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Datasheet for the decision of 18 August 2011

Case Number: T 1783/07 - 3.4.03

Application Number: 03758298.8

Publication Number: 1547211

IPC: H01S 3/13

Language of the proceedings: EN

Title of invention:
Frequency stabilized laser system comprising phase modulation of backscattered light

Applicant:
Renishaw plc

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 123(2)

Relevant legal provisions (EPC 1973):
EPC Art. 84, 54, 56

Keyword:
"Novelty and inventive step (yes) - after amendment"

Decisions cited:
-

Catchword:
-

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Case Number: T 1783/07 - 3.4.03

D E C I S I O N
of the Technical Board of Appeal 3.4.03
of 18 August 2011

Appellant: Renishaw plc
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 29 May 2007 refusing European patent application No. 03758298.8 pursuant to Article 97(1) EPC 1973.**

Composition of the Board:

Chairman: G. Eliasson
Members: V. L. P. Frank
P. Mühlens

Summary of Facts and Submissions

I. This is an appeal from the refusal of application 03 758 298 for the reason that the laser system according to claim 1 of all the requests was not new (Article 54 EPC 1973).

II. Oral proceedings before the board were held in the absence of the appellant applicant.

The appellant applicant requested in writing that the decision under appeal be set aside and that a patent be granted on the basis of claims 1 to 8 of the main request filed with letter of 23 February 2011, or on the basis of one of the auxiliary requests 1 to 3 filed with letter of 14 July 2011.

III. Independent claim 1 of the appellant's main request reads as follows (the differences with respect to the version of the independent claim of the main request refused by the examining division was highlighted by the board):

"1. A laser system comprising
a laser source (10, 70) for producing a laser beam (12, 71) along a beam path;
~~means to stabilize the frequency~~ **frequency stabilization means** (26, 28, 30) **which receives light diverted out of the beam path** to stabilize the frequency of the laser beam;
at least one optical component (20, 75) **in the beam path** which produces back-scattered light when in use;

a phase modulator (40, 50, 60, 62, 82) **in the beam path** for modulating the phase of the back-scattered light **in order to reduce the effect of the back-scattered light on the frequency stabilization means,**
characterised in that the phase modulator imposes a cyclically changing path length into the beam path."

IV. The following prior art documents are cited in this decision:

D1: US 5 535 003 A

D3: US 4 815 806 A

Document D3 was submitted by the appellant applicant with the letter dated 23 February 2011.

V. The examining division found that the Michelson interferometer with scanning mirror in the laser system of D1 was suitable for modulating any light, especially also the light back-scattered to the laser. It concluded therefore that the claimed laser system was not new with regard to D1.

VI. The appellant applicant argued essentially as follows:

– The system of claim 1 was distinguished from document D1, as the phase modulator lied in the beam path, whereas the frequency stabilization means received light diverted out of the beam path. In contrast, in D1, the scanning mirror 35 of the Michelson interferometer, which according to the

examining division corresponded to the phase modulator, formed part of the frequency stabilization means and did not lie in the beam path.

– Document D3 addressed the issue of avoiding the establishment of standing waves. This was done by adjusting the path length to a new static value, eg by moving a screw attached to the reflector. There was no need to have a continuous cyclic change in the path length.

– The cyclic change in the present invention solved the problem of producing a stabilization system which addressed a wider range of causes of instability. It prevented instability caused by the imbalance between sub-beams as well as the standing waves described in D3.

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments*

2.1 Claim 1 of the main request has been amended to clarify that the frequency stabilization means receive light diverted out from the beam path, that the one optical component and the phase modulator are located in the beam path and that the phase modulator reduces the effect of the back-scattered light on the frequency stabilization means. These amendments are based on the whole disclosure of the application and, in particular, Figures 1, 2 and 7 and page 7, lines 4 to 20.

2.2 Claim 1 of the main request also requires that the phase modulator imposes a cyclically changing path length into the beam path. This feature was consistently disclosed in all the embodiments of the application as published (page 4, line 15; page 5, lines 23 and 34; page 6, line 7; page 9, lines 12 and 22; page 10, line 29 and in particular page 10, lines 32 to 33).

2.3 The board thus considers that these amendments are clear and do not introduce subject-matter extending beyond the content of the application as published (Article 84 EPC 1973 and 123(2) EPC).

3. *Novelty (Article 54 EPC 1973)*

3.1 Document D1 discloses a laser stabilization system comprising frequency stabilization means which receives light (beam P1) diverted out of the beam path (beam P2). The frequency stabilization means comprises an interferometric device in which in one arm a scanning mirror 35 is attached to a piezoelectric device 36. The mirror 35 is swept according to a ramp wave applied to the piezoelectric device. The partial beam P3 reflected by the scanning mirror 35 interferes with the partial beam P4 reflected by a fixedly mounted staggered mirror 34. The staggered mirror 34 is formed by two surfaces A and B which differ by an amount of stagger L. The two detectors 41 and 42 receiving the interfering sub-beams output a fringe scan signal with an optical path difference of near zero for detector 41 and of about 2L for detector 42. These two output signals are used to

determine and stabilize the laser's wavelength (column 5, lines 4 to 56; Figure 1)

3.2 Although the scanning mirror 35 of D1 can be equated to the phase modulator of claim 1, as done by the examining division, the scanning mirror 35 is part of the stabilization means and is not located in the beam path, as required by claim 1, but in the path of the light diverted out of the beam path, ie beam P1. This difference is not merely accidental, but follows from the fact that in D1 the phase modulator is an integral part of the interferometer and cannot be taken out of it.

The laser system of claim 1 of the main request is thus new with respect to document D1.

3.3 Document D3 discloses a system for launching light into an optical fibre. The system includes means for suppressing the establishment of an interfering standing wave in the laser cavity. This is achieved, according to the second embodiment of document D3, by preventing that light which is reflected back into the laser cavity from establishing a standing wave by using a variable optical path length unit 22 in the beam path. Unit 22 may include an optical reflector 32 capable of reflecting incident light (either light emerging form the laser 1 or back-reflected by lens 10). The position of reflector 32 relative to laser 1 and lens 10 may be varied by a translating member 31 attached to the reflector. In an exemplary embodiment a screw is attached to the reflector 32 and rotated to decrease the likelihood that an interfering standing wave is

established (column 1, lines 24 to 53, column 4, lines 3 to 22; Figure 3).

3.4 Document D3 does not disclose that the reflector 32 imposes a cyclically changing path length into the beam path as required by the characterizing portion of claim 1.

The laser system of claim 1 of the main request is thus also new with respect to document D3.

4. *Inventive step (Article 56 EPC 1973)*

4.1 Only document D3 addresses the issue of reducing the effects of back-scattered light. The claimed laser system differs from the system disclosed by this document in that:

(a) the kind of frequency stabilization means are not explicitly disclosed, and

(b) the phase modulator imposes a cyclically changing path length into the beam path.

4.2 It is not necessary to consider feature (a), since the board is of the view that feature (b) involves an inventive step.

4.3 The effect achieved by feature (b) is as follows: According to the application, back-scattered light interferes with the reference portions 22a and 22b of each beam. As a consequence, the readings of the photodiodes 24a and 24b of the frequency stabilization system are affected by stray light which has been back-

scattered from other components in the fibre optic system. This results in that the frequency stabilization system compensates for differences which do not exist, hence destabilizing the system. By introducing a phase modulator in the beam path, the interference of the back-scattered light with the reference beam is now cyclically changing. As the response time of the frequency stabilization means is lower than the phase change of the back-scattered light, it acts like a low frequency bandpass filter reducing the influence of the back-scattered light on the frequency stabilization means (page 3, lines 16 to 34; column 6, line 34 to page 7, line 20; Figure 1).

4.4 The reflector 32 of D3, which could be equated to the phase modulator of claim 1, is moved by screw 31 to avoid the formation of an interfering standing wave (column 4, lines 14 to 22). As the appellant applicant pointed out, there is no need to have a continuous cyclic change in the path length for achieving this effect, since a standing wave is established only when a distance is a multiple of the wavelength. Once the distance differs from this value there is no need to vary it further, much less in a cyclic manner.

4.5 On the other hand, the scanning mirror 35 of D1 is cyclically moved back and forth so that detectors 41 and 42 produce fringe scan signals a and b from which the laser's wavelength can be derived (column 6, expressions 1 and 2). However, this is only possible while the phase modulator (ie the scanning mirror 35) is part of the interferometric frequency stabilizing system of D1. Taking the phase modulator out from the

interferometer and placing it in the beam path does not make technical sense.

4.6 Documents D3 and D1 address different technical problems (ie the avoidance of a standing interfering wave in D3 and the determination of the laser's wavelength in D1). Their combination does not lead to the present invention, but to a laser system in which the frequency stabilization system would comprise the interferometric device of D1 and in which the back-scattered light would be dealt with by the reflector of D3. There is no reason for the skilled person to modify the laser system of document D3 so that the reflector 35 is moved cyclically without knowledge of the present invention.

4.7 The board finds, for the above reasons, that the laser system of claim 1 of the main request involves an inventive step within the meaning of Article 56 EPC 1973.

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 grant a patent in the following version:

Claims:
1 to 8, filed with letter of 23 February 2011.

Description:
pages 1 and 6 filed with letter of 17 October 2005,
pages 1a and 2, filed with letter dated 23 February 2011,
pages 3 to 5 and 7 to 10 as published.

Drawings:
sheets 1 to 4 as published.

Registrar | Chair

S. Sánchez Chiquero | G. Eliasson