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D E C I S I O N
of 27 September 2001

Case Number: T 0236/97 - 3.4.2

Application Number: 84307484.0

Publication Number: 0146244

IPC: G01B 9/02, G01B 11/00, G01B 11/14

Language of the proceedings: EN

Title of invention:
Optical instrument for measuring displacement

Patentee:
Sony Magnescale, Inc.

Opponent:
Canon Kabushiki Kaisha

Headword:
-

Relevant legal provisions:
EPC Art. 54, 56, 84, 123

Keyword:
"Clarity and inventive step (yes)"

Decisions cited:
T 0708/93, T 0747/96

Catchword:
-

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Case Number: T 0236/97 - 3.4.2

D E C I S I O N
of the Technical Board of Appeal 3.4.2
of 27 September 2001

Appellant: (Opponent)
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Decision under appeal: Interlocutory decision of the Opposition Division of the European Patent Office posted 20 December 1996 concerning maintenance of European patent No. 0 146 244 in amended form.

Composition of the Board:

Chairman: A. G. Klein
Members: M. A. Rayner
V. Di Cerbo

Summary of Facts and Submissions

I. European patent No. 0 146 244 (application No. 84 307 484.0) was granted with a set of claims of which claim 1, the only independent claim reads as follows:

"1. An optical instrument for measuring displacement comprising a movable diffraction grating (3) used as a scale, a light source (1), the light source (1) being a multimode laser, said diffraction grating being illuminated by said light source and producing two or more diffracted beams, means (2, 4-7) for causing said two or more diffracted beams to interfere with each other, and two or more photodetectors (10, 11) for receiving and for detecting said two or more diffracted beams from said causing means (2, 4-7) whereby displacement of said diffraction grating (3) is detected based on variations of the outputs of said two or more photodetectors (10, 11) characterised in that said light source (1) is a multimode semiconductor laser device which has a coherency such as to enable said diffracted beams to interfere with one another only when they have optical path lengths which are substantially equal."

II. Following an opposition founded on the three grounds for opposition set out in Article 100 EPC the opposition division, in a first decision, revoked the patent on the ground that the feature of claim 1 as granted, according to which the coherency of the multimode semiconductor laser is such as to enable the diffracted beams to interfere with one another **only** when they have optical path lengths which are

substantially equal extended the subject-matter of the patent beyond the content of the application as filed (Article 100(c) EPC).

III. A first appeal, filed by the proprietor of the patent, resulted in decision T 708/93 - 3.4.2 of 17 October 1994 by which the present board of appeal, in a different composition, set aside the decision revoking the patent and remitted the case to the opposition division for further prosecution on the basis of a main claim which was substantially identical to claim 1 as granted.

IV. Following resumption of the opposition procedure the opposition division issued an interlocutory decision by which the patent was maintained in an amended form, with the reference in claim 1 as granted to substantially equal path lengths being replaced by a mathematical expression relating the admissible path length difference to certain parameters. The opposition division in its decision considered that the claim as so amended gave a clear teaching of how to choose the light source, and that the use of a multimode semiconductor laser in an optical instrument of the kind concerned deviated from general knowledge and from the teaching of the citations on the file.

V. The appellant (opponent) lodged an appeal against the interlocutory decision of the opposition division.

VI. Oral proceedings were held on 27 September 2001, at which the respondent (proprietor of the patent) demonstrated a commercial embodiment of a device said to incorporate the claimed invention.

Amongst the numerous prior art citations on the file the following documents were discussed at the oral proceedings:

D1: EP-A-0 065 429;

D6: US-A-3 738 753;

D7: O PLUS E, vol. 4, No. 17, May 1981, Shingijutsu Communications Corporation, Japan, pages 84-87, W.H. HUNTLEY, "Grating Interferometer"; and English translation thereof;

D8: US-A-3 756 723;

D12: GB-A-1 504 001;

D13: JP-A-59-57 487 and English translation thereof;

D14: IEEE JOURNAL OF QUANTUM ELECTRONICS, vol. QE-18, No. 2, February 1982, pages 155-157, H. SATO et al.: "Design of Nondispersion Optical Feedback System Using Diffraction Grating for Semiconductor Laser Multiple Longitudinal Modes Control";

D15: APPLIED PHYSICS LETTERS, vol. 33, No. 9, 1 November 1978, pages 835-836;, E.J. SHAUGHNESSY et al.: "GaAlAs diode sources for laser-Doppler anemometry";

D17: APPLIED OPTICS, vol. 23, No. 17, 1 September 1984, pages 2913-2920; A. ARIMOTO et al.: "Diode laser noise at control frequencies in optical videodisc players";

D18: PROCEEDINGS OF THE SPIE, vol. 329, Optical Disk Technology, 26 to 28 January 1982, Los Angeles, California, US, pages 56-60, T. GOTOH et al.: "Characteristics of laser diodes and picture quality";

D19: PHD Thesis, Technical University of Hannover, Hannover, Germany, 1978, J. Willhelm: "Dreigitterschrittgeber photoelektrische Aufnehmer zur Messung von Lageänderungen";

S01: "A Precision Displacement Measurement Using a Diffraction Grating" by Shigeo Moriyama et al. taken from Seimitsu Kikai, Volume 49, Number 6 (June 1983), pages 94 to 98; and English translation thereof.

At the end of the oral proceedings the appellant requested that the decision under appeal be set aside and that the patent in suit be revoked.

The respondent for its part requested that the decision under appeal be set aside and, as its main request, that the patent be maintained on the basis of a set of claims of which claim 1, the only independent claim, reads as follows:

"1. An optical instrument for measuring displacement comprising a movable diffraction grating (3) used as a scale, a light source (1), the light source (1) being a multimode laser, said diffraction grating being illuminated by said light source and producing two diffracted beams, means (2, 4-7) for causing said two diffracted beams to interfere with each other, and two photodetectors (10, 11) for receiving and for detecting said two diffracted beams from said causing means (2, 4-7) whereby displacement of said diffraction grating (3) is detected based on variations of the outputs of said two photodetectors (10, 11) characterised in that said light source (1) is a multimode semiconductor laser device which has a coherency such as to enable said diffracted beams to interfere with one another

only when they have optical path lengths which are substantially equal, that is to say have optical path lengths which differ in length by an amount Δl where:

$$\Delta l < \frac{\lambda^2}{\Delta\lambda} \cdot t \cdot \frac{2}{P}$$

where t is the required measurement precision, λ is the wavelength of the light source, Δλ is the wavelength variation due to temperature variation and P is the pitch of the diffraction grating".

Auxiliarily, the respondent requested that the patent be maintained on the basis of any of the 10 further sets of claims filed with its letter of 27 August 2001.

VII. The appellant's arguments in support of its request can be summarized as follows:

In respect of the definition of the coherency of the multimode semiconductor laser the specification of the patent in suit teaches that it shall be such that interference fringes are still visible, albeit with a reduced contrast, at values of the optical path difference greater than a value Δl as calculated from the expression given in claim 1, the Δl value of 70 µm in the described example being relatively large, when compared for instance to the grating pitch of 0.55 µm (see the passage bridging pages 3 and 4 of the specification in conjunction with Figure 2). Also in the commercial apparatus demonstrated by the appellant at the oral proceedings fringes were still visible at a value of the optical path difference which was so large as to necessitate automatic interruption of the measurement in order to avoid excessive errors.

In contrast, claim 1 both in its granted version and in accordance with the respondent's main request refers to the diffracted beams interfering with one another only when they have optical path lengths which are substantially equal, that is to say when the optical path difference is substantially zero.

Claim 1 of the respondent's main request also states that the diffracted beams shall interfere with one another only when they have optical path lengths which differ in length by the amount Δl as calculated from the mathematical expression given in the claim, which is not substantially equal to zero. This second definition of the optical path length difference also implies that for any greater optical path difference the visibility of the interference fringes should be zero.

Thus, the two definitions given in claim 1 for the optical path length difference at which only the diffracted beams shall interfere conflict with each other, and none of these definitions is supported by the only example in the specification of the patent in suit.

The latter example providing the only basis for a definition of the optical path lengths in the application as originally filed, the subject-matter of claim 1 of the main request also comprises subject-matter extending beyond the contents of the application as originally filed, in violation of the requirements of Article 123(2) EPC.

Moreover, the definition of the greatest permitted optical path difference in present claim 1 by reference to the mathematical expression allows for a broader visibility curve than the very shallow configuration implied by the reference in claim 1 as granted to

substantially equal optical path lengths. The scope of protection of claim 1 of the present main request therefore extends the protection conferred by claim 1 of the granted patent, in violation also of Article 123(3) EPC.

Besides the above-mentioned lack of support by the specification of the patent in suit of the two definitions given in claim 1 of the optical path lengths of the interfering diffracted beams, the claim still further offends against the requirement of clarity of Article 84 EPC in that the mathematical relationship given there refers to the wavelength variation $\Delta\lambda$ due to temperature variation and to a required measurement precision t. These variables have no definite value since the temperature variation is itself undetermined and since the requirement for a given measurement precision is a purely mental feature.

Moreover, as is apparent for instance from the explanations given on page 11 of the English translation of document S01, the "required measurement precision" referred to in the mathematical relationship of claim 1 is related in fact only to the error caused by wavelength variations due to temperature variation, not to the overall precision of the apparatus as might be understood from the wording of claim 1.

Concerning the patentability of the claimed subject-matter, it is a generally accepted legal principle that unclear features should not be taken into account for assessing novelty or inventive step. Accordingly, in the absence of any clear definition of the optical path length difference referred to in claim 1, the patentability issue in substance boils down to

examining whether it was obvious or not for the skilled person to use a short coherence multimode semiconductor laser in an apparatus of the type defined in the preamble of the claim.

Document D6 discloses such an apparatus, comprising in the specific embodiment a helium-neon gas laser. The document in the passage from lines 12 to 20 of column 2 however teaches that owing to the use of a holographic record as a moving diffraction grating the coherent requirements of the light sources are reduced and an inexpensive reliable solid state light source or even a flashlight bulb can be used rather than the conventional laser source. This document was published in 1973 but at the effective date of the patent in suit in 1984 multimode semiconductor lasers were well-known and document D6 therefore rendered the incorporation of such laser source in an optical interferometer obvious.

A short coherence semiconductor laser is disclosed also in document D15 as a cheap light source for a laser-Doppler anemometer, with a coherence length of about 250 µm. This coherence length is very close to the coherence length of about 200 µm which can be derived from the visibility curve of Figure 2 of the patent in suit, and the document explicitly stresses the advantage of such short coherence length in the adjustment of the optical path lengths.

A cheap multimode laser source is recommended in document D7 for use in an optical measuring instrument of the type referred to in the patent (see the bottom of page 13 of the English translation). At the date of the patent in suit, in the mid-eighties, selecting a semiconductor multimode laser device as such light source can hardly be considered inventive.

Document D19 also relates to an interferometer of the type concerned in the patent, and it explicitly states that the light source may be incoherent, i.e. multimode, poorly collimated and not strictly monochromatic (see pages 39 and 56). The document on page 62 refers to a coherence length as large as 2.5 mm. This is indeed more than the coherence length which can be derived from Figure 2 of the patent in suit, but the specification of this patent also allows for visibility curves varying more slowly (see page 4 of the specification, lines 21 to 23).

In respect of document D19 it should also be noticed that the board of appeal 3.4.2 in its decision T 747/96 of 3 March 1999, issued in relation to a patent granted on an application divided from the patent application on which the patent in suit is based, stated that the feature of the light source being composed of a semiconductor laser device resulted from a natural selection which would have readily occurred to a skilled person in view of the overall disclosure of document D19. This ruling, made by a competent body on a same issue as debated between the same parties should be taken into due consideration also in the present instance and not questioned again, in consideration in particular of the generally recognised principle of former issue estoppel, which is meant to avoid the same issue being litigated again and again.

Document D12, which corresponds to bibliographic reference 77 as cited in document D19, teaches controlling the coherence length of the light source used in an interferometer so that it is smaller than the path difference between diffracted beams of different orders, so as to avoid spurious

interferences. This is also one of the technical problems solved by the claimed subject-matter, as set out in the introductory portion of the specification of the patent in suit.

Using a multimode laser of low coherence as a means for reducing noise level is taught also in document D14 in conjunction with an optical system involving diffraction by a grating (see page 155, left hand column).

The effect of multimode semiconductor lasers on the reduction of noise due to stray light interference is known also from documents D17 and D18, in optical video disk players.

In summary, since at the filing date of the patent multimode semiconductor lasers were well-known in the art, as is evidenced by documents D13, D14, D15, D17 and D18, and since furthermore documents D6, D12 and D19 clearly show that there was no prejudice in the art against using such low coherence lasers in an interferometric apparatus, the claimed subject-matter cannot be considered to involve an inventive step.

VIII. The respondent for its part submitted that it was not correct to construe claim 1 in a way which was not consistent with the specification, or which resulted in the claim comprising internal contradictions.

The claims should also be read with the knowledge of a skilled person, who is perfectly aware of the fact that useful interference fringes do not abruptly disappear at a given optical path length difference and who is also well acquainted with the concepts of precision,

accuracy and measurement errors. Incidentally, the claim does not define any coherence length, it only refers to the notion of "coherency", which refers to the general aspect of the visibility curve.

The reference in claim 1 to wavelength variation due to temperature variation does not lead to any uncertainty since the temperature operation range is a well-known specification of the type of apparatus concerned.

Concerning the issue of inventive step, the closest prior art is constituted by the device of document D1, which comprises a helium-neon gas laser as did all the interferometers which were on the market at the date of the patent in suit. These gas lasers were bulky and produced a lot of heat, so that the objective problem underlying the invention should be seen in striving at reducing the size and cost of the known interferometers.

This problem is solved in accordance with the patent by the specific choice of an appropriate multimode semiconductor laser as a light source.

None of the prior art citations on the file renders the claimed solution obvious.

In particular, document D19 only hints at the use of semiconductor luminescent diodes, not semiconductor lasers.

Document D8 teaches the use of a non-specified laser device as of a light source in an interferometer, but from the drawing it is clear that the laser actually is a gas laser. The "cheap multimode laser" recommended in document D7 is a helium-neon laser, too.

The various documents which relate to the art of laser-Doppler anemometry or to the optical video disc technology are not relevant, since in these applications the problem of a reading error resulting from temperature induced wavelength variations does not occur.

Finally, even if the skilled person had actually envisaged replacing the highly coherent gas laser of document D1 with a less coherent semiconductor laser for avoiding stray interference from reflected beams, he would still have been left with the acute problem of measurement errors being induced by the well-known temperature dependence of the wavelength of light emitted by such laser. There is no indication in the prior art that an advantage could result from the low coherency of a laser device to guarantee that no substantial interference occurs from beams having an optical path difference such that it could induce an unacceptable, temperature dependent error in the measurement.

The reluctance of the skilled person to use poorly temperature-stabilised semiconductor lasers is clearly apparent from document S01, published shortly before the filing date of the patent.

Reasons for the Decision

1. The appeal is admissible.

2. *Admissibility of the respondent's main request*

Claim 1 of the respondent's main request was filed only at the beginning of the oral proceedings of 27 September 2001. The appellant submitted that this

late-filing of the respondent's main request amounted to an inadmissible abuse of the procedure, the more so since at least 30 different versions of the claim, including those of the 10 auxiliary requests still pending, had been proposed as from the beginning of the opposition procedure.

The amendment effected in claim 1 at the beginning of the oral procedure consists in re-introducing into the claim the limitation of claim 1 as granted that the diffracted beams were enabled to interfere with one another only "when they have optical path lengths which are substantially equal". This formulation had been considered unclear by the opposition division and replaced by a mathematical expression defining the optical path difference at which only the diffracted beams were enabled to interfere.

Thus, the re-introducing of the formulation of claim 1 as granted along with the above mentioned mathematical expression, with the further statement that the latter was meant to be an explanation of the former ("optical path lengths which are substantially equal, **that is to say** have optical path lengths which ...") in effect only expresses that the mathematical expression is meant to clarify the meaning of the reference to substantially equal path lengths.

Moreover, the respondent duly notified in its letter of 27 August 2001, filed one month before the oral proceedings, both its intention to file the above amendment, to make it clear that the scope of protection had not been extended compared to the scope of claim 1 as granted as required under Article 123(3) EPC, and its precise wording.

For these reasons the Board considered that the amendment effected by the respondent in claim 1 of its main request at the beginning of the oral proceedings in an attempt to overcome objections of the adverse party and identical to the amendment announced in its earlier letter, did not confront the appellant with any new issue of substance, which it could not reasonably have been expected to deal with adequately during the oral proceedings.

Accordingly, the Board admitted the main request into the procedure.

3. *Interpretation of claim 1 of the respondent's main request*

3.1 The patent in suit relates generally to optical instruments for measuring displacement in which variations in position of a diffraction grating are detected by making diffracted light interfere, using the moving diffraction grating as a scale.

According to the introductory portion of the specification of the patent, prior art optical instruments of this type were known, which incorporated an inexpensive light source such as a semiconductor laser device, with a poor wavelength stability. However, in order that these optical systems could manifest desired characteristics, it was absolutely necessary to adjust them such that the optical path lengths of the two light beams made to interfere always vary equally. If this were not the case, phase variations in interference signals would be provoked by variations in wavelength at the same time as phase variations due to displacement of the diffraction grating, giving rise to measurement errors. Accordingly, a high precision supporter for an optical system or a positioning jig it was thought necessary.

Furthermore, the use of a well coherent light source required the provision of expensive non-reflection coatings on optical parts to avoid stray interference from unnecessary reflected light beams (see page 2 of the specification, lines 2 to 40).

The specification then states that the object of the invention is to provide an optical instrument for measuring displacement, **"which avoids the adjustment difficulties described above"** (see page 2, lines 45 to 46, emphasis added). This optical instrument comprises the features of claim 1.

The following passage of the specification then links the coherency of the light source to variation in visibility of the interference pattern: **"Preferably the coherency is such that the variation in visibility of the interference pattern allows detection of non-substantially equal optical path lengths i.e. path lengths which are sufficiently unequal with regard to wavelength fluctuations in the light source that otherwise undetectable errors could result from such wavelength variations"** (see the paragraph bridging pages 2 and 3, emphasis added).

In conjunction with the description of the embodiment disclosed in the patent, the specification further indicates that whilst for a well coherent light source visibility is not lost even if the difference between the two optical path lengths is great, in the case where a light source whose coherency is not so good is used, it is known that visibility of interference fringes changes when the difference between the two optical path lengths varies. The invention is explicitly said to have been made by applying this principle (see page 3, lines 42 to 49).

In the following passage, the specification discloses the relationship between the necessary precision of the optical path adjustment and the wavelength variations which result from temperature variations. The relation

$$0.1\mu m > \frac{\Delta\lambda}{\lambda^2} \cdot 2 \cdot \Delta\ell \cdot \frac{P}{4}$$

which is the basis for the expression for Δl in claim 1, expresses that the measuring error induced by the wavelength variation as represented in the right-hand part of the relation should be smaller than the required measurement precision of the apparatus, which is 0.1 µm in the example. This leads to a tolerance of about 70 µm for the optical path length difference Δl in this example (see page 3, line 50 to page 4, line 8).

The description then further specifies that in order that such difference can be monitored it is necessary to use a light source having suitable coherency, **"for which visibility does not vary too much for Δl smaller than this value"**, because it is difficult to manipulate the device when it is too sensitive to Δl. When a suitable semiconductor laser device is used according to the invention, these conditions are fulfilled and it is possible to obtain variations in modulation for suitable variations in Δl, that is, to detect variations in difference between the two optical path lengths as variations in modulation (see page 4, lines 9 to 15, emphasis added).

A relation between the difference Δl between the two optical path lengths and the amplitude modulation of interference signals, which is representative of the interference visibility, as obtained experimentally by means of the device of the above example is represented

in Figure 2. This figure shows that the coherency of the multimode semiconductor laser is such that the amplitude modulation of interference signals varies between maximum and about half maximum values for Δl smaller than the calculated value of 70 µm.

Finally, the specification stresses that Figure 2 shows that adjustment of the optical path lengths can be effected with fairly high precision, and that when use of a single mode laser device is desired, a multimode laser device is used only during adjustment of the optical system and after completion of the adjustment, it can be replaced by the original single mode laser device (see page 4, lines 19 to 25).

Thus, it emerges from the specification of the patent in suit that the invention is mainly concerned with adjustment of the optical path lengths in a device as defined in the preamble of claim 1. In order to permit achievement of an adjustment such that the measurement error caused by temperature-induced wavelength variations in operation of the apparatus cannot exceed the required precision of the apparatus, a laser source is selected which has a coherency low enough to allow for variations in optical path length difference being detected as variations in the visibility of the fringes produced by the interfering light beams. The coherency of the laser shall be such that the optical path length difference at which there is a marked reduction of the fringe visibility does not exceed the value Δl defined in accordance with the relation given in the specification.

This ensures that after proper adjustment of the optical elements - obviously in such a way as to achieve maximum fringe visibility, which according to the specification is easier when the latter does not vary too much within the permitted range for the

optical path difference - the temperature-induced measurement error resulting from so adjusted optical path difference will always remain smaller than the required measurement precision of the apparatus.

3.2 It is a generally accepted principle that patent claims should be construed in a fair manner, that is as they can reasonably be expected to be understood by a skilled person in the light of his general knowledge and of the teaching in the patent specification, and so far as possible in a way which does not result in evident technical contradictions, both within the claims themselves and in relation to the specification.

Such evident internal contradiction would result from the interpretation proposed by the appellant, to the effect that the definition in claim 1 of the maximal path length difference by reference to the mathematical relation expresses something other than the statement that the optical path lengths are substantially equal. This interpretation would in fact contradict the very wording of the claim, which makes it clear that **the mathematical relation is intended merely to explain the meaning of the expression substantially equal** ("... have optical path lengths which are substantially equal, that is to say have optical path lengths which differ in length by an amount Δl where ...").

Another point of divergence between the parties relates to the proper construction of the reference in claim 1 to the coherency of the light source being such as to enable said diffracted beams to interfere with one another only when they have optical path lengths meeting certain conditions. The appellant, relying in particular on the definition of the coherence length given in document D12 as "the longest path difference at which interferences still arise", submitted that

this reference meant that for any optical path difference outside the permitted range fringe visibility should be substantially zero, and not at a half maximum value as shown in Figure 2 of the patent.

In the board's view, however, the skilled person is well aware of the fact, illustrated also by Figure 2 of the patent in suit, that fringe visibility varies progressively with changing optical path length differences, there being no precisely defined optical path length difference at which the fringes abruptly disappear. The skilled person also understands that for the proper adjustment of the optical path lengths, which is a main concern of the subject-matter of the patent in suit, the operator would as a matter of course set the optical elements so as to obtain maximum fringe visibility, or a degree of visibility which is not markedly reduced as compared to the maximum obtainable visibility. This is confirmed by the remark in the specification of the patent in suit that visibility shall not vary too much in the permissible range for the optical path length difference (see page 4, lines 9 to 12). It is also implicit that in order to achieve the desired effect of avoiding that the optical path length difference be set at a value which could allow for excessive temperature-induced measurement errors, it is both necessary and sufficient that **a poor adjustment outside the permitted range for the optical path length difference should manifest itself by a marked reduction of fringe visibility**, (e.g. to about half the maximum value in accordance with the example of Figure 2 of the patent).

An interpretation that fringe visibility should be zero outside the permitted range for the optical path length difference, which the appellant considers to follow from the implication in claim 1 that the beams "only

interfere" within that range, would however result in a large variation of visibility of the fringes in the permitted range (i.e. from zero to maximum). Such an interpretation would thus both contradict the requirement of the description that this variation should not be too large, and result in a technically unjustified limitation.

3.3 Accordingly, claim 1 must in the board's view and on the basis of the description of the patent as read by the skilled person be construed to the effect that:

(i) the reference to the diffracted beams being enabled to interfere with one another only when the optical path lengths meet certain conditions means that outside the permitted range for the optical path lengths fringe visibility is markedly reduced as compared to the maximum achievable value; and

(ii) the definition of the permitted optical path length difference by way of the mathematical relation merely explains the meaning of the expression "substantially equal" referred to also in the claim.

3.4 Incidentally, the question of whether the commercial device demonstrated at the oral proceedings is encompassed by claim 1 as so interpreted is of no relevance to the present decision, and it need not therefore be considered further.

4. *Clarity*

When construed in the above manner, claim 1 does not comprise any technically contradictory definitions of the permitted optical path differences, and it is also supported by the specification.

The board is also satisfied that the parameters in the mathematical relation, in particular the "required measurement precision t" and the "temperature variation" result in a clear definition of the claimed subject-matter. As a matter of fact, the measurement precision of the type of optical instrument concerned can easily be ascertained, for instance using a further instrument as a calibration means, and the specification of temperature operation range is conventional in the field as was convincingly submitted by the respondent.

Accordingly, the subject-matter of claim 1 as amended in accordance with the main request is considered to meet the requirements of Article 84 EPC.

5. *Compliance of the amendments made to the patent with the provisions of Article 123(2) and (3) EPC*

5.1 Claim 1 of the respondent's main request corresponds in substance to claim 1 as originally filed with the additional specification of the use of two photodetectors, as was set out e.g. in claim 5 as originally filed.

The claim was also supplemented with the reference to the diffracted beams being enabled to interfere with one another only when their optical path lengths are substantially equal, that is to say have optical path lengths which differ in length by an amount Δl as defined by the relation set out at the end of the claim.

For the reasons indicated under point 3 above, these features are adequately supported by the specification of the patent. The description as originally filed is in this respect substantially identical and it therefore also adequately supports the amendment.

As compared to claim 1 as granted, claim 1 of the respondent's main request was actually limited in scope, by deletion of the alternative involving more than two diffracted beams.

The addition at the end of the claim of a statement specifying the meaning of the reference in claim 1 as granted to the diffracted beams having substantially equal optical path lengths is an explanation which does not extend the scope of protection afforded by the claim.

5.2 Dependent claims 2 and 3 of the respondent's main request correspond to claims 2 and 3 as granted. The remaining dependent claims 4 and 5 as granted were deleted.

5.3 The description was adapted for consistency with claim 1 as amended, in accordance with the provisions of Rule 27(1)(c) EPC, and a clerical error in the formula at the top of page 4 was corrected in conformity with the corresponding expression in the description as originally filed (see page 7, line 10).

5.4 For these reasons, the patent documents in accordance with the respondent's main request meet the requirements of Article 123(2) and (3) EPC.

6. *Novelty*

6.1 None of the prior art citations in the file which relate to an optical measuring instrument involving interference of light beams diffracted by a movable diffraction grating as set out in substance in the preamble of claim 1 discloses the use of a multimode semiconductor laser device as a light source.

The instrument disclosed in document D1 comprises a helium-neon laser (see page 6, lines 30 to 35).

The instrument disclosed in document D6 also comprises a helium-neon gas laser, reference being made to an unstabilised multimode laser source emitting relatively monochromatic light (see column 4, lines 13 to 18 and column 5, lines 62 to 65). The embodiment of Figure 4 comprises a source of white light (see column 6, lines 1 and 2). The statement in the introductory portion of this document as relied upon by the appellant that "an inexpensive reliable solid state light source can be used **rather than the laser source** used in other interferometers and a flash light bulb can work in certain configurations" (see column 2, lines 17 to 20) thus suggests in the board's view the use of a non-laser source, like e.g. the semiconductor diode of documents D8, D19 or S01 as explained below.

Document D7 discloses a helium-neon gas laser source, as a cheap multimode laser (see English translation page 11, the first sentence of the last paragraph and the last full sentence on page 13).

The light source in the instrument of document D8 may be a semiconductor diode, an incandescent lamp or a non-specified laser source 57 (see column 4, lines 5 to 8). Such laser source as represented in Figure 1 comprises a resonant cavity and is not of the multimode semiconductor type.

Document D12 only specifies with respect to the light source that it shall "produce light of a complex degree of coherence and variable phases" (see page 1, lines 68 to 71), which suggests a non-laser device, e.g. a semiconductor diode as disclosed in document D19, of which bibliographical reference 77 is a German patent

application corresponding to document D12 (see document D19, page 93, the first sentence below the figure and page X, reference 77).

Finally, the optical instrument of document S01 comprises a laser diode which is specified throughout the document to emit "monochomatic light" (see the English translation, page 1, the third sentence from the end of the first paragraph, the first sentence on page 3, or the last sentence of the second paragraph on page 4 indicating that the light source need only be a coherent monochromatic light with a single wavelength). This document does not therefore disclose the use of a **multimode** semiconductor laser device as an adequate light source.

6.2 The prior art on the file also comprises a number of citations which disclose multimode semiconductor laser devices as light sources, albeit only in conjunction with the reading of optical video or audio discs (see documents D13, the last sentence of the second paragraph on page 2 of the English translation; D17, the title; D18 the abstract), with laser-Doppler anemometry (see document D15, the title) or with fibre-optic transmission (see document D14, the title and the second paragraph of the introduction on page 155).

6.3 The remaining citations on the file do not come closer to the subject-matter of claim 1 which, accordingly, is novel within the meaning of Article 54 EPC.

7. *Inventive step*

7.1 The board concurs with the opposition division's view, not contested by the parties, that document D1 as cited in the introductory portion of the patent in suit discloses the closest prior art instrument as defined

in the preamble of claim 1. This prior art instrument, like most of those commercially available at the date of the patent as was submitted by the respondent comprises a helium-neon gas laser as a light source.

Document D19, which was proposed by the appellant as an alternative starting point for the assessment of inventive step is considered less relevant, because the only specific construction disclosed in this PhD thesis includes a non-laser diode as a light source, the possibility and interest of using non-coherent and poorly collimated light sources instead of laser devices being consistently emphasised throughout the document (see page 39, the penultimate paragraph; page 56, the first sentence of paragraph 4.3, and the first sentence at the bottom of the figure on page 93).

The closest prior art instrument disclosed in document D1 is stressed therein as operating with a **zero** optical path difference in such a way as to eliminate the influence of temperature-induced wavelength variations (see page 2, lines 5 to 13 and 22 to 27).

In contrast, the patent in suit proposes that a multimode semiconductor laser be used as a light source, with a coherency such as to enable the diffracted beams to interfere with one another only when they have optical path lengths which are substantially equal, that is to say have optical path lengths which differ in length by an amount Δl as defined by the relation set out in the characterising portion of claim 1.

7.2 The substitution for the known helium-neon laser of a semiconductor laser device as a light source already *per se* results in a considerable reduction of the cost

and size of the apparatus. In addition, for the reasons explained in details in the specification (see point 3 above) the specific selection of the semiconductor laser device such that its coherency meets the conditions set out in the characterising portion of claim 1 allows for an adjustment of the optical path lengths with fairly high precision, which overcomes the necessity of providing a high precision support structure for the optical system or positioning jig, thus leading to further cost reductions and to the avoidance of troubles in use of the apparatus. Furthermore, the use of a less coherent laser source reduces the occurrence of stray interference signals due to unnecessary reflected, highly coherent light beams, so that expensive non-reflection coatings need no longer be provided on optical parts (see the specification of the patent, page 2, lines 33 to 40).

Thus, the technical problem solved by the invention as determined objectively from a consideration of the differences between the closest prior art and the claimed subject-matter, and formulated so as not to contain pointers to the solution, is to reduce the size and cost of the optical displacement measuring device of document D1.

7.3 The board can agree with the appellant's line of arguments in as much as the idea of replacing the helium-neon gas laser of document D1 by a semiconductor laser device must be considered obvious. The use of such semiconductor laser device in the type of measuring instruments concerned here is in fact disclosed in document S01 (see the first paragraph on page 1 of the translation) and the possibility of using such device is also briefly mentioned in document D19 (see page 56, the first sentence of paragraph 4.3).

The present board's view in respect of the obviousness of the idea of using a semiconductor laser device in the type of measuring instrument concerned here is in full agreement with the findings in decision T 747/96 as referred to by the appellant in its argumentation. In this decision, which relates to a patent granted on a divisional application of the present patent, the board in a different composition stated that using the beam of a semiconductor laser device in the instrument of document D19 was an obvious compromise having regard to coherency of light, cost reduction and miniaturization (see point 4.1 of the Reasons, the second paragraph).

However, contrary to the claims at issue in the above decision, which were directed to another aspect of the invention not relating to the limitations concerning the multimode character of the semiconductor laser device nor any limitation as to its coherency, claim 1 of the present patent recites such limitations.

These limitations, in particular the multimode character of the semiconductor laser device, are essential to the claimed invention and, in the board's view they are not suggested in an obvious way by the prior art on the file.

Document S01 explicitly addresses the problem of the relatively great temperature instability which is intrinsic to semiconductor lasers, and it reaches the conclusion that "the technology for stabilising the semiconductor laser wavelengths has yet to reach a level at which it can be applied to practical use and an accurate alignment method in detection of optics must be devised" (see page 11 of the English translation and in particular the last sentence of the penultimate paragraph). This document thus suggests directions of technical developments, namely improving

the stability of the semiconductor laser device and the accuracy of alignment of the optical system, which point clearly away from the simple solution of the patent in suit, according to which a multimode semiconductor laser device should be selected with a coherency such as to ensure that the visibility of interference fringes is markedly reduced whenever the adjusted optical path lengths difference happens to be greater than a limit beyond which temperature variations in the operation range of the instrument could induce measurements errors in excess of the required measurement precision.

The other prior art references describing an optical instrument of the type concerned by the patent and relied upon by the appellant, namely documents D6, D7, D8 and D12 do not hint at using a multimode semiconductor laser device as an adequate light source, neither do they establish any technical relationship between the coherency of the laser source on the one hand and the avoidance of temperature-induced measurement errors on the other.

The appellant further relied upon a number of citations directed either to laser anemometry (document D15), to fibre-optic transmission (D14) or to the reading of optical video discs (documents D13, D17 and D18). These citations do indeed disclose multimode semiconductor laser sources and in the appellant's view they are also closely related to the art of interferometry.

The respondent however convincingly argued that the technical difficulties encountered in the development of interferometric measuring devices, in particular in terms measurement accuracy and the avoidance of errors by temperature-induced wavelength variations, are not encountered in any comparable acuity in laser anemometry, fibre-optic transmission or in the optical

disc technology. The skilled person therefore in the board's view had no obvious reason, if not with the benefit of hindsight, to contemplate the teaching of the documents referred to by the appellant, in the expectation of a solution to the problem underlying the claimed subject-matter.

In addition, the relevant teaching of documents D13, D14, D17 and D18 in the board's view boils down to the recognition that the low degree of coherence of multimode semiconductor laser device is advantageous in as much as it reduces the noise caused by a high degree of coherence of a single mode laser, as a result for instance of stray light reflections (see document D13, page 2 of the English translation, lines 12 to 22; document D14, the second paragraph of the introduction on page 155; document D17, the paragraph VI on pages 2919 and 2920; document D18, the two first paragraphs on page 58). Even if this teaching were actually applied to the closest prior art device of document D1, in order merely to avoid the necessity for expensive non-reflection coatings on optical parts, this would still not provide any solution to the problem of the temperature dependent measurement errors caused by such poorly temperature-stabilised devices, in the absence of any consideration of the coherency these devices exhibit. As a matter of fact, the appellant did not demonstrate that any multimode semiconduction laser would automatically fulfil the coherency requirement of claim 1, nor did it even seek to do so.

Finally, document D15, which is also directed to semiconductor diode sources for the quite different technical field of laser-Doppler anemometry (see the title), where temperature-dependent wavelength variations would not appear to be of any comparable concern, is the sole citation establishing a link

between a short coherence length of the light emitted by these sources and adjustment of the optical path difference.

The document states in this respect that because of the short coherence length of the diode laser, the anemometer design shown in Figure 1 incorporates nearly equal optical paths and means to adjust the path-length difference for optimum signal quality. Doppler signals will obviously not be observed for path-lengths differences exceeding the coherence length due to the absence of interference fringes in the control volume. Moreover, the path lengths for the two beams are adjusted initially so as to produce visible fringes (see page 836, the second paragraph of the left-hand column and lines 19 to 24 of the right-hand column).

When read without the knowledge of the invention, these statements in the board's view only express that owing to low coherency of the multimode semiconductor laser source, precise adjustment of the optical path length difference is necessary, otherwise no visible fringes can be produced. This teaching does not however suggest that in an optical displacement measuring device a multimode semiconductor device should be purposefully selected with a coherency such as to ensure marked reduction of the fringe visibility when the optical path lengths difference is such that the measurement errors produced by temperature variations in the operation range of the apparatus can exceed the required precision, as set out in substance in present claim 1.

7.4 For the above reasons, the subject-matter of claim 1 in accordance with the respondent's main request involves an inventive step within the meaning of Article 56 EPC.

The same conclusion applies to the subject-matter of claims 2 and 3, by virtue of their dependence from claim 1.

8. Since, taking into consideration the amendments made, the patent and the invention to which it relates meet the requirements of the Convention, maintenance of the patent amended in accordance with the respondent's main request can be decided (see Article 102(3) EPC).

Consideration of its auxiliary requests is not therefore necessary.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the first instance with the order to maintain the patent on the basis of the respondent's main request, i.e. with the following documents:

Claims 1 to 3 as filed during the oral proceedings of 27 September 2001;

Description pages 2, 3 and 5 to 9 as annexed to the decision under appeal and page 4 as filed during the oral proceedings of 27 September 2001;

Figures 1 to 16 as annexed to the decision under appeal.

The Registrar: The Chairman:

P. Martorana A. Klein