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Datasheet for the decision of 5 September 2022

Case Number: T 1440/19 - 3.4.03

Application Number: 10739129.4

Publication Number: 2394336

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Language of the proceedings: EN

Title of invention:
APPARATUS AND METHOD FOR UTILIZATION OF A HIGH-SPEED OPTICAL WAVELENGTH TUNING SOURCE

Applicant:
The General Hospital Corporation

Headword:

Relevant legal provisions:
EPC Art. 52(1), 56, 123(2)

Keyword:
Amendments - added subject-matter (no)
Inventive step - (yes)

Decisions cited:

Catchword:

Europäisches Patentamt
European Patent Office
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Beschwerdekammern

Boards of Appeal

Chambres de recours

Boards of Appeal of the
European Patent Office
Richard-Reitzner-Allee 8
85540 Haar
GERMANY
Tel. +49 (0)89 2399-0
Fax +49 (0)89 2399-4465

Case Number: T 1440/19 - 3.4.03

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 5 September 2022

Appellant: (Applicant)	The General Hospital Corporation 55 Fruit Street Boston, MA 02114 (US)
Representative:	Ortlieb, Alexander Maiwald Patentanwalts- und Rechtsanwaltsgesellschaft mbH Elisenhof Elisenstraße 3 80335 München (DE)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 27 November 2018 refusing European patent application No. 10739129.4 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	T. Häusser
Members:	S. Ward
	G. Decker

Summary of Facts and Submissions

I. The appeal is against the decision of the Examining Division to refuse European patent application No. 10 739 129 on the grounds that the subject-matter of the main request and the first to fourth auxiliary requests then on file did not meet the requirements of Article 123(2) EPC.

The grant of a patent based on auxiliary request 4A (referred to by the Examining Division as "auxiliary request 5") had been proposed in a communication under Rule 71(3) EPC dated 23 July 2018. However, the applicant (now the appellant) disapproved the text intended for grant and maintained all requests (letter dated 29 October 2018).

The Examining Division also refused requests to amend the description and for a second oral proceedings.

II. (i) At the end of the oral proceedings held before the Board the appellant requested as a main request that the decision under appeal be set aside and that a patent be granted in the following version:

Description:
Pages 1 to 12 as submitted during oral proceedings before the Examining Division on 26 June 2018

Claims:
Numbers 1 to 3 according to the main request, received during oral proceedings on 5 September 2022 as auxiliary request 7

Drawings:
Sheets 1/6 to 6/6 as published.

(ii) Alternatively, the appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of the claims according to the previous main request or one of auxiliary requests A, B, 1, 1A, 1B, 2, 2A, 2B, 3, 4, 4A, 5 and 6, in this order of preference, filed with the statement of grounds of appeal (previous main request, auxiliary requests 1, 2, 3, 4, 4A and 5) and with the letter dated 5 August 2022 (auxiliary requests A, B, 1A, 1B, 2A, 2B and 6).

III. The following documents are referred to:

D3: OH W Y ET AL: "115 kHz tuning repetition rate ultrahigh-speed wavelength-swept semiconductor laser", OPTICS LETTERS, Optical Society Of America, Washington, DC, US, vol. 30, no. 23, 1 December 2005, pages 3159 to 3161, ISSN: 0146-9592, DOI: 10.1364/OL.30.003159

D4: DE 10 2004 051 147 A1

IV. (i) Claim 1 of the main request (filed during oral proceedings before the Board as auxiliary request 7) reads as follows:

"An apparatus comprising:
a source comprising a laser, wherein the laser has a short length unidirectional ring resonator cavity comprising a semiconductor optical amplifier (SOA) gain medium (100) and at least one arrangement which is a high-finesse wavelength tuning filter (1') and which is in a resonator of the laser, wherein the wavelength

tuning filter comprises a rotating polygon scanning mirror (700), a diffraction grating (220), a telescope comprising a set of lenses (260, 262) and wherein the wavelength tuning filter further comprises two end reflectors (280, 282), wherein the end reflectors are configured to generate four reflections on the polygon mirror via two double passes;
wherein the arrangement is configured to, periodically and as a function of time, select at least one first electro-magnetic radiation based on a mean frequency of the at least one first electro-magnetic radiation, the periodic selection being performed at a first characteristic period, wherein the mean frequency varies linearly over time, characterized in that the apparatus further comprises:
a time interleaving optical delay line (400) and a booster optical amplifier (500), which are at an output port of the source, wherein the time interleaving optical delay line (400) receives an output of the output port; the output having continuous wavelength sweeps which are separated from each other by idle portions;
wherein the time interleaving optical delay line (400) is configured to generate one or more delayed copies of the output and paste the delayed copies to the output and into the idle portions to fill up the idle portions;
wherein the apparatus is configured to emit, using the output having the pasted copies, at least one second electromagnetic radiation that has a spectrum whose mean frequency changes periodically as a function of time with a second characteristic period, and
wherein the first characteristic period is greater than the second characteristic period and the second characteristic period is 1/(N+1) times the first

characteristic period, wherein N is a number of the copies."

Reasons for the Decision

1. The appeal is admissible.

In the following all paragraph numbers refer to the description as originally filed.

2. *Main request: Article 123(2) EPC*

2.1 Claim 1 is based on claim 13 as originally filed, paragraph [0007] of the description and the embodiment of Figs. 1 and 2 and the related passages of the description, especially paragraphs [0026] to [0032].

2.2 The final feature of claim 1 ("the second characteristic period is 1/(N+1) times the first characteristic period, wherein N is a number of the copies") is not explicitly disclosed in this form. However, this relationship is disclosed for two specific examples. In the first example in paragraph [0029] the second characteristic period is 1/16 times the first characteristic period, and the idle period is exactly filled up by 15 pasted copies (in the terminology of the claim, N = 15 and 1/(N+1) = 1/16). In the second example in paragraph [0031], and depicted in Fig. 2, the second characteristic period is 1/4 times the first characteristic period and the idle period is exactly filled up by 3 pasted copies (in the terminology of the claim, N = 3 and 1/(N+1) = 1/4). It would be evident to the skilled reader that these numbers are merely exemplary, and that, for arbitrary

values of N, the process of filling up the idle period according to the manner disclosed in Fig. 2 would imply that the second characteristic period is 1/(N+1) times the first characteristic period, wherein N is the number of copies.

2.3 Claims 2 and 3 are based on claims 15 and 16 as originally filed, and the description has been suitably adapted to the claims of the current main request.

2.4 The Board therefore judges that the main request meets the requirements of Article 123(2) EPC.

3. *Inventive step*

3.1 Document D3, which discloses a wavelength swept semiconductor laser using a polygon mirror scanner, is seen as the closest prior art. The apparatus of D3 provides a laser output as shown in Fig. 3(a). In the terminology of the present application this output would correspond to the "first electro-magnetic radiation" and the cycle period of each of the four cycles depicted in Fig. 3(a) would correspond to the "first characteristic period".

3.2 The apparatus of claim 1 of the present main request differs from D3 in at least the following features:

"a time interleaving optical delay line (400) and a booster optical amplifier (500), which are at an output port of the source, wherein the time interleaving optical delay line (400) receives an output of the output port; the output having continuous wavelength sweeps which are separated from each other by idle portions;

"wherein the time interleaving optical delay line (400) is configured to generate one or more delayed copies of the output and paste the delayed copies to the output and into the idle portions to fill up the idle portions;
"wherein the apparatus is configured to emit, using the output having the pasted copies, at least one second electromagnetic radiation that has a spectrum whose mean frequency changes periodically as a function of time with a second characteristic period, and
"wherein the first characteristic period is greater than the second characteristic period and the second characteristic period is 1/(N+1) times the first characteristic period, wherein N is a number of the copies."

3.3 In order to establish the technical effect of these features, the Board will briefly review the functioning of the polygon mirror wavelength tuning filter of the present application.

3.4 As shown in Fig. 1 of the application, radiation from the short length unidirectional ring resonator cavity (2') is incident on a diffraction grating (220), where it is diffracted into beams each having essentially a single respective wavelength (two of the beams at wavelengths λ_1 and λ_N are depicted), and the beams are incident on a polygon mirror (700) via lenses (260, 262). The beams are then reflected between the polygon mirror and the end reflectors (280, 282). For any given rotational position of the polygon mirror, only a single beam (in Fig. 1, the beam having a wavelength λ_N) is reflected back to the grating to form an output via the beam-splitter (240). Hence, as the polygon rotates, an output having a sweep of wavelengths is generated.

3.5 When the gain in the laser cavity supports lasing over a bandwidth at least as great as the maximum wavelength sweep of the polygon mirror, the apparatus can generate an output at each facet position during the entire facet-to-facet period, and hence the output would have a 100% duty cycle. When the gain bandwidth is less than the wavelength sweep of the polygon mirror, there would be some facet positions corresponding to an output wavelength which does not fall within the gain bandwidth of the laser. For these rotational positions of the polygon mirror no output would be generated, resulting in corresponding idle periods and a duty cycle of less than 100%. For example, paragraph [0029] describes an apparatus where the gain in the laser cavity supports lasing over ~104 nm bandwidth and a "continuous wavelength sweep over about 104 nm can be obtained with about 6.25% duty cycle"; in paragraph [0031] the duty cycle is 25%.

3.6 The present invention deals with arrangements having a duty cycle less than 100% with idle portions in the output (claim 1: "the output having continuous wavelength sweeps which are separated from each other by idle portions"). For a duty cycle of less than 100%, the time required to scan the wavelengths within the gain bandwidth (the wavelength sweep period) may be relatively short (corresponding to the width of the pulses in the left-hand diagram of Fig. 2, and referred to in the claim as the "second characteristic period"), whereas the time between such scans (the scan repetition period) may be considerably longer (corresponding to the pulse-to-pulse period in the left-hand diagram of Fig. 2, and referred to in the claim as the "first characteristic period").

3.7 Hence, the scan repetition period may be undesirably long compared to the wavelength sweep period, or alternatively stated, the scan repetition rate may be relatively low compared to the wavelength sweep rate.

3.8 It is explained in paragraphs [0027] and [0028] that in "the conventional approach, a polygon scanning mirror with a large number of facets can be used to increase the tuning repetition rate", but that this measure has the undesirable effect of reducing the wavelength sweep rate.

3.9 The Board is therefore satisfied that the technical problem solved by the distinguishing features may be seen as that alluded to by the appellant in the letter dated 5 August 2022 (page 15, final paragraph; page 16, first two paragraphs), namely to increase the scan repetition rate of the system while providing a sufficiently high wavelength sweep rate.

3.10 This problem is plausibly solved by the distinguishing features, according to which a time interleaving optical delay line is configured to generate one or more delayed copies of the output and paste the delayed copies to the output and into the idle portions to fill up the idle portions in the claimed manner. This would leave the wavelength sweep rate unchanged, but would increase the repetition rate, for example by a factor of 16 in the arrangement of paragraph [0029], and by a factor of 4 in the arrangement of paragraph [0031].

3.11 It would not be obvious to the skilled person to arrive at the distinguishing features of claim 1 on the basis of the available prior art. The system of D3 is configured to operate at a 100% duty cycle (see Fig. 3(a) and page 3161, left-hand column, final

paragraph), and there would be no motivation to provide the claimed time interleaving optical delay line for filling up idle portions in the output, since no such idle portions exist in D3.

3.12 D4 discloses an optical pulse multiplier for generating a pulse train for use in a laser range finder or in communications engineering. There is no disclosure or hint that the device may be used in wavelength swept laser arrangements or to solve the above objective problem. The other documents cited in examination are remote from the invention as now defined by claim 1 of the main request.

3.13 The Board therefore concludes that the subject-matter of claim 1 of the main request involves an inventive step within the meaning of Articles 52(1) and 56 EPC. The subject-matter of dependent claims 2 and 3 of the main request also involves an inventive step, at least by virtue of the dependencies of these claims. The description has been satisfactorily adapted.

3.14 In view of the conclusions set out in the previous point, it is not necessary for the Board to examine the lower ranking requests (see above, point II(ii)).

4. *Other matters*

4.1 In the letter dated 29 October 2018 (page 2, fourth paragraph) the applicant requested oral proceedings in the event that the Examining Division intended to refuse the then main request. This request was refused under Article 116(1), second sentence, EPC, since oral proceedings before the Examining Division had already been held on 26 June 2018, and the new request amounted to a request for further oral proceedings before the

same department where the party and the subject of the proceedings were the same.

The appellant has not objected to this decision, nor does the Board see any reason to raise an objection of its own motion.

4.2 For the avoidance of doubt, it is noted that the appellant confirmed explicitly in oral proceedings before the Board that pages 13 to 15 of the description filed during oral proceedings before the Examining Division are not part of the description according to the present main request, which comprises pages 1 to 12 only.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the Examining Division with the order to grant a patent in the following version:

Description:
Pages 1 to 12 as submitted during oral proceedings before the Examining Division on 26 June 2018

Claims:
Numbers 1 to 3 according to the main request, received during oral proceedings on 5 September 2022 as auxiliary request 7

Drawings:
Sheets 1/6 to 6/6 as published.

The Registrar: The Chairman:

S. Sánchez Chiquero T. Häusser

Decision electronically authenticated