

Internal distribution code:

- (A) [] Publication in OJ
(B) [] To Chairmen and Members
(C) [X] To Chairmen
(D) [] No distribution

D E C I S I O N
of 10 April 2002

Case Number: T 0625/01 - 3.4.2
Application Number: 93115725.9
Publication Number: 0591832
IPC: G01D 5/34, G01D 5/36

Language of the proceedings: EN

Title of invention:

Signal processing method and displacement information measuring device

Patentee:

CANON KABUSHIKI KAISHA

Opponent:

DR. JOHANNES HEIDENHAIN GmbH

Headword:

-

Relevant legal provisions:

EPC Art. 54, 56, 84, 102(3)

Keyword:

"Maintenance - in amended form"

Decisions cited:

T 0301/87

Catchword:

-



Case Number: T 0625/01 - 3.4.2

D E C I S I O N
of the Technical Board of Appeal 3.4.2
of 10 April 2002

Appellant:
(Proprietor of the patent)

CANON KABUSHIKI KAISHA
30-2, 3-chome, Shimomaruko
Ohta-ku
Tokyo (JP)

Representative:

Tiedtke, Harro, Dipl.-Ing.
Patentanwaltbüro
Tiedtke-Bühling-Kinne & Partner
Bavariaring 4
D-80336 München (DE)

Respondent:
(Opponent)

DR. JOHANNES HEIDENHAIN GmbH
Dr.-Johannes-Heidenhain-Str. 5
D-83301 Traunreut (DE)

Representative:

-

Decision under appeal:

Decision of the Opposition Division of the
European Patent Office posted 9 April 2001
revoking European patent No. 0 591 832 pursuant
to Article 102(1) EPC.

Composition of the Board:

Chairman: E. Turrini
Members: A. G. M. Maaswinkel
V. Di Cerbo

Summary of Facts and Submissions

- I. The appellant (proprietor of the patent) lodged an appeal, received on 1 June 2001, against the decision of the opposition division, dispatched on 9 April 2001, revoking the European patent No. 0 591 832 (application No. 93 115 725.9). The fee for the appeal was paid on 1 June 2001. The statement setting out the grounds of appeal was received on 14 August 2001.

Opposition had been filed against the patent as a whole on the basis of Article 100(a) EPC, and in particular on the grounds that the subject-matter of the patent was not patentable within the terms of Articles 52(1), 54 and 56 EPC.

The opposition division held that the grounds of the opposition prejudiced the maintenance of the patent, having regard *inter alia* to the following documents:

(E1) US-A-3 709 611

(E2) EP-A-0 232 625.

During the appeal proceedings the respondent (opponent) made reference to the following document from the examination procedure:

(E4) GB-A-2 054 135.

- II. Oral proceedings were held on 10 April 2002 at the request of both parties.
- III. The appellant requested that the decision under appeal be set aside and that the patent be maintained on the basis of the following documents:

Claims: 1 and 6 filed with the letter of 1 March 2002,
2 to 5 and 7 to 15 of the patent specification;

Description: columns 1 to 15 of the patent specification;

Drawings: Figures 1 to 27 of the patent specification.

IV. The respondent requested that the appeal be dismissed.

V. The wording of claim 1 reads as follows:

"A signal processing method for measuring relative displacement information to a measured object, said signal processing method comprising the steps of:
utilizing a first scale (3a; 82) and a second scale (3b; 83) of which at least one is mounted on said measured object;

irradiating a light-beam onto said first scale (3a; 82);

receiving said light-beam which is subjected to optical modulation by said first scale (3a; 82), then introduced into said second scale (3b; 83) and subjected to optical modulation therein, with plural photodetectors (4a, 4b, 4c);

detecting said relative displacement information of said measured object from thus obtained signals;

measurement of relative displacement information to said measured object by output signals respectively obtained from one or several photodetectors (4a, 4b; 4c) among said plural photodetectors (4a, 4b, 4c), wherein said measurement is conducted by the comparison of each of said output signals from one or several photodetectors (4a, 4b, 4c) with a comparison level;

and

determination of the comparison level, said determination being conducted based on the sum of all the output signals from said plural photodetectors (4a, 4b, 4c), wherein the sum of all the output signals from said plural photodetectors includes the output signal to be compared."

The wording of claim 6 reads as follows:

"An apparatus for measuring relative displacement information of a measured object, utilizing a first scale (3a; 82) and a second scale (3b; 83), of which at least one is mounted on said measured object, comprising:

a light-beam irradiating unit (LR; 1, 2) for irradiating a light-beam onto said first scale ((3a, 82), wherein said light-beam emitted by said irradiating unit (LR; 1, 2) and subjected to optical modulation by said first scale (3a; 82) is introduced to said second scale (3b; 83);

plural photodetectors (4a, 4b, 4c) for receiving said light-beam subjected to optical modulation in said second scale (3b; 83);

a measuring unit (5) for measuring the relative displacement information of said measured object from output signals obtained respectively from one or several photodetectors (4a, 4b; 4c) among said plural photodetectors (4a, 4b, 4c); said measuring unit (5) being adapted to measure said displacement information by the comparison of each of said output signals from said one or several photodetectors (4a, 4b; 4c) among said plural photodetectors (4a, 4b, 4c) with a comparator level; and

a comparator level setting circuit (R1, R2, R3, C-5, C-6) for setting said comparator level based on the sum of all the output signals from said plural

photodetectors (4a, 4b, 4c), wherein the sum of all the output signals from said plural photodetectors includes the output signal to be compared."

Claims 2 to 5 and 7 to 15 are dependent claims.

VI. The appellant's arguments may be summarised as follows.

As to the amendments in claims 1 and 6 with respect to the corresponding granted claims, these claims have been reworded in order to unambiguously define that for the calculation of the comparison level the signals of all photodetectors are added, as is disclosed in column 7, lines 40 to 43 of the patent specification. The claims clearly define that the determination of the comparison level is based on this sum. Therefore the amendments should be allowable under Article 84 EPC and Articles 123(2) and (3) EPC.

The closest prior art for the subject-matter of claims 1 and 6 is disclosed in document E1. This document shows in Figure 1 an apparatus for measuring relative displacement between two scales; a light beam unit (light source 2); plural photodetectors ("a" and "b"); and a processor for comparing the respective signals (201 and 202) of the photodetectors, indicative of the relative movement between the two scales. Document E1 addresses the problem of fluctuations in the light source. These fluctuations result in varying signal levels in the photodetectors which, in case of a fixed comparator reference level, would lead to a poorly digitised binary signal and inaccurate position indication. The solution disclosed in E1 is to use the signal of one of the other photodetectors as a reference, see for instance Figure 1, where the signals 201 and 202 are compared. E1 furthermore discloses that the accuracy of position detection may be increased by employing plural photodetectors (Figure 5) in which

case a comparison of each detector signal with a plurality of signals of different detectors is carried out, which are added to form a time-varying intermediate comparison signal (column 7, lines 3 to 9). Therefore this document teaches that as a reference level for the comparison always the signals of one or more of the *other* detectors are used, and does not disclose or suggest that a comparison level based on the sum of *all* detector signals may be employed. See in particular column 4, lines 59 to 61 (the signals being compared two by two); and column 5, lines 8 to 10 (every signal from one detector being compared with any two other signals from two of the other detectors). The difference between the claimed subject-matter and the disclosure in E1, that the comparison level is determined based on the sum of all the output signals from the photodetectors, solves the objective problem to ensure that the comparison is based on approximately the *total* amount of light transmitted by the optical scale (column 7, lines 40 to 43 of the patent specification) and that the comparison level signal does not show a modulation structure or time-dependence as in the embodiments of E1.

Document E2 discloses an optical rotary encoder with two slitted disks (1", 2" in Figure 5). However, different from the method in claim 1 and the apparatus in claim 6, in the embodiments in E2 plural light beams irradiate the first scale (light-emitting elements 6, 7, 24 in Figure 5) and each light beam is received by only one respective detector (8, 9, 25). Therefore the subject-matter of claims 1 and 6 is clearly novel over the disclosure in document E2. Furthermore in the embodiment in Figure 6 of E2 not all the signals (a, b and \bar{b}) are summed, and these signals stem from light beams from different light sources. Hence also E2 does not suggest the subject-matter of the independent claims.

VII. The respondent's arguments may be summarised as follows.

Amended claims 1 and 6 are objectionable under Art. 84 EPC, because the expression "irradiating a light-beam" respectively "a light-beam irradiating unit" do not unambiguously define that the irradiation is by a single light beam. The claim language therefore includes the possibility of more than one irradiating light beam, see also the patent specification column 5, line 12 ("three light beams"); column 6, line 21 ("light beams"); column 10, lines 2, 34 and 51; column 11, line 29; and column 12, lines 35 and 38. Furthermore, the feature in claims 1 and 6 that the comparison level is formed by the sum of the photodetector signals is erroneous, because this level is in fact determined by the arithmetic mean of the signals.

Because of this ambiguous wording the subject-matter of these claims is not novel over the embodiment shown in Figure 5 of document E2, since the light sources 6, 7 and 24 may be considered as a light beam irradiating unit and since the further features "measuring unit" and "comparator level setting circuit" are similarly known from E2, see Figure 6, showing these units for the Figure 5 embodiment. More in particular reference is made to the comparator circuit 13 and output circuit 15. These circuits compare the photodetector output signal "b" with a signal "e", which signal is the result of the addition of input signals "b" and " \bar{b} " and does not show a time-dependence (signal \bar{b} being 180° out of phase to signal b). Therefore this circuit is equivalent to the circuit of Figure 26A in the patent specification, in which circuit signal T1 is compared with the sum signal T4 of the photodetectors, which signal is also time-independent.

The subject-matter of the independent claims is furthermore obvious in view of the teaching of document E1. This document addresses the same problem as the patent, namely to overcome the problem of a poorly binarised position signal in case of a fluctuating light source. The solution disclosed in E1 is to base the comparison level on the signal of one or more photodetectors, which are subject to the same light fluctuations as the measuring signal and therefore enable a well determined binarisation when used as a comparison signal. Document E1 teaches to base the comparison signal on one other signal (embodiment in Figure 1) or on a plurality of signals from different detectors (column 9, lines 7 to 12). The difference between the claimed subject-matter and this teaching, namely to use all photodetector signals to determine the comparison level, is merely an obvious alternative for the skilled person if he already knows that one may use the signals from one or plural detectors. It is pointed out that the patent specification does not give any information why it would be particularly advantageous to employ the signals from all detectors, and that the skilled person would be aware of the fact that, should he find that the comparison signal is too small, he could improve it by adding up all photodetector signals. Finally this feature, to add up the signals from all photodetectors, is known from document E4, which addresses the same problem as the patent under appeal and document E1, namely to compensate for fluctuations in the light source. In the embodiment shown in Figure 1 of E4 the light intensity of the light source is controlled by a feedback loop. As input signal to the feedback loop the signals of all (four) photodetectors are added, which therefore have a twofold purpose (position determination and control of the light source). Since E4 teaches that it is advantageous to add up the signals from all photodetectors as an input for the comparator (labelled

"6" in Figure 1), the skilled person would consider to include the same idea in the device of E1, because this document, moreover, stems from the same technical field.

VIII. The board gave its decision at the end of the oral proceedings.

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments*

The amendments in claims 1 and 6 defining that the comparison level is based on the output signals of all photodetectors are fairly supported by the embodiments in the Figures (see the circuits in Figures 8, 9, 23, 26A and 26B) and the corresponding passages in the description. Furthermore the board is satisfied that the amendments do not give rise to an objection under Art.123(2) or (3) EPC. Therefore the amendments are formally allowable.

3. *Article 84 EPC*

The objections by the respondent that claims 1 and 6 lack clarity are not shared by the board. Firstly, in the opinion of the board, in the present case the appeal procedure does not provide a formal basis for addressing the specific objections, because the objected features had already been present in the granted claims and are not a result of the amendments

(see Decision T 0301/87, 1st Headnote and Points 3.7 & 3.8 of the Reasons). Secondly, in the board's view, also in substance the respondent's objections are not persuasive:

Claims 1 and 6 define that "a light-beam" is irradiated onto a first scale and -after modulation- is received and modulated by a second scale. The modulation process may result in the formation of plural secondary beams (e.g. by diffraction or refraction effects of the modulating structure), which beams are received by respective plural photodetectors. Therefore the claims define a predetermined set-up between a primary light beam from a light source, one or more secondary modulated beams, and respective photodetectors. Whether, as argued by the respondent, a further primary light beam from a further light source is not excluded by the wording of the independent claims is not pertinent to the question of clarity, because, according to the claims, also any further primary beams would have to be modulated, resulting in (further) respective secondary beams and being received by (further) plural photodetectors. It is noted that the respondent's references to the plural "beams" in the patent specification are all in the context of (plural) secondary beams, therefore the cited passages are not in conflict with the claimed subject-matter.

The respondent's objection that claims 1 and 6 erroneously define that the comparison level is formed from the sum of the photodetector signals is not shared by the board. The claims require that the comparison level is *determined*, this "determination being conducted based on the sum" of all the output signals, which condition implies that in the calculation of the comparison level the sum of the signals is taken into account. This view is also supported by the disclosure, see equations (5), (10) and (17).

4. Novelty

4.1 Document E2 which, in the respondent's view, anticipates the subject-matter of the independent claims, shows in Figure 5 an apparatus for measuring relative displacement information of a measured object, utilizing a first scale (slitted disk 1") and a second scale (slitted disk 2") of which one (disk 1") is mounted on a rotary axis. The apparatus in Figure 5 of E2 comprises three light sources (6, 7 and 24), which may be regarded as forming a "light-beam irradiating unit". As discussed in point 3 *supra*, claim 6 (and *similarly claim 1*) defines a structural relation between every single primary light beam, secondary modulated beams, and the photodetectors receiving these secondary beams. Differing from the requirement in claim 6, in the apparatus shown in Figure 5 of E2 every primary light beam from a respective light source (6, 7, 24) is -after modulation- received by one -and only one- respective photodetector (8, 9, 25). See also E2, page 15, lines 21 to 28, where the positional relation between the light emitting and receiving elements 6 & 8; 7 & 9; and 24 & 25 is explained. Therefore, although the measuring apparatus of E2 comprises "plural photodetectors" (*namely: light receiving elements 8, 9 and 25*), these three photodetectors are not arranged for receiving a modulated secondary light beam or beams generated by the *same* primary light beam. A further difference between the subject-matter of claim 6 and the apparatus disclosed in document E2 resides in the processing of the signals. In Figure 6 of E2, which shows the signal processing section of the apparatus in Figure 5, the comparison level signal is based on the combination of the signals "b" and " \bar{b} " from two of the

three light receiving elements. Therefore the comparator level is not based on the sum of *all* the output signals from the plural photodetectors (8, 9 and 25).

- 4.2 Document E1 discloses in Figure 1 an apparatus for measuring relative displacement information of a measured object, utilizing a first scale (track 1); a second scale (mask 3), of which one ("movement sensor fixed to one of said members" or track 1; see claim 1 of E1) is mounted on the measured object; a light beam irradiating unit (light source 2) for irradiating a light beam onto the first scale (1), wherein the light beam is subjected to optical modulation by the first scale (1) and is introduced to the second scale (aperture plate 3); plural photodetectors (a, b) for receiving the light beam subjected to optical modulation in the second scale (3); a measuring unit for measuring the relative displacement information of the object from the output signals (201, 202; 211, 212) respectively obtained from several photodetectors (a and b); the measuring unit being adapted to measure the displacement information by the comparison of each of the output signals from the photodetectors with a comparator level in a comparator setting circuit (column 2, lines 57 to 62).

The comparison level in the apparatus shown in Figure 1 of E1 is based on the signal of the other photodetector (signal 201 compared with signal 202), or on a signal obtained by combining signals transmitted by a plurality of detectors (column 2, lines 60 to 62; claim 1, column 10, line 18). Therefore document E1 does not disclose that the comparator level is based on the sum of *all* the signals of the photodetectors.

4.3 The other known prior art documents are not relevant for the question of novelty, since in the apparatuses according to these documents the output signals from the diodes are directly used for the position indication.

4.4 Therefore in the opinion of the board the subject-matter of claim 6 is novel. For the same reason the subject-matter of claim 1 is considered novel, because this claim defines a signal processing method with the corresponding method features as the apparatus of claim 6.

5. *Inventive step*

5.1 As set out in points 4.1 and 4.2 *supra*, documents E1 and E2 disclose apparatuses for measuring relative displacement between two scales of the generic type of the apparatus defined in claim 6 and the method defined in claim 1 of the patent in suit. These documents also address the same general problem of ensuring an accurate determination of the measured position if the received signal at the photodetector varies in amplitude. However, the concrete problem underlying document E2 differs from the one in document E1 and the patent in suit. Whereas the patent and document E1 address the fluctuations of the light source, document E2 discloses an optical encoder positioned in a transfer system of an automobile wherein variations of transmission may occur through the medium (oil) in which the encoder is placed. Furthermore, the apparatus in document E1 includes the same primary light source for all photodetectors in the same way as the device in claim 6 of the patent in suit, whereas in contrast the apparatus disclosed in document E2 includes separate light sources for every detector. Hence, document E1 appears closer to the claimed subject-matter and is considered to disclose the closest prior art.

5.2 The apparatus defined in claim 6 and the measuring apparatus known from E1 differ in the determination of the comparison levels (see point 4.2). This applies correspondingly to the method defined in claim 1. The objective problem deriving from the difference in determination of the comparator signals may be seen in the idea of using approximately the *total* amount of light transmitted by the optical scale, which should ensure a stable reference level which is insensitive to fluctuations in light output of the light source due to, for instance, temperature (patent specification, column 6, line 57 to column 8, line 22; in particular column 7, lines 40 to 43) or temperature-dependent variations in the sensitivity of the photodetectors (column 14, lines 56 to 57).

5.3 In the board's opinion, document E1 does not offer a hint or suggestion to the solution defined in claims 1 and 6, to determine the comparator level by generating a reference based on the sum of all the output signals of the photodetectors. In particular, in the embodiment of Figure 1 of E1 the square-wave signal 221 is obtained by comparing the signal provided by photodetector "a" with the one from the *other* photodetector "b" (column 2, line 63 to column 3, line 35), which provides "perfectly precise positions... whatever the fluctuations of the light source" are (column 3, lines 19 to 21). Since in this case, both photodetector signals are already used, there would be no incentive to modify the comparison by adding up the signals of these photodetectors.

The respondent has furthermore argued, that document E1 also teaches to base the comparison signal on a *plurality* of signals from different detectors (column 9, lines 10 to 12) and that, by extrapolation of this teaching, the step of using the signals from *all* photodetectors would then be obvious. In the

board's understanding, the motivation for adding up a plurality of signals in the further embodiments of document E1 is not obtaining a more stable and time-independent signal, as in the patent, but increasing the positional resolution of the device, see the embodiment in Figure 5 and column 7, lines 8 to 34. For instance, in Figure 5, reference signal 524 is obtained by forming half of the sum of signals 412 and 414. It is readily understood that the higher positional resolution thus obtained is due to the higher frequent interpolated signal (*see the double-sided modulated signal 524 compared to the original signals 412 and 414 in Figure 5*). If, in this embodiment, the skilled person attempted to add up all photodetector signals for establishing a reference level, the high frequencies in the reference signal and thereby the positional information would be lost. It is therefore the board's opinion, that for the case of two photodetectors document E1 does not offer an incentive to modify that apparatus in the manner as defined in independent claims 1 and 6; and that for the case of more than two photodetectors, such a modification would go against the teaching of E1 (to increase the device's positional resolution). Hence, document E1 considered alone does not provide information to modify the measuring apparatuses disclosed in this document in the claimed way.

- 5.4 The respondent has also argued that the skilled person would consider to include the teaching of document E4 in the apparatus of E1.

In the board's view, a combination of the teachings of these documents would not seem very probable, because both documents offer complete and self-containing solutions for the problem of fluctuations in the light source. In document E4, the light source is stabilised via a feedback control loop. The feedback signal is

obtained by summing up the signals of the photodetectors, which are compared with a fixed reference voltage for the feedback loop. The problem of light fluctuations thereby being solved, the photodetector output signals are used as the position indicating output of the transducer (E4, column 5, lines 42 to 44). A hypothetical combination of the teachings of E1 and E4 would include the idea of stabilising the light intensity of the light source by including a feedback loop as disclosed in E4; and to process the photodetector signals as disclosed in E1 (using the signals of a plurality of photodetectors, different from the measuring photodetector) in order to increase the positional resolution of the apparatus. Such a combination, however, would still not correspond to an apparatus with the combined technical features of claim 6, or teach the method defined in claim 1.

5.5 Therefore the method in claim 1 and the apparatus of claim 6 is not obtainable from the prior art in an obvious way.

5.6 Claims 2 to 5 and claims 7 to 15 are dependent on claims 1 and 6 and, therefore, their subject-matter also involves an inventive step.

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 the first instance with the order to maintain the patent in amended form on the basis of the following documents:

Claims: 1 and 6 filed with the letter of 1 March 2002,
2 to 5 and 7 to 15 of the patent specification;

Description: columns 1 to 15 of the patent specification;

Drawings: Figures 1 to 27 of the patent specification.

The Registrar:

The Chairman:

P. Martorana

E. Turrini