.2.2 However, D8 does not specify that the magnetic velocity sensors, which are each adapted to generate analogue signals linearly representative of the actual movement of respective sides of the conduit on opposite sides of the deflection axis, are adapted to do so over the range of movement thereof; moreover, D8 does not specify that the

means to detect and convert the signals generated by the magnetic velocity sensors are adapted to determine, from comparing the waveforms of the signals, the time delay between passage of the said respective sides of the conduit through a predetermined plane of the oscillation pathway of the conduit and to calculate mass flow rate therefrom.

2.2.3 The other documents of the available prior art are considered as less relevant.

2.2.4 Therefore, the subject-matter of Claim 1 is novel in the sense of Article 54 EPC.

2.3 Inventive step

2.3.1 D8 pertains to the technical field of flowmeters, and in particular of flowmeters employing sensors for sensing the Coriolis forces. The person skilled in the art of said specific flowmeters is aware of the characteristics of the sensors generally employed in such flowmeters.

2.3.2 D8 does not specify that the magnetic velocity sensors which can be used should be linear over the whole range of movement of the tube. However, it is self-evident for the person skilled in the art using a magnetic velocity sensor that it should be used in the linear part of its range of movement. Therefore, no inventive contribution can be seen in this feature.

2.3.3 As indicated here above, D8 does not disclose means adapted to determine, from comparing the waveforms of the signals, the time delay between passage of the said respective sides of the conduit through a predetermined plane of the oscillation pathway of the conduit and to calculate mass flow rate therefrom.

2.3.4 D8 (see column 4, lines 55-58) specifies, in the paragraph following immediately the text location mentioning the sensors (40; 41) ("photo interrupter type modules") of the preferred embodiment as well as the other sensors including magnetic velocity sensors, that there is a phase shift between the outputs of the two sensors, which phase shift is proportional to the Coriolis force couple turning the individual sensors on and off; according to the respondent, this unambiguously relates to switch type sensors such as the photo interrupter type modules (40, 41) of the preferred embodiment and thus, there would be no incitation in D8 for utilising phase shift in relation with magnetic velocity sensors.

2.3.5 However, it is to be noted that D8 (see column 5, lines 33-38) states that there will be a phase shift between the sensors (40) and (41) and that this phase shift can be detected and will increase with respect to time as the mass flow through loops (10) and (11) is increased. This is a physical relation between mass flow rate and phase shift, which is mentioned in D8; said relation is independent of the sensors used to measure one of its terms, i.e. said phase shift. Therefore, the Board is of the opinion that the skilled person could be incited by D8 to measure the phase shift in order to determine the mass flow rate, also when using magnetic velocity sensors.

2.3.6 The respondent has argued that, if the person skilled in the art were incited to use the magnetic velocity sensors of D6, he would also use the corresponding electronic means disclosed in D6; indeed, in the electronic means of D6 to be used for measuring the said Coriolis forces, the differential output of the two sensors (83) and (84) is fed to a differential voltage amplifier (92), whose output

in turn is fed to a voltmeter (93), calibrated to indicate mass rate of flow; thus, these are not means which are adapted to determine, from comparing the waveforms of the signals, the time delay between passage of the said respective sides of the conduit through a predetermined plane of the oscillation pathway of the conduit and to calculate mass flow rate therefrom, as required in Claim 1 in dispute.

2.3.7 Indeed, D8, which incites the person skilled in the art to use magnetic velocity sensors known in the art, does not provide any information concerning any particular corresponding electronic means. Thus, the person skilled in the art may be incited, when using the magnetic velocity sensors of D6, to use the voltmeter and the other electronic means of D6. However, the person skilled in the art cannot ignore the incitation of D8 to use the phase shift. Said phase shift is a physical feature of the device when in use which is independent of the device used for sensing it. Thus, taking into account the informations derivable from D8 and concerning the preferred embodiment using photo-interrupter-type sensors, the skilled person could in an obvious way adapt the derivable circuitry for using it with magnetic velocity sensors utilised for sensing the phase shifts in the movements of the sides of the flowmeter.

2.3.8 The respondent has also argued that, even if the person skilled in the art were incited, for any reason, to combine the teaching of D6 with that of D8, wherein phase shifts are sensed, he would not arrive at the device of Claim 1 in dispute, which senses time delays, i.e. time differences.

2.3.9 However, it is to be noted that, for periodical movements such as sinusoidal movements, it is generally known to

people skilled in the art that there is a definite relation between phase shifts and time delays of the corresponding moving parts. For instance, D9 (see column 3, lines 18-40; column 5, line 43 to column 7, line 3; see also column 11, lines 19-21; Figs.1-4) discloses a Coriolis type flowmeter wherein the mass flow is indicated as a function of the time differential of the signals generated by sensors (44, 43) sensing the movements of the arms of the vibrating U- shaped conduit (14). Therefore, it would be obvious to any person skilled in the art to adapt the apparatus of D8 using the magnetic velocity sensors of D6 so that it provides time differentials as known from D9 in place of the mentioned phase shift measurements of D8 because said measurements lead in an equivalent way to the determination of mass flow rate in similar Coriolis type flowmeters.

2.4 Therefore, the Board is of the opinion that the subject-matter of Claim 1 in dispute lacks an inventive step in the sense of Article 56 EPC.

3. Claim 8

3.1 The Board is also of the opinion that, since Claim 8 in dispute only relates to a method corresponding substantially to the device of Claim 1, its subject-matter lacks an inventive step for the same reasons.

4. Therefore, since the grounds for opposition mentioned in Article 100(a) EPC prejudice the maintenance of the patent, it has to be revoked (Article 102(1) EPC).

Order

For these reasons, it is decided that:

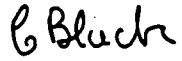
1. The decision under appeal is set aside.

2. The patent is revoked.

The Registrar

P. Martorana

The Chairman



C. Black

MCL

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