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Datasheet for the decision of 23 May 2011

Case Number: T 0415/09 - 3.4.02

Application Number: 98914045.4

Publication Number: 913670

IPC: G01F1/66

Language of the proceedings: EN

Title of invention:
ULTRASONIC FLOWMETER

Applicant:
Panasonic Corporation

Headword:

Relevant legal provisions:
EPC Art. 52(1), 54, 56

Keyword:
Inventive step (yes) - -
Novelty (yes) - -

Decisions cited:

Catchword:

Europäisches Patentamt | European Patent Office | Office européen des brevets

Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0415/09 - 3.4.02

D E C I S I O N
of the Technical Board of Appeal 3.4.02
of 23 May 2011

Appellant: (Applicant)
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 4 August 2008 refusing European patent application No. 98914045.4 pursuant to Article 97(2) EPC**

Composition of the Board:

Chairman: A. Klein
Members: A. Maaswinkel
D.S. Rogers

Summary of Facts and Submissions

I. The appellant lodged an appeal against the decision of the examining division, refusing the European patent application 98914045.4.

According to the decision of the examining division the independent claims according to the main and auxiliary requests 1 to 3 were objectionable under Art. 84 EPC and furthermore these claims did not meet the requirements of Art. 52(1) and 54 EPC, since their subject-matter was anticipated by the disclosure in document D9 (WO-A-94/20822).

II. In the notice of appeal the appellant requested that the decision under appeal be set aside. Furthermore with the statement containing the grounds of appeal the appellant filed a set of claims replacing all previous claim requests on file.

III. In a communication under Rule 100(2) EPC the board raised objections under Article 84 EPC and Rule 43(1) EPC and remarked that an amended set of documents in which these were overcome could possibly also meet the further provisions of the Convention.

IV. The appellant filed a substitute set of claims 1 to 18 replacing the claims on file.

V. The documents comprising this request include:

Claims:	1 to 18, enclosed with a letter dated 11 February 2011;
Description:	pages 1, 12 - 64 as originally filed; pages 2 and 11, enclosed with a letter

dated 5 August 2005;
Drawings: sheets 1/18 - 18/18 as originally filed.

VI. The wording of independent claim 1 reads as follows:

" An ultrasonic flowmeter for measuring a flow rate of an object fluid using ultrasonic waves, comprising:

a flow path (6) including

a flow measurement section (7) in which the object fluid flows, said flow measurement section being defined by at least one wall section (8, 9); and

a pair of ultrasonic oscillators (10, 11) both configured to transmit and receive from each other an ultrasonic wave having a propagation frequency and a wavelength in the object fluid, said ultrasonic wave comprising a direct wave (17) and a reflected wave (18) which is reflected from one of said at least one wall section (8, 9) resulting in a phase difference, said pair of ultrasonic oscillators (10, 11) being separated by a distance, said pair of ultrasonic oscillators (10, 11) connected to at least one of said at least one wall section;

a measurement section (12) coupled to said pair of ultrasonic oscillators (10, 11) and configured to measure a propagation time of said ultrasonic wave which propagates between said pair of ultrasonic oscillators (10, 11); and

a calculation section (13) coupled to said measurement section (12) and configured to calculate a flow of said fluid in said flow measurement section (7) in response to a measurement result output from said measurement section (12);

characterized in that

a cross-section of said flow measurement section has a rectangular shape,

said phase difference corresponds to the difference between a propagation distance of said direct wave and a propagation distance of said reflected wave which has been reflected only once when it is received by the ultrasonic oscillator, and

the distance between the pair of ultrasonic oscillators, and a length and a width of the rectangular cross-section of the flow measurement section are configured such that the phase difference between said direct wave (17) and said reflected wave (18) is within the range of [3/2, 2.2] or within the range [0, 0.2] ".

The wording of independent claim 18 reads as follows:

" A method of manufacturing an ultrasonic flowmeter as defined in claim 1,

characterized in that said method comprises the step of an appropriate selection of at least one of the distance between the pair of ultrasonic oscillators, and a length and a width of the rectangular cross-section of the flow measurement section such that the phase difference between said direct wave (17) and said reflected wave (18) is within the range of [3/2, 2.2] or within the range [0, 0.2]".

Claims 2 to 17 are dependent claims.

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

With respect to the issue of clarity (Art. 84 EPC), the objection that the expression "to reduce an influence of the phase difference" is a relative term rendering the scope of the claim unclear has been overcome by deleting it and defining by how much the influence is

reduced in terms of the actual configuration of the flowmeter. In particular, claim 1 defines that the distance between the pair of ultrasonic oscillators, and a length and a width of the rectangular cross-section of the flow measurement section are constructed to satisfy the relationship that the phase difference caused by such configuration between said direct wave and said reflected wave upon said measurement result is within the range of [3/2, 2.2]; or within the range of [0, 0.2].

In order to overcome the objection that this describes a result to be achieved it is defined in the characterising portion of claim 1 that the shape of the cross-section of the flow measurement section is rectangular (see p. 14, l. 26-28 of the original specification) and that the distance between the ultrasonic oscillators and a length and a width of this cross-section are configured in order to obtain this phase difference. On p.6, 2nd para of the decision under appeal it is acknowledged that "the phase difference is always a function of the distance separating said pair of ultrasonic oscillators and said shape of said cross-section of said flow measurement section", therefore one skilled in the art will understand how to configure the flow measurement section.

The objection that the phase difference of "at least 3/2, or up to O.2" does not clearly limit the scope of the claim, since the phase difference depends on the wavelength and therefore depends on the medium present in the flow measurement section has been overcome: claim 1 now specifies that the ultrasonic flowmeter is for measuring a flow rate of an object fluid; and that the ultrasonic wave has a propagation frequency and a

wavelength in this object fluid. Finally, the objection that in the definition of the phase difference the expression "reflected wave" is vague because it not restricted to a particular reflected wave has been overcome by defining that the reflected wave has been reflected only once. Therefore claim 1 should meet the requirements of Art. 84 EPC.

Regarding the novelty objections based on document D9, this document fails to teach or suggest the feature of the characterising portion of claim 1 that the cross-section of the flow measurement section is rectangular, nor does D9 disclose the ranges of the phase difference defined in this claim. Therefore the subject-matter of claim 1 is novel.

Claim 1 also involves an inventive step over the disclosure in document D9. In the decision it is stated that the problem of the present invention is to overcome the reduction of measurement precision by reflected waves which cause a phase difference with the direct wave, and that this problem would be known from document D9. Furthermore it is stated in the decision that the object of the present invention is to overcome this problem by optimizing the arrangement of the ultrasonic oscillators and the geometry of the flow tube, which would also be known from D9. In particular the decision states that D9 discloses that the phase relationship depends on the diameter of the duct (104) and length of the duct between the transducers. It is then concluded that document D9 implicitly discloses the selected flow path geometry that will lead to a phase difference which is at least 3/2, or up to 0.2. In particular, it is asserted that:
(1) the two intervals of the phase differences defined in the claim are rather broad, and

(2) since the phase difference is dependent on the medium, it is always possible to find a fluid such that the phase differences are within the specified ranges.

The appellant disagreed with this analysis. The appellant argued that, contrary to the opinion of the examining division, D9 does not have the same problem as the present invention. For example, one key problem that D9 aims to solve is the fluid pressure drop caused by the configuration of the tube (see p. 2, l. 32-35 of D9). Accordingly, although D9 appears to state that "the accuracy of a time-flight ultrasonic meter is enhanced by a longer measuring tube, or acoustic path, between the transducers since the time of flight is lengthened, and by a narrower tube or bore since the flow velocity, hence the difference in upstream and downstream flow times, is increased for the same volumetric flow rate" (p. 8, l. 34 to p. 9, l. 4 of D9), immediately thereafter, D9 teaches "however, lengthening the metering tube or decreasing the tube bore will increase the pressure drop through the meter" (p. 9, l. 2-4). Therefore, the criterion of D9 is a compromise between competing requirements (p. 8, l. 33-34). Importantly, the configuration of D9 is adapted to minimize a fluid pressure drop even if it aids in the propagation of high order acoustic modes. In view of such an object of D9, this document fails to teach or suggest the feature of "a cross-section of said flow measurement section having a rectangular shape" as claimed in the present invention. Rather, the cross-sections of the measurement tube of D9 appear to be either circular (Figure 6), semi-circular, or part elliptical (Figure 9A, 9B). That is, the cross-sections of this measurement tube appear to have mostly a curved shape. In fact, D9 appears to directly teach away from non-curved cross-sections, since it teaches that "the

pressure drop in the flowing gas will be higher for a shape with a larger wall perimeter than for a circular cross-section of the same area". Clearly, D9 does not teach, or even fairly suggest a rectangular cross-section of the measurement tube to solve its objective. Moreover, claim 1 defines the further distinction that "the phase difference between said direct wave and said reflected wave is within the range of [3/2, 2.2], or within the range of [0, 0.2]", which have been found to cover the optimum ranges (see Fig.7, respectively Fig.11). On p.6, para 3 and 4 of the decision reference is made to the passage on p. 12, l. 30- 37 of D9 where it is disclosed that the phase relationship depends on the diameter of the duct and its length, from which it was concluded that this would implicitly disclose that the selected flow path geometry leads to the phase difference ranges defined in claim 1. Rather, D9 only discloses, in terms of actual configuration, that the accuracy is enhanced by "a longer measuring tube" since the time of flight is lengthened, and by "a narrower tube or bore" since the difference in the upstream and downstream flow times is increased (p. 8, l. 35 to p. 9, l. 4 of D9). The person skilled in the art would appreciate that these two requirements contribute to a similar object, a lengthened time and a consequently lengthened time difference. However, when putting these two conditions into expressions 4 and 5 of the present patent application, it follows that a lengthened measuring tube will increase the phase difference, and a narrowed tube will decrease the phase difference, which are contradictory, and therefore do not contribute to a similar object. Hence, the criterion of D9 is different from that of the present invention and amended claim 1 is novel and inventive over the disclosure in D9. Furthermore, none of cited references D1O - D12, or D1 - D2 appears to disclose the claimed

specific ranges, and therefore, even combining the teachings of these documents with D9 would not lead to the claimed subject-matter. Claim 1 and all dependent claims thereon are thus novel and inventive over the cited references. The appellant considered that corresponding method claim 18 is novel and inventive for the same reasons.

Reasons for the Decision

1. The appeal is admissible.

2. Amendments - Art. 123 EPC and Art. 84 EPC

The board is satisfied that the set of claims finds support in the patent application as originally filed and that the amendments adequately overcome the objections raised by the examining division under Art. 84 EPC.

3. *Patentability - Claim 1*

3.1 *Novelty*

3.1.1 In the decision under appeal reference had been made to document D9. This document discloses an ultrasonic flow meter with the technical features of the preamble of claim 1. The board concurs with the appellant that the flow meter of document D9 has a flow measurement section of a generally curved shape: for instance, the arrangement in Fig. 1E includes a duct 104 having a cylindrical shape and a circular cross-section (see p. 1, l. 26 - 29); similarly Fig. 4, showing a measuring tube 9 having an intermediate portion with an internal

diameter d_i and connecting pipelines; see also claims 1 and 2, from which it follows that the fluid meter has an intermediate portion having an internal radius r_i. Therefore the subject-matter of the flowmeter defined in claim 1 differs from the arrangement in document D9 in that in claim 1 its flow measurement section has a rectangular shape.

3.1.2 As to the further features of the characterising portion of claim 1 which defines the selection of the ranges of phase difference by configuring the distance between the ultrasonic oscillators, and the length and width of the rectangular cross-section of the flow measurement section for a particular fluid, the examining division argued with reference to the passage on p. 8, l. 22-37; and p.12, l. 30-37 of D9, that the selected flow path geometry in this device would implicitly lead to the phase difference defined in prior claim 1 "at least 3/2, or up to 0.2", in particular since the two intervals of phase differences were "rather broad" and since the phase difference was dependent on the medium (fluid). In particular it was stated that "it is always possible to find such a fluid such that the phase differences are within the specified ranges".

3.1.3 In this respect it is noted that present claim 1 is more restricted than the claim according to the main request in the decision under appeal, since it defines the rectangular cross-section and the phase difference is defined to be within two ranges of specific, closed, intervals. Hence, in the opinion of the board, these present intervals are clearly defined. Furthermore, as convincingly argued by the appellant, by the wording of claim 1 it is clear that the flow meter is configured for measuring a flow rate of a particular object fluid,

and that this fluid flows through the flow measurement section. Therefore the feature of the ranges of the phase difference includes a specific, unambiguous teaching. It is observed that document D9, neither explicitly, nor implicitly discloses these specific ranges.

3.1.4 It is concluded that the subject-matter of claim 1 is novel over the disclosure in document D9 by virtue of the features of the characterising portion of this claim.

3.1.5 With respect to the further documents cited during the examining procedure, the only other document explicitly referred to (EP-A-0 631 114, document D1) discloses the measurement of a fluid passing through a "smooth bore pipe" and therefore does not disclose a flow meter having a rectangular cross-section. Furthermore, similar to D9, document D1 also does not disclose a particular range of phase difference between a direct wave and a reflected wave which has been reflected only once.

3.1.6 Therefore the subject-matter of this claim is novel.

3.2 *Inventive step*

3.2.1 For the definition of the technical problem addressed in the patent application the examining division decision referred to the passage on p. 1, last para, of the original patent application where the problem of ultrasonic waves reflected from the inside walls of the flow path and subsequent phase difference to the direct propagating ultrasonic wave was discussed. According to the examining division this problem was known from document D9. In this respect it is recalled that the

claims of the patent application in suit considered by the examining division did not include the condition that the flow measurement section has a rectangular shape.

3.2.2 As noted in point 3.1.1 *supra*, in all embodiments disclosed in document D9 the flow measurement sections have generally curved shapes. Furthermore, according to D9 (see p. 15, l. 13 - 17) the wall perimeter of the measurement section should not be too large, because the pressure drop in the flowing gas will be higher for a shape with a larger wall perimeter (*e.g. rectangular*) than for a circular cross-section of the same area. Therefore the selection of the shape of the measurement section in document D9 is made quite deliberately, which is why the skilled person would not have an incentive to consider different shapes, for instance a rectangular shape as in document JP-A-8-233628, acknowledged on p.1 l. 13 of the originally filed patent application.

3.2.3 In any case, neither document D9, nor the other available documents disclose to configure the distance between the pair of ultrasonic oscillators and the wall dimensions of the rectangular cross-section in order to render the phase difference between the direct wave and the only once reflected wave within the ranges defined in the claim. Since, as illustrated in Figures 7 and 10 of the patent application, these ranges result in particularly advantageous signals with only small relative variations between these waves the solution defined in claim 1 also involves an inventive step.

3.3 *Claim 18*

3.3.1 Independent claim 18 defines a method of manufacturing a flow meter as defined in claim 1. Since it has been found that the device of claim 1 includes novel and inventive subject-matter, the same conclusion is drawn for the method of manufacturing and this method is novel and not obvious for the same reasons as given for the corresponding device claim 1.

3.4 *Claims 2 - 17*

3.4.1 These claims are dependent claims and are equally allowable.

4. Since the main request is allowable, there is no need to address the auxiliary requests.

5. For the above reasons, the board finds that the appellant's main request meets the requirements of the EPC and that a patent can be granted on the basis thereof.

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: 1 to 18, enclosed with a letter dated 11 February 2011;
Description: pages 1, 12 - 64 as originally filed;

pages 2 and 11, enclosed with a letter dated 5 August 2005;

Drawings: sheets 1/18 - 18/18 as originally filed.

The Registrar: The Chairman:

M. Kiehl A. Klein