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(54) Title: HIGH-POWER CW FIBER-LASER

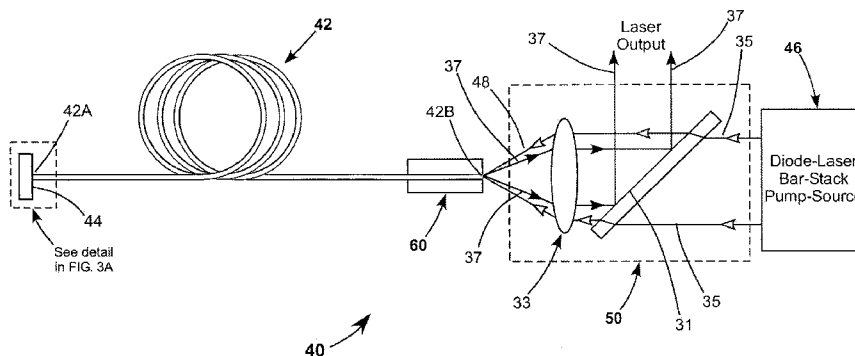


FIG. 3

(57) Abstract: A CW fiber-laser includes a gain fiber (42) having a reflector (44) proximity-coupled to one end (42A), with the other end left (42B) uncoated. A laser resonator is defined by the reflector (44) and the uncoated end (42B) of the gain-fiber. Pump-radiation from two fast-axis diode-laser bar stacks (46) is combined and focused into the uncoated end (42B) of the gain-fiber for energizing the fiber. Laser radiation (37) resulting from the energizing is delivered from the uncoated end of the gain-fiber and separated from the pump-radiation by a dichroic mirror (31). A coupler (60) is provided at the uncoated end (42B) of the fiber to absorb pump light not guided in the cladding of the fibre (42).

WO 2012/122012 A3

INTERNATIONAL SEARCH REPORT

International application No PCT/US2012/027445

A. CLASSIFICATION OF SUBJECT MATTER		
INV. H01S3/042	H01S3/067	H01S3/08
ADD. H01S3/094	H01S3/105	H01S5/40
H01S3/0941		
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) H01S B23K G02B		
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 practicable, search terms used) EPO-Internal, COMPENDEX, INSPEC, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	JOHN MINELLY ET AL: "Al-glass kW fibre laser end-pumped by MCCP-cooled diode stacks", 2011 CONFERENCE ON LASERS AND ELECTRO-OPTICS EUROPE AND 12TH EUROPEAN QUANTUM ELECTRONICS CONFERENCE (CLEO EUROPE/EQEC), 1 May 2011 (2011-05-01), pages 1-1, XP55027386, DOI: 10.1109/CLEOE.2011.5943192 ISBN: 978-1-45-770533-5 page 1; figure 1	1,10,12, 15,16
X	----- US 2006/280208 A1 (BAEV VALERY [DE] ET AL) 14 December 2006 (2006-12-14)	1-4,9, 15,16
Y	paragraphs [0004], [0005], [0034] - [0058]; figures 1,4 -----	1-14, 17-21
-/--		
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> 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	"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	
"E" earlier application or patent but published on or after the international filing date	"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	
"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)	"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	
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family	
"P" document published prior to the international filing date but later than the priority date claimed		
Date of the actual completion of the international search	Date of mailing of the international search report	
17 September 2012	01/10/2012	
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 Laenen, Robert	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/027445

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 all searchable 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 report covers 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.:

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.

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2012/027445

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WANG Y ET AL: "Analysis of Raman and thermal effects in kilowatt fiber lasers", OPTICS COMMUNICATIONS, NORTH-HOLLAND PUBLISHING CO. AMSTERDAM, NL, vol. 242, no. 4-6, 8 December 2004 (2004-12-08), pages 487-502, XP027254704, ISSN: 0030-4018 [retrieved on 2004-11-30]	1-4,9,10,15,16
Y	page 487, left-hand column - page 494, left-hand column, paragraph 2; figures 1-3; tables 1,2	1-14,17-21
Y	----- US 2009/190218 A1 (GOVORKOV SERGEI V [US] ET AL) 30 July 2009 (2009-07-30) paragraphs [0025] - [0043]; figures 1,2; tables 1-3	11-14,20,21
Y	----- US 2007/172174 A1 (SCERBAK DAVID G [US] ET AL SCERBAK DAVID GERALD [US] ET AL) 26 July 2007 (2007-07-26) paragraphs [0020], [0036] - [0042]; figures 1,2,4,6	5-8,17-19
Y	----- US 2010/247055 A1 (ARASHITANI YOSHIHIRO [JP] ET AL) 30 September 2010 (2010-09-30) paragraphs [0033] - [0038], [0066] - [0069]; figure 7	19

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No PCT/US2012/027445

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2006280208 A1	14-12-2006	DE 10302031 A1 EP 1586143 A2 US 2006280208 A1 WO 2004066456 A2	23-09-2004 19-10-2005 14-12-2006 05-08-2004

US 2009190218 A1	30-07-2009	US 2008019010 A1 US 2009190218 A1 WO 2008010966 A2	24-01-2008 30-07-2009 24-01-2008

US 2007172174 A1	26-07-2007	NONE	

US 2010247055 A1	30-09-2010	CN 101854020 A EP 2251943 A2 US 2010247055 A1	06-10-2010 17-11-2010 30-09-2010

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

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

1. claims: 1-4, 9-16, 20, 21

Claims 1-4,9-16,20,21 comprise in common a gain-fiber having first and second opposite ends and having a fundamental emission wavelength for laser radiation, the gain-fiber providing optical gain over a characteristic gain-bandwidth;a laser resonator defined by the first end of the gain-fiber and a mirror proximity-coupled to the second end of the gain-fiber;a source of optical pump-radiation having a pump-radiation wavelength;the mirror being highly reflective for wavelengths within the gain-bandwidth of the fiber, highly reflective for the pump-radiation wavelength, and highly transmissive for radiation having wavelengths longer than the gain-bandwidth;an optical arrangement configured to focus at least a substantial portion of the pump-radiation into the first end of the gain-fiber thereby causing laser-radiation at a natural wavelength within the gain-bandwidth to be generated in the laser-resonator, and delivered from the first end of the gain-fiber as output radiation.

2. claims: 5-8, 17-19

Claims 5-8,17-19 comprise in common a gain-fiber having first and second opposite ends and having a fundamental emission wavelength for laser radiation, the gain-fiber providing optical gain over a characteristic gain-bandwidth;a laser resonator defined by the first end of the gain-fiber and a mirror proximity-coupled to the second end of the gain-fiber;a source of optical pump-radiation having a pump-radiation wavelength;the mirror being highly reflective for wavelengths within the gain-bandwidth of the fiber, highly reflective for the pump-radiation wavelength, and highly transmissive for radiation having wavelengths longer than the gain-bandwidth;an optical arrangement configured to focus at least a substantial portion of the pump-radiation into the first end of the gain-fiber thereby causing laser-radiation at a natural wavelength within the gain-bandwidth to be generated in the laser-resonator, and delivered from the first end of the gain-fiber as output radiation; andwherein a length of the gain-fiber immediately adjacent the first end thereof is surrounded by a coupling unit, the coupling unit being configured to absorb any pump-radiation not coupled into the end of the fiber, strip out pump-radiation propagating in the second cladding of the fiber, and provide cooling in the region of the gain-fiber surrounded thereby.
