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(71) Applicant and

(72) Inventor: **GAN, Lahav** [IL/IL]; 11/4 Keli Hachoresch, Neshet 36870 (IL).

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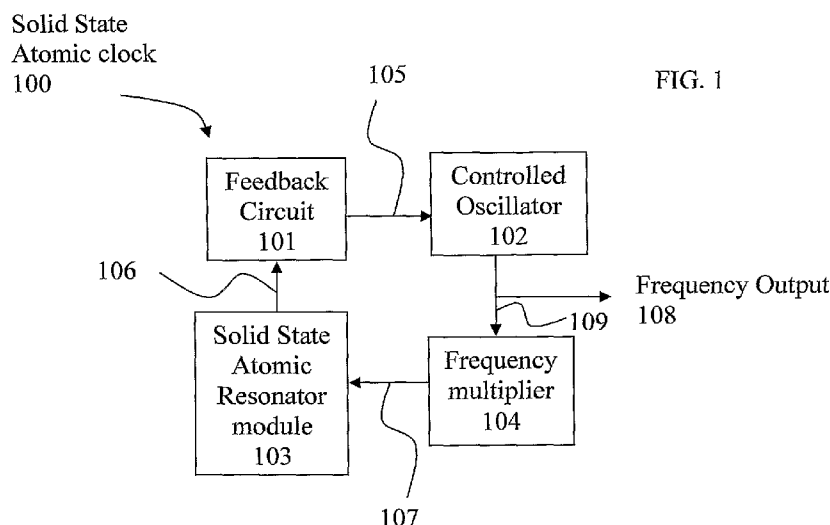
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- with international search report (Art. 21(3))
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5 November 2009

(54) Title: DEVICE, SYSTEM, AND METHOD OF FREQUENCY GENERATION USING AN ATOMIC RESONATOR



(57) Abstract: A solid state atomic clock may utilize quantum states capable of exhibiting a hyperfine resonance in order to generate a frequency standard. A device capable of coupling a free running oscillator to the hyperfine resonance frequency in order to generate output signal is described herein. In some aspect of the invention, the atomic clock may be fabricated on a silicon substrate and it may be integrated, in chip scale, as part of an electronic integrated circuit. The principal of operation, the method of making and system which utilized a solid state atomic clock are also disclosed.

INTERNATIONAL SEARCH REPORT

International application No
PCT/IL2009/000131

A. CLASSIFICATION OF SUBJECT MATTER
INV. H03L7/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H03L G04F H01S

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	MATAN KAHANOV ET AL: "An atomic clock based on a VCSEL-driven CPT resonance and a small 87Rb vapor cell" CLEO '07. 2007 CONFERENCE ON LASERS AND ELECTRO-OPTICS 5-11 MAY 2007 BALTIMORE, MD, USA, OSA, PISCATAWAY, NJ, USA, 1 May 2007 (2007-05-01), pages 1-2, XP031203354 ISBN: 978-1-55752-834-6 the whole document ----- -/--	1-14,16

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *&* document member of the same patent family

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26 June 2009

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Name and mailing address of the ISA/
European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Aouichi, Mohamed

INTERNATIONAL SEARCH REPORT

International application No

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	R. LUTWAK ET AL: "THE CHIP-SCALE ATOMIC CLOCK COHERENT POPULATION TRAPPING VS. CONVENTIONAL INTERROGATION" 34TH ANNUAL PRECISE TIME AND TIME INTERVAL (PTTI) MEETING, [Online] 3 December 2002 (2002-12-03), - 5 December 2002 (2002-12-05) pages 539-550, XP002533933 Retrieved from the Internet: URL:http://www.pttmeeting.org/archivemeetings/2002papers/paper52.pdf [retrieved on 2009-06-24] page 539 - page 547, line 3	1-14,16
X	US 6 300 841 B1 (ATSUMI KEN [JP] ET AL) 9 October 2001 (2001-10-09) column 6, line 66 - column 16, line 13; figures 1-3	1-14,16
A	CHARLES SANTORI ET AL: "Coherent Population Trapping of Single Spins in Diamond under Optical Excitation" PHYSICAL REVIEW LETTERS, [Online] vol. 97, no. 247401, 15 December 2006 (2006-12-15), pages 247401-1-247401-4, XP002534171 Retrieved from the Internet: URL:http://scitation.aip.org/getpdf/servlet/GetPDFServlet?filetype=pdf&id=PRLTA0000097000024247401000001&idtype=cvips&prog=normal [retrieved on 2009-06-24] the whole document	1-4,16
A	CHARLES SANTORI ET AL: "Coherent population trapping in diamond N-V centers at zero magnetic field" OPTICS EXPRESS, [Online] vol. 14, no. 17, 21 August 2006 (2006-08-21), XP002533934 Retrieved from the Internet: URL:http://www.opticsinfobase.org/DirectPDFAccess/12743E3E-BDB9-137E-C17D362EF785ADE1_97689.pdf?da=1&id=97689&seq=0&CFID=43920600&CFTOKEN=53189687 [retrieved on 2009-06-24] the whole document	1-14,16

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL2009/000131

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers allsearchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search reportcovers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-14, 16

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-14,16

A solid state atomic frequency generator for providing an output frequency related to the hyperfine resonance frequency of color centers of the solid state resonator.

2. claims: 15,17

A system comprising a plurality of components.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IL2009/000131

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6300841	B1	JP 3780123 B2	31-05-2006
		JP 2001036405 A	09-02-2001