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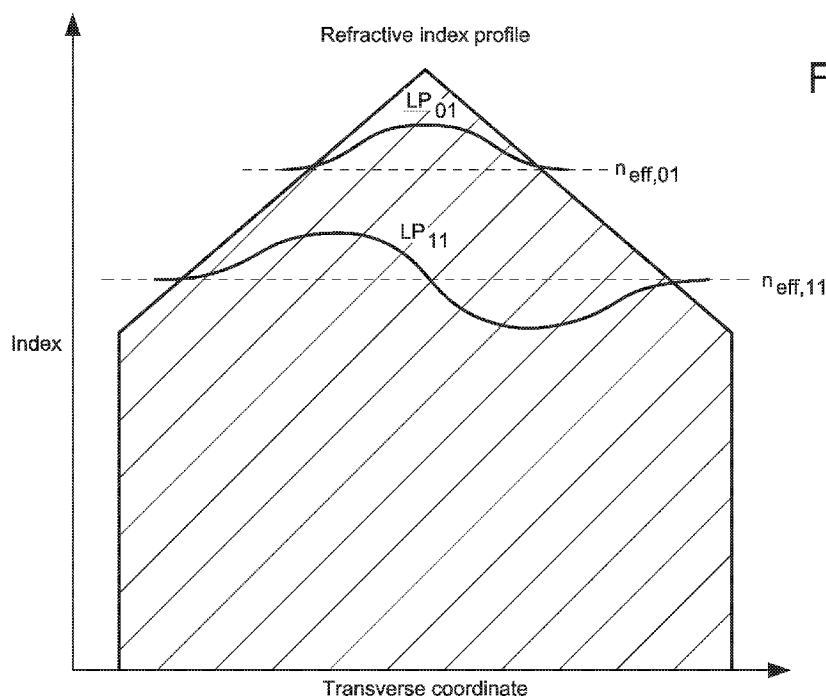
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TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— of inventorship (Rule 4.17(iv))

(54) Title: LMA FIBERS FOR SUPPRESSION OF THERMAL MODE INSTABILITY



(57) Abstract: An optical fiber, such as in some instances a high-power, diode-pumped, dual-clad, ytterbium-doped fiber amplifier (YDFAs), having a fundamental mode and at least one higher order mode, wherein the higher order mode or modes have mode areas that are substantially larger than a mode area of the fundamental mode.

Published:

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(88) Date of publication of the international search report:

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INTERNATIONAL SEARCH REPORT

International application No

PCT/US2017/042968

A. CLASSIFICATION OF SUBJECT MATTER

INV. G02B6/02 H01S3/067
ADD.

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)

G02B 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 practicable, search terms used)

EPO-Internal, 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	US 2009/324168 A1 (HOTOLEANU MIRCEA [FI] ET AL) 31 December 2009 (2009-12-31) paragraphs [0057], [0061]; figures 4-6 -----	1,21
X	US 2014/093205 A1 (GRUNER-NIELSEN LARS [DK] ET AL) 3 April 2014 (2014-04-03) paragraphs [0164] - [0167]; figure 5 -----	1,21
X	US 2003/174984 A1 (CHIANG KIN SENG [HK] ET AL) 18 September 2003 (2003-09-18) figures 1,2,3a,3b -----	1-3, 21-23
X	US 2015/192733 A1 (ABEDIN KAZI S [US] ET AL) 9 July 2015 (2015-07-09) paragraph [0003]; figures 3-7 ----- -/-	1,2,21, 22

☒ 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 application or patent but published on or after the international filing date

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Date of the actual completion of the international search

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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	US 2002/003926 A1 (ENOMOTO TADASHI [JP] ET AL) 10 January 2002 (2002-01-10) figures 1a,2,3,4a -----	1,2,21, 22
X	US 2009/092365 A1 (DONLAGIC DENIS [SI]) 9 April 2009 (2009-04-09) figures 3-7 -----	1-3, 21-23
X	US 2003/063629 A1 (DAVIS MONICA K [US] ET AL) 3 April 2003 (2003-04-03) paragraphs [0106], [0107]; figure 5 -----	1,21
X	US 2011/141555 A1 (FERMANN MARTIN E [US] ET AL) 16 June 2011 (2011-06-16) paragraphs [0052], [0061]; figure 1c -----	1,21

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2017/042968

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.:

1-3, 21-23

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: 1-3, 21-23

optical fiber with a fundamental mode and at least one higher order mode (HOM), the latter having mode area(s) larger than that of the fundamental mode, in particular more than 60/80% of the fundamental mode.

2. claims: 1, 4-7

optical fiber with a fundamental mode and at least one higher order mode, the latter having mode area(s) larger than a mode area of the fundamental mode, wherein the fibre has a core-diameter to wavelength ratio in a specific range; core-diameter to wavelength ratio. Claims 1, 6, 7 are treated as a sub-invention, directed to the specific numerical aperture of the fibre;

3. claims: 1, 8-12

optical fiber with a fundamental mode and at least one higher order mode, the latter having mode area(s) larger than a mode area of the fundamental mode, and wherein the fibre has a particular refractive index profile.

4. claims: 1, 13-19

optical fiber with a fundamental mode and at least one higher order mode, the latter having mode area(s) larger than a mode area of the fundamental mode and wherein specific properties of the gain doping region and their overlap with the mode(s) are defined.

5. claims: 1, 20, 21, 24

optical fiber with a fundamental mode and at least one higher order mode, the latter having mode area(s) larger than a mode area of the fundamental mode, or occupies a different space than that of the fundamental mode and wherein the optical fiber is a doped fiber amplifier.

6. claims: 21, 25-33

Optical fiber with a fundamental mode and at least one higher order mode, the latter having mode area(s) larger than a mode area of the fundamental mode, wherein the fibre has a core with tri-fold azimuthal symmetry.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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