

**Internal distribution code:**

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

**D E C I S I O N**  
of 18 April 2002

**Case Number:** T 0096/98 - 3.4.2

**Application Number:** 90105852.9

**Publication Number:** 0390092

**IPC:** G01D 5/38

**Language of the proceedings:** EN

**Title of invention:**  
Encoder

**Patentee:**  
CANON KABUSHIKI KAISHA

**Opponent:**  
DR. JOHANNES HEIDENHAIN GmbH

**Headword:**  
-

**Relevant legal provisions:**  
EPC Art. 56

**Keyword:**  
"Inventive step - yes"

**Decisions cited:**  
-

**Catchword:**  
-



Case Number: T 0096/98 - 3.4.2

**D E C I S I O N**  
of the Technical Board of Appeal 3.4.2  
of 18 April 2002

**Appellant:**  
(Proprietor of the patent)      CANON KABUSHIKI KAISHA  
30-2, 3-chome, Shimomaruko  
Ohta-ku  
Tokyo 146      (JP)

**Representative:**  
Tiedtke, Harro, Dipl.-Ing.  
Patentanwaltsbüro  
Tiedtke-Bühling-Kinne & Partner  
Bavariaring 4  
D-80336 München      (DE)

**Respondent:**  
(Opponent)      DR. JOHANNES HEIDENHAIN GmbH  
Postfach 1260  
D-83292 Traunreut      (DE)

**Representative:**      -

**Decision under appeal:**      Decision of the Opposition Division of the  
European Patent Office posted 27 November 1997  
revoking European patent No. 0 390 092 pursuant  
to Article 102(1) EPC.

**Composition of the Board:**

**Chairman:**      E. Turrini  
**Members:**      M. A. Rayner  
                         V. Di Cerbo

## Summary of Facts and Submissions

I. The present appeal is against the decision of the opposition division revoking European patent number 0 390 092 (application number 90105852.9). The opposition was based on the grounds of lack of novelty and inventive step (Article 100(a) EPC). The patent relates to an encoder and during the proceedings reference has been made to inter alia the following documents:

E1: EP-A-0 220 757

E3: JP-A-60 100013 and German language translation

E7: JP-U-61-39289 and English translation (E7')

E8: "Wie funktioniert das ?", Bibliographisches Institut, Mannheim, Germany, 3rd edition, 1986; pages 206 and 207

In the decision under appeal, the opposition division held that most of the features of the claim then under consideration were deducible from document E7, in particular from Figures 1 and 4 thereof, and that the remaining features constituted standard measures and straightforward modifications having regard to the disclosure of documents E1 and E3 and the techniques generally known in the technical field of optical and compact discs.

II. Oral proceedings were appointed consequent to auxiliary requests of both the patent proprietor (=appellant) and the opponent (=respondent).

III. The case of the appellant can be summarised as follows:

**Requests**

The appellant requested setting aside of the decision and maintenance of the patent in amended form on the basis of the claims of a main request or an auxiliary request, respectively, both filed during the oral proceedings

**Written Submissions**

In the encoder of the diffraction grating interference type disclosed in document E7 a reflection film is applied onto a relief grating and the contours of the resulting coated grating are no longer well defined. Loss of sharpness of the edges of the diffraction grating relief causes disturbance of the wavefront of the light diffracted by the grating. Consequently, the interference light beam is degraded and the measurement precision adversely affected. The invention overcomes this problem by means of a reflection film coated grating relief formed on the side of a transparent substrate opposite to the side on which the illumination light is projected.

Figures 5 and 6 of document E3 show absolute rotation detectors in which binary coded groove patterns are illuminated to obtain positional information. Figures 1 to 4 show incremental rotation detectors which are generally based on coarse gratings the properties of which do not depend on diffraction. Since no detection information can be obtained on the basis of diffraction light components diffracted by a coarse grating, the detection can only rely on reflected light beams, i.e. light reflected by the scale having the groove pattern (page 5, lines 26 to 34 of the German translation). The pattern of projections and recesses is optically read

as in a compact disc. Contrary to document E3, the claimed encoder requires the illumination of a plurality of periods of the diffraction grating and is therefore not adapted to detect each period of the diffraction grating. In addition, unlike document E3 where no detection problem arises if there is a variation in configuration of the recesses, in a diffraction interferometer variations in the sectional shape of the relief type diffraction grating, and in particular variations caused by thickness deviations and inclinations of a metal reflection layer deposited on the grating, result in fluctuations in the phase and amplitude of the periodic signal generated by the interference of the diffracted light which, in turn, results in degradation of the positional detection accuracy. Furthermore, document E3 is silent as to the application of coatings on a grating.

Document E1 discloses phase gratings designed with a groove depth of a quarter wavelength for optimum cancellation of radiation and arranged so that the detection unit receives no light from the gratings (column 8, lines 1 to 14), so displacement information is not derived from interference of diffracted light. Furthermore, document E1 teaches the provision of a layer onto a grating as a protective coating which does not have to comply with any special optical requirement (column 8, lines 34 to 36 and 40 to 48) and refers to transparent coatings for preventing damage (column 8, lines 28 to 31 and 35 to 36), but does not disclose the use of reflective films.

Since both documents E3 and E1 use light reflected by a grating arrangement, their teaching would not have prompted the skilled person to the provision of a reflective coating on a relief grating according to the claimed subject matter. In addition, in the arrangements of documents E1 and E3 wavefront

disturbances caused by irregularities in the groove structure have little or no adverse influence on the detection accuracy, and therefore cannot have been conceived in the context of the present invention. For these reasons, the claimed subject matter cannot be derived from the teaching of documents E1 or E3.

#### Oral Submissions

The reflective phase grating represented in Figure 4 of document E7 is constituted by portions of a resist material formed on the surface of the transparent substrate and only the resist portions are coated with a reflective metallic layer (paragraph bridging pages 2 and 3 of document E7'). Since the phase grating is illuminated from the side of the substrate having the resist portions, the phase grating characteristics are determined by the shape and the total height of the coated resist portions.

Document E3 teaches evaluation of the intensity of the light reflected by the substrate surface structure (lines 6 to 8 of claim 1 and lines 6 to 8 of the first paragraph on page 4). As the light beam scans the surface structure, the intensity of the reflected light is maximum when the light beam is incident on the portion between grooves, decreases when the light beam reaches the edge of the groove and then increases when the light beam is incident on the groove region. The evaluation of the reflected light intensity amounts to the detection of the position of the groove. Contrary to the surface structure of document E3 (second paragraph on page 4 and lines 6 to 11 on page 5), a phase grating relies on neither information associated with, nor the position of individual ones of the elements constituting the grating pattern. While diffraction by a phase grating requires that the incident light beam covers a plurality of the grating

periods, in document E3 the light beam is only slightly wider than the width of one groove. Even were it assumed that higher diffraction orders are produced in the document, corresponding light is not detected. Since document E3 relies on different principles, the teaching of the document cannot be combined with the disclosure of document E7.

According to document E1, the diffraction light is neither detected nor evaluated so that no teaching or suggestion towards enhancing the diffraction characteristics of the grating is provided.

Document E8 relates to compact discs the pattern structure of which is formed by grooves having different lengths. The information in a compact disc is encoded in the length of the grooves, and the groove lengths are detected following light reflection techniques, not by diffraction of light.

IV. The case of the respondent can be summarised as follows:

#### **Requests**

The respondent requested dismissal of the appeal.

#### **Written Submissions**

Starting from document E7 as the closest prior art, the claimed subject matter solves the problem of improving the measurement precision of interferometric encoders operating with a phase grating, and the problem is solved by forming the reflective grating on the side of a transparent substrate opposite the side from which the grating is illuminated, i.e. by means of the reflective grating arrangement well known in the

technical field of compact discs and optical laser discs. The use of such reflective grating arrangement in encoders is already known from documents E1 and E3.

Document E3 discloses an encoder and is directed to the same problem considered in the patent, i.e. the improvement of the precision and the signal-to-noise ratio (page 2, last paragraph of the German translation). There is disclosed a substrate made of acryl (page 5, lines 17 and 18) and a relief diffraction grating constituted by grooves made on one side of the substrate (page 5, lines 1 and 2) and having a depth of  $\lambda/4n$  falling within the claimed range. Light from a semiconductor laser is incident on the grooves from the other side of the substrate, as shown by the dotted circle in Figure 2 representing the incident light spot and as implied by the calculation of the depth of the grooves according to an optical path length determined on the basis of the refractive index 1.5 of acryl. The arrangement can only operate reflectively as disclosed in the document (page 5, lines 26 to 29) if the surface of the relief grating is reflective; therefore, even though not explicitly mentioned in the document, the arrangement includes a reflective film applied on the relief grating, reflective films being usually applied in the form of metallic films. In addition, the light reflected by the grooves interfere with light reflected by the portions between grooves and the resulting modulated intensity is detected by a phototransistor which generates positional information signals (page 5, lines 32 to 34). The grating constant  $1 \mu\text{m}$  is greater than the wavelength ( $0.6328 \mu\text{m}$ ) of light used, and therefore the reflected light is diffracted by the grating, the coherence of the diffracted light causing the diffracted light components to interfere with each other. The single difference with the patent in suit is that in the disclosure of the patent the diffracted



light components of different diffraction orders are represented as separate collimated light beams whereas in document E3 the diffracted light components are all included within a common light beam directed towards the detector. Therefore, the device disclosed in document E3 also constitutes a diffraction interferometer in which the light being reflected and diffracted by both the grooves and the portions between grooves interferes and the intensity modulation of the resulting interference light is detected. In addition, the light reflecting interface lies within the substrate, and the reflective layer applied on the relief grating has no adverse effect on the measurement precision and therefore also achieves the main object of the contested patent.

Document E3 pertains to optical discs which are generally constituted of a metallic reflective layer, usually of aluminium or gold, formed on the data carrying grooved surface side of a transparent substrate, the data being optically read from the other side of the substrate. The skilled person would therefore understand the reflective layer of document E3 as a metallic reflective layer, and for this reason the document is close to anticipating the subject matter of claim 1.

Document E1 is directed to an encoder in which light components cancel each other due to a phase difference of  $180^\circ$  (column 8, lines 1 to 8). The encoder therefore teaches interference of light.

Document E8 shows general knowledge in the field of compact disc technology, the features relative to the illumination and the metallisation of a compact disc thus being part of the knowledge of the skilled person reading documents E1 and E3.

### Oral Submissions

The patent specification starts with the encoder disclosed in document E7 as shown in Figure 8 of the patent. The optimisation of the intensity of the first-order diffraction light at the expense of the zero-order diffraction light according to the patent is also achieved in document E7 where the depth of the grooves is a quarter of the wavelength (document E7', page 3, lines 1 to 3). This arrangement is therefore based on phase shift. The positional measurement precision according to the patent is also achieved in the device of document E7 (lines 6 to 8 on page 2 of document E7'). The problem considered in the patent is therefore confined to the enhancement of the accuracy of the constructional arrangement of the encoder to accurately achieve the appropriate phase shift, this aspect being itself independent of the measurement precision which relies rather on the principles underlying the measurement determination design, and in particular on whether or not the measurement is based on diffracted light and, in the affirmative, on whether the light being detected is the zero or the higher-order diffraction light.

Document E3 discloses a phase grating designed to produce a phase shift of a quarter the wavelength, thus cancelling the zero-order diffraction light. Deviations in the phase shift are detrimental to the signal-to-noise ratio and the measurement precision, aspects which are explicitly considered in the document (page 2, last paragraph and page 7, middle paragraph). The document therefore addresses the problem of the accuracy of the constructional arrangement of the grating. In addition, as shown in Figure 3 and as it can be inferred from the algebraic expression on page 5, the light is incident on the phase grating from the side of the substrate opposite the grating.

Document E1 achieves the measurement precision on the basis of the phase gratings shown in Figures 4 and 5 designed to produce a phase shift such that the zero-order diffraction light is cancelled, as is the case with the encoder of the patent in suit. The first-order diffraction light is also used by purposeful exclusion from the detector. The document addresses the problem of the accuracy of the constructional arrangement of the phase grating (column 4, line 40, column 10, lines 10 to 13 and paragraph bridging columns 10 and 11), and the arrangement accuracy is improved in terms of the embodiment disclosed with reference to Figure 5 in which the light is incident on the grating from the side of the substrate opposite to the grating.

The disc of document E3 is an optical disc and Figure 5 of document E1 shows a CD-like structure. As shown in document E8, a compact disc is illuminated from the side opposite the side formed with the groove structure and coated with a reflective metallic layer.

V. Claim 1 according to the main request of the appellant is worded as follows:

"1. An encoder (111) comprising:  
a light transmission substrate (1);  
a relief type diffraction grating formed on one surface of said light transmission substrate (1);  
means (31; 10) for radiating a light beam onto said diffraction grating from the other surface (2) of said light transmission substrate (1); and  
means (35; 15) for obtaining relative displacement information of said diffraction grating;  
wherein  
a metal reflection film (3) is deposited on said diffraction grating;  
said means (35; 15) for obtaining relative displacement information of said diffraction grating detects

interference light formed by diffracted light produced by said diffraction grating upon radiation with an incident light beam (20) reaching an interface between the grooves of said diffraction grating and said reflection film (3) and being reflected by the reflection film (3) thus producing reflected/diffracted light components (21, 22); and

the groove depth  $h$  of said light transmission substrate (1) satisfies the following relation:

$(\lambda/n) \times (m/2 + 0.199) \leq h \leq (\lambda/n) \times \{(m+1)/2 - 0.199\}$   
wherein a refractive index of said light transmission substrate (1) is represented by  $n$ , a wavelength of the radiated beam is represented by  $\lambda$ , and  $m$  is an integer ( $m \geq 0$ )."

Claims 2 to 10 are appendant to claim 1.

VI. At the end of the oral proceedings, the board gave its decision.

### Reasons for the Decision

1. *Admissibility of the appeal*

The appeal complies with the provisions mentioned in Rule 65(1) EPC and is therefore admissible.

2. *Main request - Amendments (Articles 123 EPC)*

Claim 1 derives from the combination of claims 1 and 2 as granted, the claim being recast in the one-part form and further specifying that the radiation giving rise to the diffracted light corresponds with "an incident light beam reaching an interface between the grooves of said diffraction grating and said reflection film and being reflected by the reflection film thus producing

reflected/diffracted light components". This feature is based on lines 6 to 12 of page 5 of the application as originally filed, corresponding to the sentence at lines 27 to 29 on page 3 of the patent specification. Moreover, the expression "groove depth h of said relief diffraction grating" has been replaced by the expression "groove depth h of said light transmission substrate", and the term "formed" in the expression "reflection film formed on said diffraction grating" has been replaced by the term "deposited". Both amendments are supported by the documents as filed, see the grooved substrate shown in Figure 4, and page 4, lines 21 to 24 of the application as originally filed, corresponding with the feature at lines 20 to 22 on page 3 of the patent specification. Claim 9, which contains a reference to claim 1, and dependent claims 2 to 8 and 11 correspond to claim 10 and dependent claims 3 to 9 and 12 as granted, respectively, these claims being further adapted to the one-part form of claim 1. Thus, Article 123(2) EPC can be considered satisfied.

The amendments made result in further limitation of the subject matter of claim 1, and Article 123(3) EPC can thus also be considered satisfied.

3. *Prior Art*

3.1 *Document E7 (interpreted according to document E7')*

This document discloses an optical scale reading device constituting an encoder. The encoder comprises a glass substrate 10 having a relief type diffraction grating 4 formed on one of its surfaces (Figures 1 and 4, and document E7', page 2, lines 11 to 13 and page 2, line 45 to page 3, line 1). The diffraction grating is constituted by an array of resist portions 11 arranged on the substrate surface and coated with a reflective

material such as gold (page 3, line 1). The light from a semiconductor laser 1 is projected onto the diffraction grating and diffracted by the grating (page 2, lines 15 to 25). The first-order diffraction light components reflected by the grating are then brought into interference with each other (page 3, lines 7 to 8 and 22 to 24). Photodetection means 5 and d1 to d4 detect the resulting interference light and a control circuit 6 determines the relative displacement of the diffraction grating (Figure 1, page 2, lines 26 to 31 and page 3, lines 24 to 46). The depth of the grating relief, i.e. the height  $h$  of the coated resist portions relative to the surface of the substrate (see Figure 4), is one quarter the wavelength of the laser light and results in the first-order diffraction light being reinforced at the expense of the zero-order diffraction light (page 3, lines 1 to 7).

### 3.2 Document E3

This document discloses an apparatus for detecting the position and the speed of a rotatable optical disc 1 an annular surface portion 2 of which is engraved with a pattern consisting of a periodic array of grooves 3 (Figures 1 to 3 and page 4, first and last paragraphs of the German translation). The light beam from a laser source 11 is converged to a light spot 5, projected on the groove pattern and then reflected by the pattern (Figures 2 and 3 and second and last paragraphs on page 4). The disc is made of acryl with a refraction index  $n$  of 1,5, the wavelength  $\lambda$  of the laser beam is  $0.6328 \mu\text{m}$  and the depth  $h$  of the grooves is  $0.1 \mu\text{m}$ , these values satisfying the relationship  $h = \lambda/4n$  (page 5, middle of the page). The value  $hn = \lambda/4$  of the optical path difference causes the light reflected by a groove to interfere with the light reflected by the portions between grooves (page 5, last four lines). As the disc rotates about its axis, the light spot scans

the groove pattern and the intensity of the interference light is modulated by the groove pattern between maximum and minimum values. The position and the speed of the rotating disc are then determined on the basis of the modulated reflected light detected by photodiode 17 (page 5, lines 6 to 11 and page 6, lines 4 to 9).

The value of the optical path difference  $hn$  takes account of the refractive index  $n$  of the material of the disc (see algebraic expression on page 5). It therefore has to be concluded that the light is projected onto the groove pattern from the side of the disc opposite the side including the groove pattern.

### 3.3 Document E1

This document discloses a device for detecting the displacement of an object by means of an optical transducer connected thereto. The transducer is constituted by a disc 1 comprising a pattern 2 of equidistant light reflecting and non-reflecting strips 3 and 4 alternately arranged along the displacement direction so that, of the light 6 emitted by a light source 5 towards the disc, only the light incident on and reflected by the reflection strips 4 reaches the detection means 14 (Figures 1a and 1b, column 5, lines 11 to 36 and column 8, lines 9 to 14). The displacement of the disc is then determined on the basis of the detected light (column 6, lines 31 to 42). Each of the non-reflecting strips 4 is constituted by a phase grating comprising a plurality of grating grooves 30 (Figure 3 and column 7, lines 20 to 27) and the light incident on a phase grating is split into a zero-order and a plurality of first and higher order diffraction light components (column 7, lines 34 to 42). The phase gratings and the wavelength of the light beam are such that the zero-order diffraction light is



cancelled, and the device is arranged so that the first and the higher order diffraction light components do not reach the detector (column 7, line 45 to column 8, line 11). The grooves of the phase grating are formed on the disc substrate 34 and the groove depth  $d$  is one-quarter the wavelength of the light emitted by the light source, or  $\lambda/4n$  when the grooved surface of the disc is coated with a transparent protective material 33 of refractive index  $n$  (Figure 4 and column 8, lines 22 to 33). According to the alternative embodiment shown in Figure 5, the disc is constituted by a transparent substrate 35 having a grooved surface coated with a protective thin layer 36 and the grating grooves are illuminated from the side opposite the grooved surface of the substrate (column 8, lines 34 to 48).

The phase gratings disclosed in document E1 therefore constitute relief type diffraction gratings provided by arrays of grooves formed in the substrate. The diffraction gratings according to the alternative disclosed in document E1 with reference to Figure 5 are coated with a thin layer that may be constituted by a foil and need not comply with special optical requirements (column 8, lines 40 to 48).

#### 3.4 Document E8

This document discloses standard design and reading techniques used in compact disc technology. As shown in Figures 1 and 4 of document E8, a compact disc is constituted by a transparent disc-shaped substrate having pits or grooves formed in one of its sides and a metallic layer deposited thereon, the pits being then read out by means of a light beam projected on the pits from the other side of the substrate the pits having different lengths and, unlike a diffraction grating, forming a non-periodic pattern.



4. *Main request - Novelty (Article 54 EPC)*

4.1 The subject matter of claim 1 differs from the subject matter of document E7 in that reflection and diffraction of the light incident on the diffraction grating occurs at the "interface between the grooves of said diffraction grating and said reflection film" and the depth of the diffraction grating relief corresponds with the "groove depth  $h$  of said light transmission substrate", which means the relief type diffraction grating is constituted by grooves formed in the substrate material.

The claimed subject matter also differs from the disclosure of document E7 by virtue of the value of the groove depth  $h$  satisfying the algebraic relationship defined in the claim, this being a technical consequence of illumination from the interior of the substrate.

4.2 The subject matter of claim 1 of the main request differs from the disclosure of document E3 by virtue of the metal reflection film deposited on the diffraction grating and by requiring the means for obtaining relative displacement information to operate on the basis of the detection of light resulting from the interference between diffraction light components reflectively diffracted by the grooved surface operating as a diffraction grating.

While the light beam incident on and reflected by the relief region of a groove of the periodic relief pattern engraved in the disc shown in Figure 2 of document E3 undergoes local scattering and interference phenomena resulting in diffraction of the light reflected by the groove region, generation of diffraction light components by a diffraction grating requires an incident light beam having a width covering

a plurality of grating periods. Since in document E3 the width of the light spot incident on the periodic relief pattern is only slightly bigger than the width of one groove and thus smaller than the period of the relief pattern (see Figure 2 and last four lines on page 4), diffraction of light by the region of the relief pattern associated with one single groove cannot give rise to diffraction light components diffracted by a diffraction grating according to the claimed subject matter as this would require the light beam incident on the relief pattern of document E3 to be broad enough to cover a plurality of periods of the pattern in such a way that the light sub-beams scattered by different periods are brought into interference with each other and generate distinct diffraction light components having different interference orders. Therefore, although the periodic relief pattern disclosed in document E3 with reference to Figure 2 constitutes a diffraction grating within the usual meaning of the term, the periodic pattern is not used as a diffraction grating because no diffraction light components as claimed are generated in document E3. The grooves of the periodic pattern are individually read out by the laser beam, and the positional measurement does not rely on diffraction interferometry, as is the case in the claimed subject matter, but merely on the sequential detection of individual ones of the grooves.

In addition, the operation by reflection according to the arrangement of document E3 does not necessarily require a reflection layer since the disclosure of the document does not exclude a portion of the light being transmitted by the disc. Therefore, the disclosure of the document does not anticipate a reflection film, let alone the provision of a reflection film in the form of a metal layer.

4.3 The diffraction grating according to claim 1 differs from the disclosure of document E1 by virtue of the light detection arrangement because detection relies on interference of diffraction light components reflectively diffracted by the diffraction grating whereas the arrangement according to document E1 prevents detection of the diffraction light components (column 8, lines 9 to 11). A further difference is the provision of a metal reflection film deposited thereon.

4.4 The subject matter of claim 1 differs substantially from the disclosure of document E8 because the information encoded in the compact disc is not read out using diffraction interferometric detection techniques but by a detection technique similar to that disclosed in document E3 (compare in particular Figure 3 of document E8 with Figures 1 and 3 of document E8).

4.5 Therefore, in view of the differences mentioned, the subject matter of claim 1 of the main request is novel within the meaning of Article 54 EPC having regard to the disclosure of any one of documents E1, E3, E7 or E8.

5. *Main request - Inventive Step (Article 56 EPC)*

5.1 Closest prior art

The device disclosed in document E7 was conceived for the same purpose as the encoder of the invention, i.e. the determination of displacement information, and, unlike documents E1 and E3 (see points 3.1 to 3.3 above), also relies on diffraction interferometry for the displacement measurement. Therefore, the board concurs with the first instance and the parties that document E7 constitutes the closest prior art.

5.2 Objective problem

The objective problem addressed by the claimed subject matter, as compared to the disclosure of document E7, can be seen as improving the precision in the displacement measurement as determined on the basis of the diffraction light components diffracted by the diffraction grating.

The respondent submitted that the technical problem is confined to improving the accuracy of the structural arrangement of the encoder to achieve accurately the appropriate phase shift. However, this definition incorporates part of the solution of operating with the internal relief interface of the diffraction grating coated with the metal reflection layer, thus entailing hindsight when the state of the art is then assessed in terms of the problem so defined. Moreover, it is this hindsight which suggests the dissociation of structural accuracy of the diffraction arrangement from measurement precision. Therefore, the board reached the view that the problem formulated by the respondent results from an *ex post facto* analysis of the technical contribution of the claimed subject matter which cannot be adopted as the objective problem according to the problem-solution approach (see in this respect "Case Law of the Boards of Appeal", 4th Ed., 2001, section I.D.4.2 on page 107).

5.3 Teaching of Prior Art

Document E3 teaches the sequential detection of individual grooves of a relief pattern engraved in one side of a transparent disc by means of a light beam incident on the relief pattern from the other side of the disc and reflected by the grooves. The structural arrangement of the relief pattern of document E3 is in this respect closer to the claimed subject matter than

that disclosed in document E7. However, even if it were assumed that the skilled person would consider the provision of a metal reflection film in the reflective arrangement of document E3 as an inherent or at least as a straightforward measure, this document cannot contribute to a solution of the objective problem because the relief pattern is not used as a diffraction grating and there are thus no diffraction light components the relative interferometric characteristics of which would determine the precision in the displacement measurement.

According to document E1 detection relies exclusively on light reflected without diffraction and/or interference, by the reflection strips positioned between the non-reflection phase grating strips. Thus the arrangement of document E1 prevents the detection measurement from being influenced by the light diffracted by the phase gratings and rules out any evaluation of the light reflected by the reflection strips, which means that no teaching towards the higher precision displacement measurement on the basis of the interferometric analysis of the diffraction light components diffracted by a diffraction grating can be extracted from the document. The suggestion of the respondent that use of diffracted light is taught thus only makes sense in the differing context of improving the efficiency in the cancellation of the zero-order diffraction light (column 7, line 52 to column 8, line 8).

As both documents E3 and E1 as opposed to document E7 make use of a relief pattern in technically non-equivalent ways and the determination of the positional measurement is based on different principles, the application of the teaching of document E1 or E3 to the encoder of document E7 is intrinsically not obvious.

Standard compact disc manufacturing and reading techniques with which document E8 is concerned demonstrate a reflective pattern arrangement presenting structural similarities with the claimed diffraction grating. However, the pattern of pits of a compact disc does not constitute a diffraction grating, but a non-periodic pattern (see Figure 1). In addition, the reading technique of a compact disc is of the sort employed in the detection of the grooves or pits of the relief pattern used in document E3 and does not involve diffraction interferometric techniques. Therefore, the lines of reasoning offered by the respondent and followed by the opposition division in its decision, which are based on technical measures, as shown in document E8, being well known in the technical field of compact discs and inherent in the disclosure of document E3 are not persuasive in relation to an encoder operating with a diffraction grating as claimed and cannot therefore provide a convincing argument of lack of inventive step.

For these reasons, the main line of argument of the respondent relying on the structural similarities between the relief pattern arrangements disclosed in documents E1, E3 and E8 and the reflective diffraction grating arrangement according to the claimed subject matter did not convince the board. In view of the absence of any indication of function or effect towards the improvement of the precision of a diffraction interferometric measurement arrangement, the incorporation of the relief pattern arrangements of any of these documents in the encoder of document E7 is not obvious.

According to a second line of argument advanced by the respondent, the skilled person would recognise that the reflective pattern arrangements disclosed in documents E3 and E1 and known in CD technology as shown in

document E8 intrinsically provide a solution to the problem of the accuracy and sharpness of the diffraction grating relief addressed in the contested patent. In documents E1, E2 and E8, however, the measurement operation relies merely on the detection of maxima and minima in the modulated light intensity reflected by the relief pattern. Small irregularities and minor misalignments in the pattern would certainly modify the absolute value of the detected maximum and/or the minimum light intensities, but would not distort the modulated light intensity distribution to the extent of impairing detection of the presence of maxima and minima. For these reasons, irregularities or misalignments of the kind considered in the patent would have in documents E1, E3 and E8 little or no adverse effect on the accuracy of the determination of whether a groove or pit is being detected or not. As the claimed subject matter is based on an interferometric measurement technique which requires a degree of accuracy in the diffraction grating pattern much higher than in the measurement techniques used in documents E1, E3 and E8, it is again only hindsight in the knowledge of the present invention which could suggest that such prior art arrangements would provide a solution to the technical problem solved by the claimed subject matter.

A third line of argument of the respondent was based on the references in documents E3 and E1 to the accuracy of the respective devices. The paragraphs of document E3 cited by the respondent, however, refer to the signal-to-noise ratio and the measurement accuracy in the detection of individual ones of the grooves or pits of the relief pattern. Since the relief pattern of document E3 does not operate as a diffraction grating, the cited passages offer no hint towards the improvement of the interference characteristics of the diffracted light components diffracted by the relief



pattern when used as a diffraction grating. The passages of document E1 cited by the respondent refer to measures directed to the improvement of the accuracy of the arrangement, and in particular of the relief patterns. These measures, however, only refer to mastering and replica techniques known in compact disc and laser vision manufacturing technology (column 10, lines 10 to 13) and to the positional accuracy of the phase gratings in a direction orthogonal to the grating period (column 10, line 58 to column 11, line 7 and Figure 3). Therefore, none of these specific measures can give a hint towards the diffraction arrangement of the claimed subject matter. Accordingly, the submissions of the respondent on this basis do not amount to a successful attack on inventive step of the claimed subject matter.

Other prior art documents in the file are less pertinent to the claimed encoder than the prior art already considered and, therefore, the disclosure of these documents does not call into question the inventive step of the claimed encoder.

Accordingly, the subject matter of claim 1 of the main request and that of the dependent claims appendant to it is considered to involve an inventive step within the meaning of Article 56 EPC.

6. *Auxiliary request*

In view of the positive conclusion reached by the board with respect to the main request, consideration of the claims of the auxiliary request is not necessary.

7. *Adaptation of the description*

In view of the adaptations necessary in the description, the board exercises its discretion under



Article 111(1) EPC to remit the case to the first instance. It is observed in particular that claim 1 of the main request was recast during the oral proceedings in the so called one-part form and that this amendment requires the content of the closest prior art document E7 to be appropriately acknowledged in the introductory part of the description. Although document E7 is already cited in the patent specification, the discussion of the disclosure of the document with reference to Figure 8 of the patent does not reflect faithfully the content of the document since in document E7 the diffraction grating is formed, not by grooves formed in the substrate as shown in Figure 8 of the patent, but by an array of portions of a resist material arranged on the surface of the substrate.

**Order**

**For these reasons it is decided that:**

1. The decision under appeal is set aside.
2. The case is remitted to the opposition division with the order to maintain the patent in amended form as follows:
  - claims 1 to 10 of the main request filed during the oral proceedings,
  - description to be amended,
  - drawing sheets as in the patent specification.

The Registrar:

The Chairman:

P. Martorana

E. Turrini