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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/649,460	05/14/2013	8441721	C.A. White 17	5576

22046 7590 04/24/2013
Alcatel-Lucent USA Inc
600-700 Mountain Avenue
Docket Administrator - Room 3B-212F
Murray Hill, NJ 07974

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (application filed on or after May 29, 2000)

The Patent Term Adjustment is 648 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (<http://pair.uspto.gov>).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site <http://pair.uspto.gov> for additional applicants):

Christopher Alan White, Neshanic Station, NJ;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
 or **Fax (571)-273-2885**

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

22046 7590 01/10/2013
 Alcatel-Lucent USA Inc
 600-700 Mountain Avenue
 Docket Administrator - Room 3B-212F
 Murray Hill, NJ 07974



Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

<u>Patty Giebler</u>	(Depositor's name)
<u>Patty Giebler</u>	(Signature)
<u>4-4-13</u>	(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/649,460	12/30/2009	Christopher Alan White	C.A. White 17	5576

TITLE OF INVENTION: SYSTEM AND METHOD OF RAMAN AMPLIFIER PUMP CONTROL

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	~~\$420~~ \$1780	\$300	\$0	~~\$420~~ \$2080	04/10/2013

EXAMINER	ART UNIT	CLASS-SUBCLASS
HELLNER, MARK	3645	359-334000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. Use of a Customer Number is required.

2. For printing on the patent front page, list
 (1) the names of up to 3 registered patent attorneys or agents OR, alternatively,
 (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1. David M. LaBruno
 2. _____
 3. _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

ALCATEL LUCENT Paris, France

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

- ☒ Issue Fee
☒ Publication Fee (No small entity discount permitted)
☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): (Please first reapply any previously paid issue fee shown above)

- ☐ A check is enclosed.
☐ Payment by credit card. Form PTO-2038 is attached.
☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number 12-2325 (enclose an extra copy of this form).

5. Change in Entity Status (from status indicated above)

- ☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27. ☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature

Patty Giebler

Typed or printed name

Patty Giebler

Date 04/10/2013 HUONG2 00000050 122325 12649460
 01 FC:1501 1780.00 DA
 02 FC:1504 300.00 DA
 Registration No.

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

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PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: **Mail** Mail Stop ISSUE FEE
Commissioner for Patents
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Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

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22046 7590 01/10/2013
 Alcatel-Lucent USA Inc
 600-700 Mountain Avenue
 Docket Administrator - Room 3B-212F
 Murray Hill, NJ 07974



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Patty Giebler (Depositor's name)
Patty Giebler (Signature)
4-4-13 (Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/649,460	12/30/2009	Christopher Alan White	C.A. White 17	5576

TITLE OF INVENTION: SYSTEM AND METHOD OF RAMAN AMPLIFIER PUMP CONTROL

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	\$1700	\$300	\$0	\$2000	04/10/2013

EXAMINER	ART UNIT	CLASS-SUBCLASS
HELLNER, MARK	3645	359-334000

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☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. Use of a Customer Number is required.

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 (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

David M. LaBrune
 2 _____
 3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

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(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

ALCATEL LUCENT Paris, France

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

- ☒ Issue Fee
☒ Publication Fee (No small entity discount permitted)
☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): (Please first reapply any previously paid issue fee shown above)

- ☐ A check is enclosed.
☐ Payment by credit card. Form PTO-2038 is attached.
☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number 12-2325 (enclose an extra copy of this form).

5. Change in Entity Status (from status indicated above)

- ☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27. ☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature

Patty Giebler

Date

4-4-13

Typed or printed name

Patty Giebler

Registration No.

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

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NOTICE OF ALLOWANCE AND FEE(S) DUE

22046 7590 01/10/2013
Alcatel-Lucent USA Inc
600-700 Mountain Avenue
Docket Administrator - Room 3B-212F
Murray Hill, NJ 07974

EXAMINER

HELLNER, MARK

ART UNIT

PAPER NUMBER

3645

DATE MAILED: 01/10/2013

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/649,460	12/30/2009	Christopher Alan White	C.A. White 17	5576
TITLE OF INVENTION: SYSTEM AND METHOD OF RAMAN AMPLIFIER PUMP CONTROL				

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	\$1770	\$300	\$0	\$2070	04/10/2013

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

- A. If the status is the same, pay the TOTAL FEE(S) DUE shown above.
- B. If the status above is to be removed, check box 5b on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above, or

If the SMALL ENTITY is shown as NO:

- A. Pay TOTAL FEE(S) DUE shown above, or
- B. If applicant claimed SMALL ENTITY status before, or is now claiming SMALL ENTITY status, check box 5a on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and 1/2 the ISSUE FEE shown above.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

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(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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12/649,460	12/30/2009	Christopher Alan White	C.A. White 17	5576
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TITLE OF INVENTION: SYSTEM AND METHOD OF RAMAN AMPLIFIER PUMP CONTROL

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	\$1770	\$300	\$0	\$2070	04/10/2013

EXAMINER	ART UNIT	CLASS-SUBCLASS
HELLNER, MARK	3645	359-334000

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- 3 _____

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Authorized Signature _____

Date _____

Typed or printed name _____

Registration No. _____

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/649,460	12/30/2009	Christopher Alan White	C.A. White 17	5576

22046	7590	01/10/2013
Alcatel-Lucent USA Inc 600-700 Mountain Avenue Docket Administrator - Room 3B-212F Murray Hill, NJ 07974		

EXAMINER	
HELLNER, MARK	

ART UNIT	PAPER NUMBER
3645	

DATE MAILED: 01/10/2013

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 513 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 513 day(s).

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (<http://pair.uspto.gov>).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No.	Applicant(s)	
	12/649,460	WHITE, CHRISTOPHER ALAN	
	Examiner	Art Unit	
	MARK HELLNER	3645	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to the amendment filed 10/25/2012.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on ____; the restriction requirement and election have been incorporated into this action.

3. ☒ The allowed claim(s) is/are 1-24.

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
 a) ☐ All b) ☐ Some* c) ☐ None of the:
 1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).
 * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.

6. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
 (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
 1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
 (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

7. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892) 2. ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 3. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____ 4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material	5. ☐ Notice of Informal Patent Application 6. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ 7. ☐ Examiner's Amendment/Comment 8. ☐ Examiner's Statement of Reasons for Allowance 9. ☐ Other _____.
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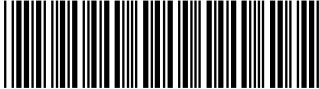
/Mark Hellner/ Primary Examiner, Art Unit 3645	
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Search Notes 	Application/Control No. 12/649,460	Applicant(s)/Patent under Reexamination WHITE, CHRISTOPHER ALAN	
	Examiner MARK HELLNER	Art Unit 3645	

SEARCHED			
Class	Subclass	Date	Examiner
359	334 337	12/23/2012	/MH/

INTERFERENCE SEARCHED			
Class	Subclass	Date	Examiner
359	334 337	12/23/2012	/MH/

SEARCH NOTES (INCLUDING SEARCH STRATEGY)		
	DATE	EXMR

Issue Classification 	Application/Control No.		Applicant(s)/Patent under Reexamination	
	12/649,460		WHITE, CHRISTOPHER ALAN	
	Examiner		Art Unit	
	MARK HELLNER		3645	

ISSUE CLASSIFICATION											
ORIGINAL					CROSS REFERENCE(S)						
CLASS		SUBCLASS			CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)					
359		334			359	337					
INTERNATIONAL CLASSIFICATION											
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- (Assistant Examiner) (Date)					/Mark Hellner/ Primary Examiner AU 3663 12/23/2012 (Primary Examiner) (Date)					Total Claims Allowed: 24	
(Legal Instruments Examiner) (Date)										O.G. Print Claim(s) 1	

☒ Claims renumbered in the same order as presented by applicant										☐ CPA		☐ T.D.		☐ R.1.47		
Final	Original		Final	Original		Final	Original		Final	Original		Final	Original		Final	Original
1	1			31			61			121			151			181
2	2			32			62			122			152			182
3	3			33			63			123			153			183
4	4			34			64			124			154			184
5	5			35			65			125			155			185
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7	7			37			67			127			157			187
8	8			38			68			128			158			188
9	9			39			69			129			159			189
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11	11			41			71			131			161			191
12	12			42			72			132			162			192
13	13			43			73			133			163			193
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16	16			46			76			136			166			196
17	17			47			77			137			167			197
18	18			48			78			138			168			198
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BIB DATA SHEET

CONFIRMATION NO. 5576

SERIAL NUMBER 12/649,460	FILING or 371(c) DATE 12/30/2009 RULE	CLASS 359	GROUP ART UNIT 3645	ATTORNEY DOCKET NO. C.A. White 17		
APPLICANTS Christopher Alan White, Neshanic Station, NJ; ** CONTINUING DATA ***** ** FOREIGN APPLICATIONS ***** ** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ** 01/21/2010						
Foreign Priority claimed ☐ Yes ☒ No 35 USC 119(a-d) conditions met ☐ Yes ☒ No Verified and Acknowledged <u>/MARK HELLNER/</u> Examiner's Signature		☐ Met after Allowance Initials	STATE OR COUNTRY NJ	SHEETS DRAWINGS 4	TOTAL CLAIMS 20	INDEPENDENT CLAIMS 5
ADDRESS Alcatel-Lucent USA Inc 600-700 Mountain Avenue Docket Administrator - Room 3B-212F Murray Hill, NJ 07974 UNITED STATES						
TITLE SYSTEM AND METHOD OF RAMAN AMPLIFIER PUMP CONTROL						
FILING FEE RECEIVED 2408	FEES: Authority has been given in Paper No. _____ to charge/credit DEPOSIT ACCOUNT No. _____ for following:		☐ All Fees			
			☐ 1.16 Fees (Filing)			
			☐ 1.17 Fees (Processing Ext. of time)			
			☐ 1.18 Fees (Issue)			
			☐ Other _____			
				☐ Credit		

Index of Claims 		Application/Control No. 12/649,460		Applicant(s)/Patent under Reexamination WHITE, CHRISTOPHER ALAN	
		Examiner MARK HELLNER		Art Unit 3645	

✓	Rejected	—	(Through numeral) Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

Claim		Date						
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Serial No. 12/649460

**IN THE UNITED STATES
PATENT AND TRADEMARK OFFICE**

Patent Application

Inventor(s): Christopher A. White

Attorney Docket No: C.A. White 17

Serial No.: 12/649460 Group Art Unit: 3645

Filing Date: December 30, 2009 Confirmation No.: 5576

Title: System and Method Of Raman Amplifier Pump Control

**COMMISSIONER FOR PATENTS
P.O. BOX 1450
ALEXANDRIA, VA 22313-1450**

SIR:

Amendment & Response

In response to the Office Action dated July 25, 2012, please consider the following amendment and response for the above-identified application.

Claims

1. (Original) A method comprising:
 - receiving measured channel powers;
 - determining deviations of respective measured channel powers from respective target channel powers;
 - projecting the deviations into a space that defines Raman gain profiles achievable with a set of channels and pump lasers whereby projected deviations are formed; and
 - determining power setting values for the pump lasers based on the projected deviations.
2. (Original) The method of claim 1 further comprising:
 - applying the power setting values determined to the pump lasers.
3. (Original) The method of claim 2 wherein the method is repeated until the projected deviations satisfy a convergence criteria.
4. (Original) The method of claim 1 further comprising:
 - compensating the deviations for fiber propagation loss.
5. (Original) The method of claim 1 further comprising:
 - determining deviations that are not correctable based on the projected deviations; and
 - passing the deviations that are not correctable to a wavelength selectable switch for diagnostic purposes.
6. (Original) The method of claim 1 further comprising:
 - measuring channel power for a plurality of channels.
7. (Original) The method of claim 1 wherein determining power setting values comprises:
 - solving an optimization problem using the projected deviations.

8. (Original) The method of claim 7 wherein the optimization problem is a first-order optimization problem, a linear programming optimization problem, a steepest descent optimization problem, genetic optimization problem, or simulated annealing optimization problem.

9. (Original) A method comprising:

- removing a feature which cannot be corrected by the adjustment of a plurality of Raman pumps from a set of measured deviations from targeted optical channel powers; and

- optimizing power setting values for the plurality of Raman pumps based on a space of correctable changes, the space of correctable changes comprising the set of measured deviations from targeted optical channel powers after the feature is removed.

10. (Original) The method of claim 9 wherein optimizing power settings comprises:

- solving an optimization problem with use of the space of correctable changes to thereby determine the power setting values for the plurality of Raman pumps for subsequent use in setting one or more Raman pump powers.

11. (Original) The method of claim 10 wherein the optimization problem is a first-order optimization problem, a linear programming optimization problem, a steepest descent optimization problem, genetic optimization problem, or simulated annealing optimization problem and the like.

12. (Original) The method of claim 10 wherein the optimization problem is directed to determining one or more of the power setting values for the plurality of Raman pumps which substantially minimize the measured deviations from targeted optical channel powers after the feature is removed.

13. (Currently Amended) A method comprising:

- receiving power measurements for a plurality of optical channels;
- creating deviation measurements representing a difference between respective power measurements and corresponding power targets for the plurality of optical channels;

determining correctable deviations for the plurality of optical channels based on the deviation measurements, the correctable deviations being a correctable portion of a partition of the deviation measurements into the correctable portion and non-correctable portion; and

determining a pump setting for a plurality of pumps based upon the correctable deviations for each channel.

14. (Original) The method of claim 13 wherein the correctable deviations for respective optical channels depend on Raman pump gain profiles of a set of the plurality of pumps that address the respective optical channel and corresponding deviation measurements that are directed to the respective optical channel.

15. (Original) The method of claim 13 wherein determining correctable deviations comprises:

determining a correctable deviation vector Y_i , wherein $Y_i = \sum(j) P_{ij} E_j$ wherein i, j are channel numbers of one of the plurality of channels, P_{ij} is a projector into the space spanned by the column vectors of the Raman gain matrix, and E_j is the deviation measurement for channel j .

16. (Original) The method of claim 13 wherein determining a pump setting for a plurality of pumps comprises:

solving an optimization problem using the correctable deviations for each channel.

17. (Original) The method of claim 13 further comprising:

applying the pump setting for the plurality of pumps to the pumps.

18. (Original) The method of claim 13 further comprising:

determining non-correctable deviations for the plurality of optical channels based on the correctable deviations; and

forwarding the non-correctable deviations for subsequent use setting one or more optical channel powers.

19. (Original) An apparatus comprising:

a processor configured to receive measured channel powers and to determine deviations of respective measured channel powers from respective target channel powers, wherein the processor is further configured to project the deviations into a space that defines Raman gain profiles achievable with a set of channels and pump lasers whereby projected deviations are formed, and wherein the processor is further configured to determine power setting values for the pump lasers based on the projected deviations.

20. (Currently Amended) A non-transitory computer readable medium having stored thereon instructions comprising machine executable code which when executed by at least one processor, causes the processor to

receive power measurements for a plurality of optical channels;

create deviation measurements representing a difference between respective power measurements and corresponding power targets for the plurality of optical channels;

determining correctable deviations for the plurality of optical channels, the correctable deviations being a correctable portion of a partition of the deviation measurements into the correctable portion and a non-correctable portion; and

determining a pump setting for a plurality of pumps based upon the correctable deviations for each channel.

21. (New) The apparatus of claim 19 wherein the processor is configured to compensate the deviations for fiber propagation loss.

22. (New) The apparatus of claim 19 wherein the processor is configured to determine deviations that are not correctable based on the projected deviations; and

forward the deviations that are not correctable for diagnostic purposes.

23. (New) An apparatus comprising:

a processor configured to remove a feature which cannot be corrected by the adjustment of a plurality of Raman pumps from a set of measured deviations from targeted optical channel powers; and wherein the processor is further configured to optimize power setting values for the plurality of Raman pumps based on a space of

correctable changes, the space of correctable changes comprising the set of measured deviations from targeted optical channel powers after the feature is removed.

24. (New) An apparatus comprising:

- a processor and a memory unit associated with the processor, the processor configured to

- receive power measurements for a plurality of optical channels;

- create deviation measurements representing a difference between respective power measurements and corresponding power targets for the plurality of optical channels;

- determine correctable deviations for the plurality of optical channels based on the deviation measurements, the correctable deviations being a correctable portion of a partition of the deviation measurements into the correctable portion and non-correctable portion; and

- determine a pump setting for a plurality of pumps based upon the correctable deviations for each channel.

REMARKS

Claim Status

Claims 1-20 were pending.
Claims 1-12 and 19 were indicated to be allowable.
Claims 13, 14, 16, 17 and 20 were rejected.
Claims 15 and 18 were objected to.

Claims 21-24 are newly added
Claims 1, 9, 13, 19, 20, 23 and 24 are independent claims.
Claims 13 and 20 are amended herein.
Claims 1-24 are now pending.

Detailed Action

Allowable Subject Matter

Claims 1-12 and 19 were indicated to be allowable and Claims 15 and 18 were objected to as being dependent upon a rejected base claim, but allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Applicant appreciates the indications of allowable subject matter and further responds as follows.

Rejections under 35 U.S.C. § 102

Claims 13, 14, 16, 17 and 20 were rejected under 35 U.S.C. 102(b) as being anticipated by Seydnejad et al (6,590,700).

The applicant traverses the rejection with the submission of amended claims. In particular, note that claim 15, which recites a specific determining of a correctable deviation vector, is indicated to contain allowable subject matter.

Accordingly, claim 13 is amended to further state "the correctable deviations being a correctable portion of a partition of the deviation measurements into the correctable portion and a non-correctable portion". Support for the amended claim may be found in, for example, [0050], [0054] and [0073] of the specification. No new matter is added.

Seydnejad fails to teach or suggest determining a pump setting for a plurality of pump based on correctable deviations for each channel, and determining correctable deviations for the plurality of optical channels based on deviation measurements wherein the correctable deviations are a correctable portion of a partition of the deviation measurements into correctable and non-correctable portions. Therefore, applicant submits that claim 13 is distinguishable and patentable over Seydnejad.

Serial No. 12/649,460

Claims 14-18 depend from claim 13. Accordingly, based on at least claim dependency, applicant submits that claims 14-18 are likewise patentable over Seydnejad.

Claim 20 is amended to recite "determining correctable deviations for the plurality of optical channels, the correctable deviations being a correctable portion of a partition of the deviation measurements into the correctable portion and a non-correctable portion". Accordingly, it is submitted that claim 20 is patentable over Seydnejad for the reasons discussed above.

New Claims

Claims 21-24 are newly added. Support for the new claims may be found in through the specification including in particular original claims 4, 5, 9 and 13, No new matter is added. These claims are believed to be patentable over Seydnejad

Conclusion

For the reasons discussed above, all pending claims are allowable over the cited art. Reconsideration and allowance of all claims is respectfully requested.

Respectfully submitted

//David M La Bruno//
David M. La Bruno
Reg. # 46,266
908-582-3190

Date: October 25, 2012

Docket Administrator (Room 3B 212-F)
Alcatel-Lucent USA Inc.
600-700 Mountain Avenue
Murray Hill, NJ 07974
USA

Electronic Patent Application Fee Transmittal				
Application Number:		12649460		
Filing Date:		30-Dec-2009		
Title of Invention:		SYSTEM AND METHOD OF RAMAN AMPLIFIER PUMP CONTROL		
First Named Inventor/Applicant Name:		Christopher Alan White		
Filer:		David Michael La Bruno		
Attorney Docket Number:		C.A. White 17		
Filed as Large Entity				
Utility under 35 USC 111(a) Filing Fees				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Claims in excess of 20	1202	4	62	248
Independent claims in excess of 3	1201	2	250	500
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				748

Electronic Acknowledgement Receipt	
EFS ID:	14080157
Application Number:	12649460
International Application Number:	
Confirmation Number:	5576
Title of Invention:	SYSTEM AND METHOD OF RAMAN AMPLIFIER PUMP CONTROL
First Named Inventor/Applicant Name:	Christopher Alan White
Customer Number:	22046
Filer:	David Michael La Bruno
Filer Authorized By:	
Attorney Docket Number:	C.A. White 17
Receipt Date:	25-OCT-2012
Filing Date:	30-DEC-2009
Time Stamp:	19:06:21
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	\$748
RAM confirmation Number	6568
Deposit Account	122325
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees) Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)	

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)
Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)
Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment/Req. Reconsideration-After Non-Final Reject	White17-US-Amendment.pdf	42282	no	8
			8244c5b27917e689362301ae78e54b76174a0dddf		

Warnings:

Information:

2	Fee Worksheet (SB06)	fee-info.pdf	32073	no	2
			7a4c921b130c6b26896949c69961523853eebf24		

Warnings:

Information:

Total Files Size (in bytes):	74355
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This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875					Application or Docket Number 12/649,460		Filing Date 12/30/2009		☐ To be Mailed	
APPLICATION AS FILED – PART I										
(Column 1)			(Column 2)			SMALL ENTITY ☐ OR		OTHER THAN SMALL ENTITY		
FOR	NUMBER FILED	NUMBER EXTRA	RATE (\$)	FEE (\$)	OR	RATE (\$)	FEE (\$)			
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A				
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A				
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A				
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X \$ =			X \$ =				
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X \$ =			X \$ =				
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$250 (\$125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).									
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))										
* If the difference in column 1 is less than zero, enter "0" in column 2.										
APPLICATION AS AMENDED – PART II										
(Column 1)			(Column 2)			SMALL ENTITY OR		OTHER THAN SMALL ENTITY		
AMENDMENT	10/25/2012	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)	OR	RATE (\$)	ADDITIONAL FEE (\$)	
	Total (37 CFR 1.16(i))	* 24	Minus	** 20	= 4	X \$ =		OR	X \$62=	248
	Independent (37 CFR 1.16(h))	* 7	Minus	***5	= 2	X \$ =		OR	X \$250=	500
	☐ Application Size Fee (37 CFR 1.16(s))							OR		
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	748
AMENDMENT	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)	OR	RATE (\$)	ADDITIONAL FEE (\$)		
	Total (37 CFR 1.16(i))	*	Minus	**	=	X \$ =		OR	X \$ =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X \$ =		OR	X \$ =	
	☐ Application Size Fee (37 CFR 1.16(s))							OR		
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.										
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".										
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".										
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.										

Legal Instrument Examiner:
/STEFANIE BRYCE/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/649,460	12/30/2009	Christopher Alan White	C.A. White 17	5576
22046 7590 07/25/2012 Alcatel-Lucent USA Inc 600-700 Mountain Avenue Docket Administrator - Room 3B-212F Murray Hill, NJ 07974			EXAMINER HELLNER, MARK	
			ART UNIT 3645	PAPER NUMBER
			NOTIFICATION DATE 07/25/2012	DELIVERY MODE ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

narpatent@alcatel-lucent.com

Office Action Summary	Application No.		Applicant(s)	
	12/649,460		WHITE, CHRISTOPHER ALAN	
	Examiner		Art Unit	
	MARK HELLNER		3645	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).

Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1) ☐ Responsive to communication(s) filed on ____.

2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.

3) ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on ____; the restriction requirement and election have been incorporated into this action.

4) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

5) ☒ Claim(s) 1-20 is/are pending in the application.

5a) Of the above claim(s) ____ is/are withdrawn from consideration.

6) ☒ Claim(s) 1-12 and 19 is/are allowed.

7) ☒ Claim(s) 13, 14, 16, 17 and 20 is/are rejected.

8) ☒ Claim(s) 15 and 18 is/are objected to.

9) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

10) ☐ The specification is objected to by the Examiner.

11) ☐ The drawing(s) filed on ____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
 Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
 Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

12) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
 a) ☐ All b) ☐ Some * c) ☐ None of:
 1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. ____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)	4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. ____.
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)	5) ☐ Notice of Informal Patent Application
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date <u>12/30/2009</u> .	6) ☐ Other: ____.

DETAILED ACTION

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 13, 14, 16, 17 and 20 are rejected under 35 U.S.C. 102(b) as being anticipated by Seydnejad et al (6,590,700).

With respect to claim 13, Seydnejad et al disclose:

A method comprising:

receiving power measurements for a plurality of optical channels { this function is met by detector 10 }; creating deviation measurements representing a difference between respective power measurements and corresponding power targets for the plurality of optical channels { this function is met by error calculator 12 }; determining correctable deviations for the plurality of optical channels based on the deviation measurements { this function is met by the adaptive controller 14 operating on the Error Vector }; and determining a pump setting for a plurality of pumps based upon the correctable deviations for each channel { this function is met by the control variables being applied by the adaptive controller 14 to the optical amplifier 4 }.

Claim 14 is met by figures 3, 4 and 5.

Claims 16 and 17 are met by the signal processing taught by column 5, line 60 to column 10, line 22.

Claim 20 is anticipated by the operation of the teachings of Seydnejad et al applied to claim 13.

Allowable Subject Matter

Claims 15 and 18 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Claims 1-12 and 19 are allowed.

Claim 1 is allowable for at least reciting... “projecting the deviations into a space that defines Raman gain profiles achievable with a set of channels and pump lasers whereby projected deviations are formed...” within its whole context.

Claims 2-8 depend on claim 1.

The cited prior art does not teach or suggest “removing a feature which cannot be corrected by the adjustment of a plurality of Raman pumps from a set of measured deviations from targeted optical channel powers”.

As a result, claim 9 is allowable when taken in its whole context.

Claims 10-12 depend on claim 9.

The cited prior art does not teach or suggest a processor configured to project deviations into a space that defines Raman gain profiles achievable with a set of channels and pump lasers whereby projected deviations are formed.

As a result, claim 19 is allowable when taken in its entire context.

Any inquiry concerning this communication should be directed to MARK HELLNER at telephone number (571)272-6981.

Application/Control Number: 12/649,460
Art Unit: 3645

Page 4

/Mark Hellner/

Primary Examiner, Art Unit 3645

Notice of References Cited	Application/Control No. 12/649,460	Applicant(s)/Patent Under Reexamination WHITE, CHRISTOPHER ALAN	
	Examiner MARK HELLNER	Art Unit 3645	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-6,590,700	07-2003	Seydnejad et al.	359/341.4
*	B	US-2007/0258132	11-2007	Zhou et al.	359/334
*	C	US-2005/0219681	10-2005	Hayashi, Etsuko	359/334
*	D	US-2003/0151799	08-2003	Wight et al.	359/334
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	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
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	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
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	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes 	Application/Control No. 12/649,460	Applicant(s)/Patent under Reexamination WHITE, CHRISTOPHER ALAN	
	Examiner MARK HELLNER	Art Unit 3645	

SEARCHED			
Class	Subclass	Date	Examiner
359	334 337 337.1	7/10/2012	/MH/

INTERFERENCE SEARCHED			
Class	Subclass	Date	Examiner

SEARCH NOTES (INCLUDING SEARCH STRATEGY)		
	DATE	EXMR
East Text	7/10/2102	/MH/

Receipt date: 12/30/2009

PTO/SE/08a (07-09)

Approved for use through 07/31/2012. OMB 0651-2031

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Substitute for form 1449/PTO

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**

(Use as many sheets as necessary)

Complete if Known

Application Number	TBA
Filing Date	December 30, 2009
First Named Inventor	Christopher A White
Art Unit	TBA
Examiner Name	TBA
Attorney Docket Number	White 17

Sheet 1 of 2

U. S. PATENT DOCUMENTS

[illegible]

FOREIGN PATENT DOCUMENTS

[illegible]

Examiner
Signature

/Mark Hellner/

Date	Considered
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07/19/2012

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. *Applicant's unique citation designation number (optional). *See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 903.04. *Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). *For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. *Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. *Applicant is to place a check mark here if English language translation is attached.

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.34. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.H./

Receipt date: 12/30/2009

PTO/SB/099 (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Use as many sheets as necessary)		Complete if Known	
		Application Number	TBA
		Filing Date	December 30, 2009
		First Named Inventor	Christopher A White
		Art Unit	TBA
		Examiner Name	TBA
Sheet 2	of 2	Attorney Docket Number	White 17

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No. ¹	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	Y ²
		R. W. FREUND, Optimal Pump Control of Broadband Raman Amplifiers via Linear Programming, Bell Labs Technical Memorandum No. ITD-03-44004F, 2003.	

Examiner Signature	/Mark Hellner/	Date Considered	07/19/2012
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*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.
¹ Applicant's unique citation designation number (optional). ² Applicant is to place a check mark here if English language Translation is attached.
This collection of information is required by 37 CFR 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.H./

EAST Search History**EAST Search History (Prior Art)**

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	303	raman same (deviation or error) same pump	US-PGPUB; USPAT	OR	OFF	2012/07/10 15:54
L2	31631	vector with space	US-PGPUB; USPAT	OR	OFF	2012/07/10 15:54
L3	1	1 and 2	US-PGPUB; USPAT	OR	OFF	2012/07/10 15:54
L4	45533	vector with matrix	US-PGPUB; USPAT	OR	OFF	2012/07/10 15:55
L5	3	1 and 4	US-PGPUB; USPAT	OR	OFF	2012/07/10 15:55
L6	6	("5909305" "6008935" "6061173").PN. OR ("6590700").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2012/07/10 16:08

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Index of Claims 	Application/Control No. 12/649,460	Applicant(s)/Patent under Reexamination WHITE, CHRISTOPHER ALAN	
	Examiner MARK HELLNER	Art Unit 3645	

x	Rejected
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
12/649,460	12/30/2009	Christopher Alan White	C.A. White 17

CONFIRMATION NO. 5576

22046

Docket Administrator - Room 3D-201E

Alcatel-Lucent USA Inc.

600-700 Mountain Avenue

Murray Hill, NJ 07974

PUBLICATION NOTICE



OC000000048524604

Title:SYSTEM AND METHOD OF RAMAN AMPLIFIER PUMP CONTROL

Publication No.US-2011-0157687-A1

Publication Date:06/30/2011

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently <http://www.uspto.gov/patft/>.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	TOT CLAIMS	IND CLAIMS
12/649,460	12/30/2009	3663	1660	C.A. White 17	20	5

CONFIRMATION NO. 5576

UPDATED FILING RECEIPT



OC000000040745010

22046
Docket Administrator - Room 3D-201E
Alcatel-Lucent USA Inc.
600-700 Mountain Avenue
Murray Hill, NJ 07974

Date Mailed: 03/24/2010

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Applicant(s)

Christopher Alan White, Neshanic Station, NJ;

Power of Attorney: The patent practitioners associated with Customer Number 22046

Domestic Priority data as claimed by applicant

Foreign Applications

If Required, Foreign Filing License Granted: 01/21/2010

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 12/649,460**

Projected Publication Date: 06/30/2011

Non-Publication Request: No

Early Publication Request: No

Title

SYSTEM AND METHOD OF RAMAN AMPLIFIER PUMP CONTROL

Preliminary Class

359

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page 1 of 3

in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

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Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

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Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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IN THE UNITED STATES
PATENT AND TRADEMARK OFFICE

Declaration and Power of Attorney

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am an original, first and sole inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled **System And Method Of Raman Amplifier Pump Control** the specification of which

☐ is attached hereto

OR

☒ was filed on December 20, 2009 as Application Serial Number 12/649460

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by an amendment, if any, specifically referred to in this oath or declaration.

I acknowledge the duty to disclose all information known to me which is material to patentability as defined in Title 37, Code of Federal Regulations, 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

None

I hereby claim the benefit under Title 35, United States Code, 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

None

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States

Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

I hereby appoint Practitioners associated with Customer Number:

22046

as my Attorneys with full power of substitution and revocation, to prosecute said application, to make alterations and amendments therein, to receive the patent, and to transact all business in the Patent and Trademark Office connected therewith.

I hereby authorize these attorneys to insert in the above blanks the filing date and Application Serial Number when known.

Please address all correspondence to Alcatel-Lucent USA Inc., Docket Administrator - Room 2F-190, 600-700 Mountain Avenue, Murray Hill, New Jersey 07974-0636. Telephone calls should be made to **David M. La Bruno** by dialing **908-582-3190**.

Full name of sole inventor: **Christopher Alan White**

Inventor's signature *Christopher A. White* Date 11/11/2011

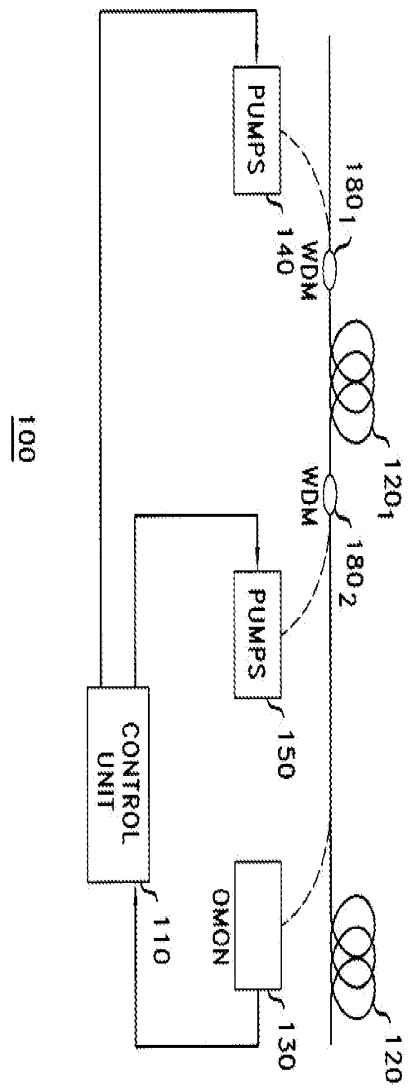
Residence: Neshanic Station, Somerset County, New Jersey

Citizenship: United States of America

Post Office Address: 301 Reyna Place
Neshanic Station, New Jersey, 08853

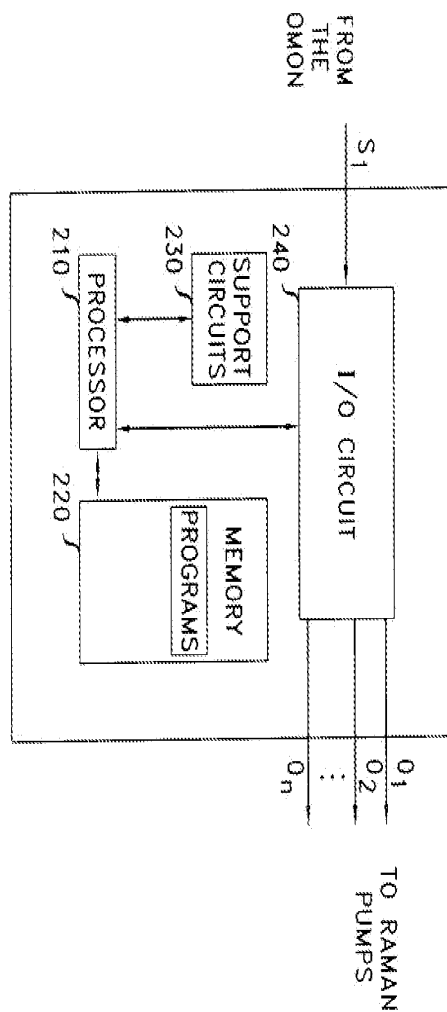
1/4

FIG. 1



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FIG. 2



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FIG. 3

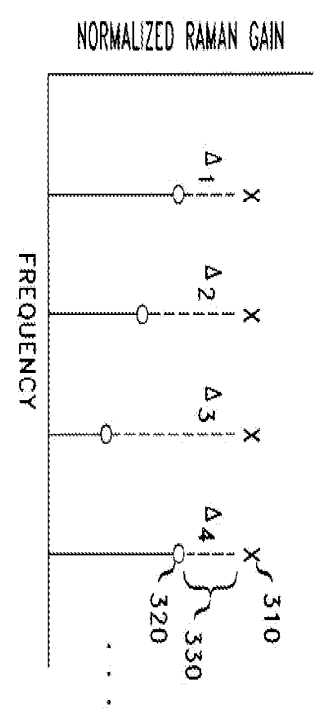
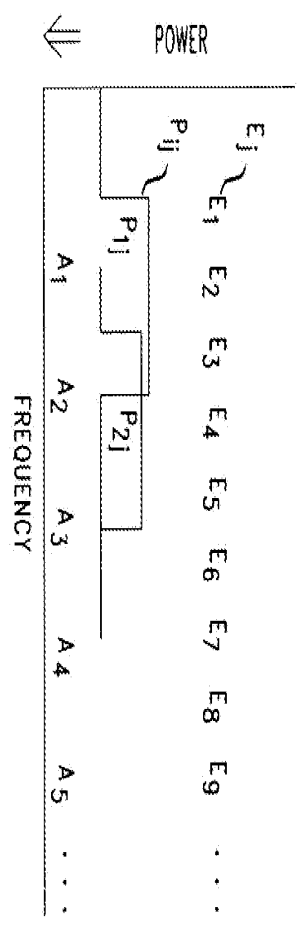
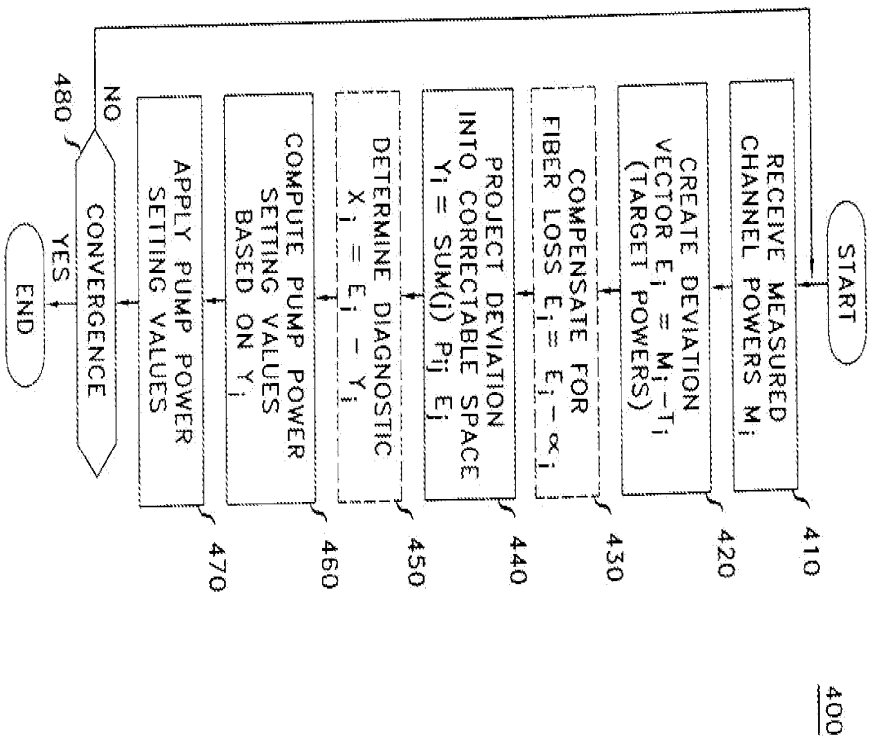


FIG. 5



4/4

FIG. 4



Electronic Patent Application Fee Transmittal				
Application Number:		12649460		
Filing Date:		30-Dec-2009		
Title of Invention:		SYSTEM AND METHOD OF RAMAN AMPLIFIER PUMP CONTROL		
First Named Inventor/Applicant Name:		Christopher A White		
Filer:		David Michael La Bruno/Margaret Cardoso		
Attorney Docket Number:		White 17		
Filed as Large Entity				
Utility under 35 USC 111(a) Filing Fees				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Late filing fee for oath or declaration	1051	1	130	130
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Miscellaneous:				
Total in USD (\$)				130

Electronic Acknowledgement Receipt	
EFS ID:	7219026
Application Number:	12649460
International Application Number:	
Confirmation Number:	5576
Title of Invention:	SYSTEM AND METHOD OF RAMAN AMPLIFIER PUMP CONTROL
First Named Inventor/Applicant Name:	Christopher A White
Customer Number:	22046
Filer:	David Michael La Bruno/Margaret Cardoso
Filer Authorized By:	David Michael La Bruno
Attorney Docket Number:	White 17
Receipt Date:	16-MAR-2010
Filing Date:	30-DEC-2009
Time Stamp:	15:07:24
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	\$130
RAM confirmation Number	1554
Deposit Account	122325
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees) Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)	

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	White17_Transmittal.pdf	69144	no	2
			09d19004b7ebafbcbe990155e4c944b76786c7d		
Warnings:					
Information:					
2	Power of Attorney	White17_Dec.pdf	467804	no	2
			1721d4cd2c054d921cf94d147543a340e5584524		
Warnings:					
The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing					
Information:					
3	Drawings-only black and white line drawings	White17_Dwgs.pdf	864165	no	4
			79a9f565386e9fa4a13e5a39a7616db6728e6aca		
Warnings:					
Information:					
4	Fee Worksheet (PTO-875)	fee-info.pdf	30110	no	2
			0642ef7fdc0541d812cd6ca85dd331f0688a6a5f		
Warnings:					
Information:					
Total Files Size (in bytes):			1431223		
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.					

TRANSMITTAL FORM <i>(to be used for all correspondence after initial filing)</i>	Application Number	12/649460
	Filing Date	December 30, 2009
	First Named Inventor	Christopher Alan White
	Art Unit	3663
	Examiner Name	
Total Number of Pages in This Submission	Attorney Docket Number	C. A. White 17

ENCLOSURES (Check all that apply)		
☐ Fee Transmittal Form ☐ Fee Attached ☐ Amendment/Reply ☐ After Final ☐ Affidavits/declaration(s) ☐ Extension of Time Request ☐ Express Abandonment Request ☐ Information Disclosure Statement ☐ Certified Copy of Priority Document(s) ☒ Reply to Missing Parts/ Incomplete Application ☐ Reply to Missing Parts under 37 CFR 1.52 or 1.53	☒ Drawing(s) ☐ Licensing-related Papers ☐ Petition ☐ Petition to Convert to a Provisional Application ☒ Power of Attorney, Revocation Change of Correspondence Address ☐ Terminal Disclaimer ☐ Request for Refund ☐ CD, Number of CD(s) _____ ☐ Landscape Table on CD	☐ After Allowance Communication to TC ☐ Appeal Communication to Board of Appeals and Interferences ☐ Appeal Communication to TC (Appeal Notice, Brief, Reply Brief) ☐ Proprietary Information ☐ Status Letter ☐ Other Enclosure(s) (please Identify below):
Remarks Declaration and Power of Attorney Formal Drawings - 4 Sheets		
SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT		
Firm Name	Alcatel-Lucent USA Inc.	
Signature	/David M. La Bruno/	
Printed name	David M. La Bruno	
Date	16 March 2010	Reg. No. 46,266

CERTIFICATE OF TRANSMISSION/MAILING		
I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below:		
Signature	/Margaret Cardoso/	
Typed or printed name	Margaret Cardoso (E-filed)	Date 16 March 2010

This collection of information is required by 37 CFR 1.5. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: **Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
12/649,460	12/30/2009	Christopher A White	White 17

CONFIRMATION NO. 5576

FORMALITIES LETTER



22046

Docket Administrator - Room 3D-201E

Alcatel-Lucent USA Inc.

600-700 Mountain Avenue

Murray Hill, NJ 07974

Date Mailed: 01/22/2010

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The oath or declaration is missing.

A properly signed oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.

Note: If a petition under 37 CFR 1.47 is being filed, an oath or declaration in compliance with 37 CFR 1.63 signed by all available joint inventors, or if no inventor is available by a party with sufficient proprietary interest, is required.

The application is informal since it does not comply with the regulations for the reason(s) indicated below.

The required item(s) identified below must be timely submitted to avoid abandonment:

- Replacement drawings in compliance with 37 CFR 1.84 and 37 CFR 1.121(d) are required. The drawings submitted are not acceptable because:
 - The drawings must be reasonably free from erasures and must be free from alterations, overwriting, interlineations, folds, and copy marks. See Figure(s) 3-5.
 - The drawings have a line quality that is too light to be reproduced (weight of all lines and letters must be heavy enough to permit adequate reproduction) or text that is illegible (reference characters, sheet numbers, and view numbers must be plain and legible) see 37 CFR 1.84(l) and (p)(1)); See Figure(s) 1,4 .

Applicant is cautioned that correction of the above items may cause the specification and drawings page count to exceed 100 pages. If the specification and drawings exceed 100 pages, applicant will need to submit the required application size fee.

The applicant needs to satisfy supplemental fees problems indicated below.

The required item(s) identified below must be timely submitted to avoid abandonment:

- To avoid abandonment, a surcharge (for late submission of filing fee, search fee, examination fee or oath or declaration) as set forth in 37 CFR 1.16(f) of **\$130** for a non-small entity, must be submitted with the missing items identified in this notice.

SUMMARY OF FEES DUE:

Total additional fee(s) required for this application is **\$130** for a non-small entity

- **\$130** Surcharge.

Replies should be mailed to:

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web.

<https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html>

For more information about EFS-Web please call the USPTO Electronic Business Center at **1-866-217-9197** or visit our website at <http://www.uspto.gov/ebc>.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

/sduong/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	TOT CLAIMS	IND CLAIMS
12/649,460	12/30/2009	3663	1530	White 17	20	5

CONFIRMATION NO. 5576

22046
Docket Administrator - Room 3D-201E
Alcatel-Lucent USA Inc.
600-700 Mountain Avenue
Murray Hill, NJ 07974

FILING RECEIPT



OC000000039788963

Date Mailed: 01/22/2010

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Applicant(s)

Christopher A White, Residence Not Provided;

Power of Attorney: None

Domestic Priority data as claimed by applicant

Foreign Applications

If Required, Foreign Filing License Granted: 01/21/2010

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 12/649,460**

Projected Publication Date: To Be Determined - pending completion of Missing Parts

Non-Publication Request: No

Early Publication Request: No

Title

SYSTEM AND METHOD OF RAMAN AMPLIFIER PUMP CONTROL

Preliminary Class

359

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent

page 1 of 3

in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at <http://www.uspto.gov/web/offices/pac/doc/general/index.html>.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, <http://www.stopfakes.gov>. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4158).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

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The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign Assets Control, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

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Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

UTILITY PATENT APPLICATION TRANSMITTAL <i>(Only for new nonprovisional applications under 37 CFR 1.53(b))</i>	Attorney Docket No.	White 17
	First Inventor	Christopher A White
	Title	System & Method of Raman Amplifier
	Express Mail Label No.	e-filed

APPLICATION ELEMENTS <i>See MPEP chapter 600 concerning utility patent application contents.</i>	ADDRESS TO: Commissioner for Patents P.O. Box 1450 Alexandria VA 22313-1450
1. ☐ Fee Transmittal Form (e.g., PTO/SB/17) 2. ☐ Applicant claims small entity status: See 37 CFR 1.27. 3. ☒ Specification [Total Pages: 25] Both the claims and abstract must start on a new page. (For information on the preferred arrangement, see MPEP 608.01(a)) 4. ☒ Drawing(s) (35 U.S.C. 113) [Total Sheets: 4] 5. Oath or Declaration [Total Sheets:] a. ☐ Newly executed (original or copy) b. ☐ A copy from a prior application (37 CFR 1.63(d)) (for continuation/divisional with Box 18 completed) i. ☐ DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) name in the prior application; see 37 CFR 1.63(d)(2) and 1.33(b). 6. ☐ Application Data Sheet. See 37 CFR 1.76 7. ☐ CD-ROM or CD-R in duplicate, large table or Computer Program (Appendix) ☐ Landscape Table on CD 8. Nucleotide and/or Amino Acid Sequence Submission (if applicable, items a. - c. are required) a. ☐ Computer Readable Form (CRF) b. ☐ Specification Sequence Listing on: i. ☐ CD-ROM or CD-R (2 copies); or ii. ☐ Paper c. ☐ Statements verifying identity of above copies	ACCOMPANYING APPLICATION PARTS 9. ☐ Assignment Papers (cover sheet & document(s)) Name of Assignee _____ 10. ☐ 37 CFR 3.73(b) Statement ☐ Power of Attorney (when there is an assignee) 11. ☐ English Translation Document (if applicable) 12. ☒ Information Disclosure Statement (PTO/SB/08 or PTO-1449) ☐ Copies of citations attached 13. ☐ Preliminary Amendment 14. ☐ Return Receipt Postcard (MPEP 503) (Should be specifically itemized) 15. ☐ Certified Copy of Priority Document(s) (if foreign priority is claimed) 16. ☐ Nonpublication Request under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or equivalent. 17. ☐ Other: _____
18. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in the first sentence of the specification following the title, or in an Application Data Sheet under 37 CFR 1.76: ☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No. _____ Prior application information: Examiner: _____ Art Unit: _____	
19. CORRESPONDENCE ADDRESS ☒ The address associated with Customer Number: 22046 OR ☐ Correspondence address below	
Name: _____ Address: _____ City: _____ State: _____ Zip Code: _____ Country: _____ Telephone: _____ Email: _____	
Signature: /David M. La Bruno/ Date: December 30, 2009 Name (Print/Type): David M. La Bruno Registration No. (Attorney/Agent): 46,266	

This collection of information is required by 37 CFR 1.53(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

SYSTEM AND METHOD OF RAMAN AMPLIFIER PUMP CONTROL

Field of the Invention

[0001] The invention relates to Raman amplification, and more specifically to the control of Raman amplification via the adjustment of the power levels of Raman pump lasers which may be used to compensate for fiber loss in broadband optical transmission systems.

Background

[0002] The demand for higher capacity optical communication systems pushed common design approaches of Wavelength-Division-Multiplexed (WDM) optical systems to their limits. A typical configuration of a point-to-point WDM system includes a number of optical transmitters, optical multiplexers, spans of transmission fiber, optical amplifiers (traditionally, erbium-doped fiber amplifiers (EDFAs)), dispersion compensating devices, optical demultiplexers, and a number of optical receivers. Unfortunately, the usable gain bandwidth for the traditional EDFA optical amplifiers is limited and narrow which limits the number of independent channels supportable in a system. In addition, signal distortion and noise growth do not allow for transmission over very long optical transmission links. These limitations led to alternate methods for amplification with lower noise and greater broadband capabilities that will allow more channels and for longer spacing in between amplification and thus longer transmission distances. Optical systems with such broadband capabilities are commonly referred to as ultra long haul, Dense Wavelength-Division-Multiplexed (DWDM) systems.

[0003] Raman amplification provides a solution for broadband amplification in modern ultra long haul DWDM optical systems. Stimulated Raman scattering, which is a well-known physical phenomenon, can be employed to build amplifiers to compensate for fiber loss in optical transmission systems. In particular, Raman amplification advantageously uses the fiber itself as the amplification medium. Specifically, the output from high-power (Raman) optical pumps lasers are launched into an optical fiber at a

wavelength shorter (i.e., higher energy) than that of the signal(s) to be amplified. Amplification then occurs when the pump photons are converted by the stimulated Raman effect into new photons at the signal wavelength(s).

[0004] Use of the Raman effect to transfer energy from a set of pump lasers to a set of channels is a key element in current and next generation long haul optical systems. Because the process of Raman amplification is inherently non-linear, control of a Raman amplifier should take into account not only the target channel power, but also the distribution of input channel and pump powers. For example, the addition of a single channel can significantly affect the gain profile applied to the original channel set. Further, component aging and environmental effects can cause optical channel powers to deviate from their optimal channel power targets. For these reasons, a Raman amplifier is dynamically controlled.

[0005] The typical control of Raman amplifiers requires the adjustment of the power levels of Raman pump lasers to attain a target output spectrum (i.e., target gain profile). The power of the pump lasers is adjusted dynamically so that signal powers are as flat as possible relative to some given power target. The complicated, non-linear nature of the Raman process requires a measurement and feedback based control scheme. Existing control methodologies utilized in Raman amplifiers typically consist of an iterative process which initiates pump changes based upon an approximate Raman gain model. For each iteration of the control process, output channel powers are compared to a predefined target; when the channel powers match the target, the process terminates. The definition of an error function which quantifies this comparison provides the goal of the control methodology. Aside from reducing the deviation from target, the pump changes also need to satisfy several constraints on channel and pump powers (e.g., maximum power available from the pump, maximum power per channel, etc.).

[0006] For example, a linear programming method of determining optimal pump configurations may be utilized for broadband Raman amplifier control. In one embodiment employing this type of Raman amplifier control, disclosed by the teachings of U.S. Patent Application Publication 2004/0036954, published Feb 26, 2004, and incorporated herein by reference in its entirety, a linear program based on a linearized

model of Raman gain is created. The linear program can be solved using a standard linear program solver and the solution provides Raman pump settings to obtain an optimal gain profile.

Summary

[0007] The constraints on channel and pump powers and the non-linear coupling involved in the control of Raman amplification make such control a difficult problem. Conventional methodologies of Raman amplifier controls can be slow to converge, may achieve non-optimal solutions at convergence and are sensitive to small (and large) measurement errors or noise. Unfortunately as the number of channels grows or the complexity of the targeted gain profile increases, all of these problems increase.

[0008] Many of the problems of conventional methods of Raman amplifier control are related to the definition of an error function which quantifies the comparison between measured and targeted optical channel powers. Since the error function provides the goal of the control methodology, the nature of the error function can have a significant effect on control stability and convergence. More critical for Raman control is the fact that adjustments to the Raman pump lasers cannot produce an arbitrary gain profile for the channels.

[0009] One critical failing of existing control methodologies is their use of an error function which relies on channel by channel power comparisons with a set of target powers. In particular, a channel power distribution which cannot be corrected by adjusting the Raman pump powers can cause significant convergence difficulties, or worse, cause the system to converge to an incorrect pump setting.

[0010] For example, if an in-field optical channel power measurement device fails such that an improper channel measurement occurs, conventional control schemes will encounter significant difficulties handling this error, resulting in sub-optimal performance. For instance, a single channel power measurement error may cause conventional linear programming methodologies of Raman amplifier control to fail to converge to a suitable solution.

[0011] System, method and apparatus embodiments are provided for the control

of Raman amplification. Such embodiments involve the determination and setting of the power levels of Raman pump lasers to attain a target output spectrum. The embodiments provided here enhance the stability and convergence of Raman amplifier control methodologies as compared to conventional embodiments. The provided apparatuses and methods achieve this stability by projecting the current deviation from the target output onto the subspace of correctable changes so as to achieve a target output spectrum in a faster, more stable manner. For instance, in the face a channel power measurement error, implementations of Raman amplifiers including the projection methodology provided herein converge to a suitable solution for Raman pump settings.

[0012] In one embodiment, a projection based error method for the optimization of optical channel power levels is provided in a Raman amplified transmission system. The projection based methodology removes a feature which cannot be corrected by the adjustment of Raman pump lasers from a set of measured deviations from targeted optical channel powers. The removal of the non-correctable feature allows the optimization method to focus on the space of correctable changes. The Raman control methodology thus provided has the benefit of being faster, more stable and more robust to both hardware and software measurement failures.

[0013] In one embodiment, a measured error vector is projected into the space of correctable deviations. The projection is enabled by expressing the basic Raman physics as a matrix vector multiplication through a manipulation and integration of the basic Raman equations. Within this formulation, the matrix defines the space of possible Raman gain profiles achievable given a set of channels and pump lasers. By projecting the measured error vector into this space, the matrix can be partitioned into the deviations which are correctable and the deviations which are not correctable. The optimization method gains significant benefits from the projection based error function's removal of the non-correctable deviations.

[0014] In one embodiment, a method comprises receiving measured channel powers, determining deviations of respective measured channel powers from respective target channel powers, projecting the deviations into a space that defines Raman gain profiles achievable with a set of channels and pump lasers whereby projected deviations

are formed, and determining power setting values for the pump lasers based on the projected deviations.

[0015] The method may further include applying the power setting values determined to the pump lasers. The method may also be repeated until the projected deviations satisfy a convergence criteria.

[0016] In one embodiment, the method includes compensating the deviations for fiber propagation loss. In another embodiment, the methods include determining deviations that are not correctable based on the projected deviations, and passing the deviations that are not correctable to a wavelength selectable switch for diagnostic purposes. Measuring channel power for a plurality of channels may be included in an embodiment.

[0017] Determining power setting values may include solving an optimization problem using the projected deviations. And, the optimization problem may be a first-order optimization problem, a linear programming optimization problem, a steepest descent optimization problem, a genetic optimization problem, a simulated annealing optimization problem and the like.

[0018] In one example, a method includes removing a feature which cannot be corrected by the adjustment of a plurality of Raman pumps from a set of measured deviations from targeted optical channel powers, and optimizing power setting values for the plurality of Raman pumps based on a space of correctable changes, the space of correctable changes comprising the set of measured deviations from targeted optical channel powers after the feature is removed.

[0019] Optimizing power settings may include solving an optimization problem with use of the space of correctable changes to thereby determine the power setting values for the plurality of Raman pumps for subsequent use in setting one or more Raman pump powers.

[0020] In one embodiment, the optimization problem is directed to determining one or more of the power setting values for the plurality of Raman pumps which substantially minimize the measured deviations from targeted optical channel powers after the feature is removed.

[0021] In another example embodiment, a method includes receiving power measurements for a plurality of optical channels, creating deviation measurements representing a difference between respective power measurements and corresponding power targets for the plurality of optical channels, determining correctable deviations for the plurality of optical channels based on the deviation measurements, and determining a pump setting for a plurality of pumps based upon the correctable deviations for each channel.

[0022] In one embodiment, the correctable deviations for respective optical channels depend on Raman pump gain profiles of a set of the plurality of pumps that address the respective optical channel and corresponding deviation measurements that are directed to the respective optical channel.

[0023] In another embodiment, determining correctable deviations includes determining a correctable deviation Y_i , wherein $Y_i = \sum(j) P_{ij} E_j$ wherein i and j are channel numbers of one of the plurality of channels, P_{ij} is a projector which represents the space of correctable deviations and E_j is the deviation measurement for channel j . The correctable deviation vector Y_i is the deviation in channel power away from a target power which can be corrected by adjusting the Raman Pumps and will be used for the control. Accordingly, determining a pump setting for a plurality of pumps may include solving an optimization problem using the correctable deviations for each channel. Pump settings for the plurality of pumps may also be applied to pumps in one embodiment.

[0024] In one embodiment, the method is repeated until the correctable deviation satisfies a convergence criteria. In another embodiment, approximate fiber propagation loss is removed from the deviation measurements.

[0025] One embodiment may include determining the power measurements for the plurality of optical channels. Another embodiment may include determining non-correctable deviations for the plurality of optical channels based on the correctable deviations, and forwarding the non-correctable deviations for subsequent use setting one or more optical channel powers.

[0026] One example method includes receiving a Raman gain coupling matrix based upon at least one of fiber type, fiber loss, channels and pumps present in a Raman

amplifier. Another example method includes constructing a projector (P_{ij}) which projects into the column space of the Raman gain coupling matrix R . For example, the projector may be obtained through a Gram-Schmidt orthogonalization procedure of the columns of R .

[0027] Reference herein to “one embodiment” “another embodiment” or “an embodiment” means that a particular feature, structure, or characteristic described in connection with the embodiment can be included in at least one embodiment of the invention. The appearances of these phrases (e.g., “in one embodiment”) in various places in the specification are not necessarily all referring to the same embodiment, nor are separate or alternative embodiments necessarily mutually exclusive of other embodiments. The same applies to the term “implementation.”

Brief Description of the Drawings

[0028] Example embodiments will become more fully understood from the detailed description given herein below and the accompanying drawings, wherein like elements are represented by like reference numerals, which are given by way of illustration only and thus are not limiting, and wherein:

[0029] Figure 1 is a high-level block diagram of a Raman-pumped DWDM system employing Raman amplification according to the principles of the described embodiments;

[0030] Figure 2 shows a high-level block diagram of an example control unit suitable for use in a system for controlling the pump powers of a Raman-pumped optical system in accordance with the description herein; and

[0031] Figure 3 is a graphical illustration of target and measured power for a plurality of channels in an example embodiment according to the principles of the described embodiments; and

[0032] Figure 4 is a flowchart detailing the operation of an example method for controlling the pump powers of a Raman-pumped optical system in accordance with the principles described herein; and

[0033] Figure 5 is a graphical illustration of the projected space for a plurality of

channels in an example embodiment according to the principles described herein.

Detailed Description

[0034] Various example embodiments will now be described more fully with reference to the accompanying figures, it being noted that specific structural and functional details disclosed herein are merely representative for purposes of describing example embodiments. Example embodiments may be embodied in many alternate forms and should not be construed as limited to only the embodiments set forth herein.

[0035] It will be understood that, although the terms first, second, etc. may be used herein to describe various elements, these elements should not be limited by these terms since such terms are only used to distinguish one element from another. For example, a first element could be termed a second element, and, similarly, a second element could be termed a first element, without departing from the scope of example embodiments. As used here in the description, the term “and” is used in both the conjunctive and disjunctive sense and includes any and all combinations of one or more of an associated list of items.

[0036] Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which example embodiments belong. It should also be noted that in some alternative implementations, the functions/acts noted may occur out of the order noted in the figures. For example, two figures shown in succession may in fact be executed substantially concurrently or may sometimes be executed in the reverse order, depending upon the functionality/acts involved.

[0037] Figure 1 is a high-level block diagram of a Raman-pumped Dense Wavelength-Division-Multiplexed (DWDM) system 100 employing Raman amplification according to the principles described herein. Signals are carried on spans of optical fiber 120₁, 120₂. Optical fiber 120₁, 120₂ may be True Wave Reduced Slope fiber (TWRS), Dispersion-Compensating fiber (DCF) and the like, which are conventional and fully familiar to those of ordinary skill in the art. Power profiles of amplified optical signals are measured by Optical Channel Monitor (OMON) 130 and may be used to calculate

parameters employed to achieve broadband Raman gain flattening.

[0038] Briefly stated, optical signals enter DWDM system 100. The signals are then amplified in the first fiber span 120₁ and the power profile is subsequently measured by OMON 130. The optical signals then proceed to a second fiber span 120₂ and proceed through the DWDM system 100. Example system 100 of Figure 1 includes control unit 110, a set of forward Raman pumps 140 (e.g., three), a first set of backward Raman pumps 150 (e.g., six), and two Wavelength-Division-Multiplexers (WDMs) 180₁, 180₂ for coupling the Raman pump waves into system 100.

[0039] As can be seen from Figure 1, all entering optical signals pass through fiber span 120₁, where they may be amplified by the three forward Raman pumps 140 and the six backward Raman pumps 150. The Raman pump waves of the Raman pump sets 140 and 150 are coupled into the fiber span by WDMs 180₁ and 180₂. The first set of backward Raman pumps 140 may be optionally implemented to advantageously reduce WDM loss in the span due to noise nonlinearity caused by power fluctuations in the pumps. After the optical signal is amplified, a first gain profile is determined by the OMON 130. The optical signals then proceed to a second fiber span 120₂, for example a 5-km DCF. Though not illustrated, in the second fiber span, the optical signals may again be amplified, for example by Raman amplification as described herein. For instance, the second fiber span 120₂ may include a second Raman amplifier.

[0040] In accordance with an illustrative embodiment, the channel power measurements determined by the OMON 130 are transmitted to control unit 110. These determinations may, for example, include data reflecting signal powers, pump wavelengths, and other system parameters. The control unit 110 may advantageously process the information from the OMON 130 and calculate the appropriate Raman pump powers for gain flattening across the system in accordance with the principles described herein, and illustratively, in accordance with the method described in detail below.

[0041] Briefly, control unit 110 utilizes power spectrum data provided by the OMON 170 to responsively adjust the pump powers of the Raman pumps (illustratively, Raman pumps 140, 150) in a manner tending to produce a relatively flat gain profile (or other desired gain profile). The control function of the exemplary embodiment may also

include a negative feedback loop that automatically adjusts Raman pump powers based on signal power profile. In one embodiment, the output signal profile is advantageously used as the input to the next fiber span 120₂ and gain flattening is then performed according to the output signal profile from the first fiber span 120₁.

[0042] Figure 2 shows a high-level block diagram of a control unit suitable for use in a system for controlling the pump powers of a Raman-pumped optical system in accordance with an example embodiment. More specifically, the illustrated control unit comprises an illustrative embodiment of a control unit suitable for use in the Raman-pumped DWDM system 100 of Figure 1. The control unit 110 of Figure 2 illustratively comprises processor 210, as well as memory 220 for storing software and/or firmware implementations of the methodology described herein and other control programs. Processor 210 advantageously cooperates with conventional support circuitry 230 such as power supplies, clock circuits, cache memory and the like, as well as circuits that assist in executing the software/firmware routines stored in memory 220. Control unit 110 also advantageously contains input-output circuitry 240 that forms an interface between the various functional elements communicating with the control unit 110. For example, as shown in Figure 2, control unit 110 advantageously communicates with the OMON 110 devices via a signal path S1 and to each of a plurality of Raman pumps via signal paths O₁-O_n.

[0043] A Raman amplifier can be described according to the equations for a Raman amplification model which describes the physics of Raman amplification occurring within the Raman amplifier. For example, a distributed Raman amplifier may be described by a simplified Raman model that includes only the fiber loss and the Raman amplification terms. While it is possible to add several other optical power effects to the model such as Rayleigh back scattering, four wave mixing, etc, typical optical networks are designed to operate within a control regime where these effects are not important. For instance, while a first order optimization method is described herein, one skilled in the art may extend the Raman model and thus the optimization problem to next level utilizing known techniques.

[0044] It is noted that for Raman amplification both the Raman gain matrix (R)

and the loss coefficient (A) are independent of distance (z); this indicates a single type of optical fiber is used to perform the amplification, which is a good approximation for a typical optical Raman amplifier. This simplified Raman model may be denoted

$$\frac{d\rho^{\pm}(z, \nu)}{dz} = A(\nu)\rho^{\pm}(z, \nu) + \int_{-\infty}^{\infty} d\mu R(\nu, \mu) \rho^{\pm}(z, \nu) [\rho^{+}(z, \mu) + \rho^{-}(z, \mu)] \quad (1)$$

where ρ is optical power density; ν is frequency of the amplified signal; and μ is frequency of the optical power density providing the Raman gain

[0045] By dividing through by $\rho(z, \nu)$, one obtains

$$\frac{d \ln \rho^{\pm}(z, \nu)}{dz} = A(\nu) + \int_{-\infty}^{\infty} d\mu R(\nu, \mu) [\rho^{+}(z, \mu) + \rho^{-}(z, \mu)] \quad (2)$$

[0046] Integrating through by z, one obtains

$$\ln \rho^{\pm}(L, \nu) - \ln \rho^{\pm}(0, \nu) = A(\nu) + \int_{-\infty}^{\infty} d\mu R(\nu, \mu) \int_0^L dz [\rho^{+}(z, \mu) + \rho^{-}(z, \mu)] \quad (3)$$

where L is the optical propagation length in the fiber span.

[0047] Moving to dealing directly with the logarithmic quantities

$$\gamma^{\pm}(L, \nu) = [\gamma^{\pm}(0, \nu) + A(\nu)] + \int_{-\infty}^{\infty} d\mu R(\nu, \mu) \int_0^L dz [e^{\gamma^{+}(z, \mu)} + e^{\gamma^{-}(z, \mu)}] \quad (4)$$

where γ is the natural log of the optical power density.

[0048] Moving to a discretized version of these equations, one obtains

$$y_i = \alpha_i + \sum_j R_{i,j} \beta_j \quad (5)$$

Here y_i is a column vector containing output power measurements of all relevant frequencies of interest in both the forward and backward power densities, α is approximate fiber propagation loss and R is the Raman gain matrix. All information

concerning the input optical signal and pump powers are contained within the β_j (Beta j) term.

[0049] If i, j are allowed to run over all pumps and signals both backward and forward propagating in the system

$$\beta_j = \int_0^L dz \left[e^{\gamma^+(z, \nu)} + e^{\gamma^-(z, \nu)} \right] \quad (6)$$

It is noted that β_j depends strongly on the input optical powers for both the channels and the optical pumps. The β_j are difficult to compute since they require knowledge of the power density throughout the fiber.

[0050] Typically, computational methods which solve for Raman gain proceed iteratively, refining the β_j values on each iteration of the solver. For our purposes, it is sufficient to note that the β_j values exist and contain all of the information regarding the input power densities. Thus, if it can be stated that no β_j exists which is consistent with a required Raman gain, it is clear that no set of channel and pump powers can correct this measured deviation. Thus, a measured deviation can be partitioned into a correctable portion for which a consistent β_j exists and a non-correctable portion for which no suitable β_j exists.

[0051] Typically, Raman control algorithms attempt to minimize the ripple of the span which consists of minimizing the largest peak to peak difference from a target while keeping dist_to_target constrained within a limited range. This ensures the smallest possible deviation from the target as well as attempts to center the spectrum along the target.

$$\begin{aligned} \text{ripple}(y - y^{\text{target}}) &\equiv \max_{i=1,2,\dots,n} (y_i - y_i^{\text{target}}) - \min_{i=1,2,\dots,n} (y_i - y_i^{\text{target}}) \\ \text{dist_to_target}(y - y^{\text{target}}) &\equiv \frac{1}{2} \left(\max_{i=1,2,\dots,n} (y_i - y_i^{\text{target}}) + \min_{i=1,2,\dots,n} (y_i - y_i^{\text{target}}) \right) \end{aligned} \quad (7)$$

[0052] However, this type of objective function (7) has several significant shortcomings including that it only depends on two points of the distribution of signals. Therefore, any hardware or other error that produces a single channel measurement

which is incorrect may cause the error function to reflect the properties of that single point. Error functions which attempt to look at the error for all channels often ensure most channels are close to the target but at the expense of a few channels which may be far from the target. For a commercial communications system, where it may be preferable to ensure that all channels are within an acceptable range, these type of methods fail to produce the optimal solution.

[0053] The interplay between single point errors and collective errors can lead to a variety of methods which use heuristics to reach an optimal solution. Instead of appealing to such a heuristics based method, the methodology described herein uses the information contained within the Raman gain matrix directly to determine which errors are correctable via adjustment of the Raman pumps

[0054] Because the number of pumps in a Raman amplifier is usually much smaller than the number of signals to be amplified, there is not enough flexibility to achieve every possible (i.e., any) signal change. In fact, the changes possible by changing pump power settings create a subspace of possible changes. Looking at the projection of a goal signal change onto this space, one can obtain the signal changes which are achievable by changing the pumps within the approximation give by Equation (5) above. Such a methodology is robust to single or few channel power measurement problems.

[0055] In one embodiment, the methodology described may be implemented by performing a Gram-Schmidt orthogonalization on the columns of the Raman gain matrix R . This will produce n orthogonal vectors (one for each pump) each of length m (one element for each signal). During this process, pairs of vectors may be tested to determine if two vectors approach unit overlap. Such linear dependence results because two pumps may have an identical effect on a limited number of signals. For cases of near linear dependency, it is possible for the optimization algorithm to attempt to achieve a non-physical situation where it uses these small differences to correct the current error. However, such a case often leads to unrealistically large pump powers. To remove this problem, near linearly dependent vectors are removed from the definition of the subspace. The optimization algorithm will still attempt to adjust both pumps, but only

one vector need be included in the definition of the correctable space.

[0056] Removal of near linearly dependent vectors does introduce a small asymmetry in the optimization algorithm since the vector that gets selected depends on the order in which the vectors are created. But, if the two vectors are nearly linearly dependent, this asymmetry should be small. This asymmetry may also be able to be removed by including the average of the two vectors in the definition of the subspace.

[0057] Each new orthogonal vector ψ may be subtracted from the current error

$$E_{new} = E_{old} - \sum_j (E \cdot \psi_j) \psi_j \quad (8)$$

to produce the projection of the current error vector into the subspace of the possible adjustments using this set of pumps, where j is pump number, E is measured error. It is noted that this process will project out any sharp features in the error which are inconsistent with errors which are correctable with a smooth Raman gain curve. The projected error is then passed back to an optimization algorithm which applies the error criteria to the projected error. Since the features which within this approximation cannot be corrected have been removed, the optimization algorithm will no longer attempt to change the pumps to fix these features. It is noted the outer product of these vectors ψ is exactly the projector P_{ij} described above.

[0058] Figure 3 is a graphical illustration of target and measured power for a plurality of channels in an example embodiment according to the principles of the described embodiments. For each channel of a plurality of channel noted in the frequency domain, the illustrated Raman gain profile has a target power 310 (indicated by an 'X'). For each channel of the plurality of channels, a measured power 320 (indicated by an 'O') is determined, for example through use of the OMON as illustrated in Figure 1. There is a deviation 330 ($\Delta_1, \Delta_2, \Delta_3, \Delta_4$, etc.) between the measured power and the target power for each channel (four channels being shown for ease of illustration). The objective of the Raman control methodology provided herein is to minimize the sum of the deviations.

[0059] Figure 4 is a flowchart detailing the operation of an example method for controlling the pump powers of a Raman-pumped optical system in accordance with the

principles of the invention. The steps of method 400 will be described with reference to control unit 110 in Figure 2 and graphical illustration of Figure 3. The steps of the flow charts described herein are not all inclusive and example methods may include other steps not shown. The steps may also be performed in an alternative order.

[0060] For example, prior to the method steps shown, a Raman gain coupling matrix (R) is created based upon fiber types, fiber loss, channels and pumps present in the Raman amplifier. Also a projector (P_{ij} , where i, j are channel numbers) which projects into the column space of the Raman gain coupling matrix may be constructed. For example, the projector can be obtained through a Gram-Schmidt orthogonalization procedure on the columns of R to produce the ψ vectors described in Equation (8) above.

[0061] At step 410, the control unit 110, receives power measurements (M_i) for a plurality of optical channels. The power measurement may be made by an OMON and provided to the control unit. At step 420, deviation measurements (E_i) representing a difference between respective power measurements and corresponding power targets (T_i) for the plurality of optical channels are created ($E_i = M_i - T_i$). The deviation vector E_i may be calculated by subtracting measured channel powers from target channel powers.

[0062] At optional step 430, the deviation measurements may be compensated for the approximate fiber propagation loss ($E_i = E_i - \alpha_i$, where α_i is fiber propagation loss for signal i). Such a step serves to remove approximate fiber propagation loss from the deviation vector.

[0063] At step 440, correctable deviations (Y_i) for the plurality of optical channels are determined. Y_i is the deviation which can be corrected by adjusting the Raman Pumps and is used for the control of the pumps. The correctable deviations for respective optical channels depends on Raman pump gain profiles of a set of the plurality of pumps that address the respective optical channel and corresponding deviation measurements that are directed to the respective optical channel ($Y_i = \text{Sum}(j) P_{ij} E_j$). Thus, determining correctable deviations may include determining a correctable deviation vector Y_i , wherein $Y_i = \text{Sum}(j) P_{ij} E_j$ wherein i, j are channel numbers of one of the plurality of channels, P_{ij} is a projector into the subspace represented by the columns of the Raman gain matrix, and E_j is the deviation measurement for channel j .

[0064] At optional step 450, a deviation which can not be corrected (X_i) is determined based on the deviation which is correctable. For example, the deviation which can not be corrected may be calculated as the difference between the measured deviation vector and the deviation which can be corrected ($X_i = E_i - Y_i$). The deviation which can not be corrected may be used as a diagnostic signal. For instance, the deviation which can not be corrected may be passed to a wavelength selectable switch, which may have more flexibility in changing power, for further diagnostic purposes.

[0065] At step 460, a pump setting for a plurality of pumps is determining based upon the correctable deviations for each channel (Y_i). Determining a pump setting for the plurality of pumps may include solving an optimization problem using the correctable deviations for each channel. The optimization problem to be solved may be a first-order optimization problem, a linear programming optimization problem, a steepest descent optimization problem, a genetic optimization problem, a simulated annealing optimization problem and the like.

[0066] In another embodiment, step 440 may be described as removing a feature which cannot be corrected by the adjustment of a plurality of Raman pumps from a set of measured deviations from targeted optical channel powers. In that embodiment, step 460 optimizes power setting values for the plurality of Raman pumps based on a space of correctable changes, which is the set of measured deviations from targeted optical channel powers after the feature is removed. The power settings for subsequent use in setting one or more Raman pump powers are determined by solving an optimization problem with use of the space of correctable changes. The optimization problem is directed to determining one or more of the power setting values for the plurality of Raman pumps which substantially minimize the measured deviations from targeted optical channel powers after the feature is removed.

[0067] At step 470, the pump settings for the plurality of pumps are applied to the pumps. The methodology described to this step may be repeated until the correctable deviations satisfy a convergence criteria. Thus, at step 480, a convergence criteria is tested. The convergence criteria may be a threshold level of correctable deviations such that ripple is sufficiently small. If the correctable deviation Y_i satisfies the convergence

criteria, the method terminates. If the correctable deviation Y_i does not satisfies the convergence criteria, the method loops to step 410, and the methodology described above is repeated.

[0068] The methodology described herein may be implemented in the control software which runs on Raman amplifiers in an optical network. Amplifiers enabled with the described methodology may periodically attempt to adjust optical channel powers to match targeted power levels. Each amplifier can accordingly measure optical channel powers and adjust Raman pump lasers in order to provide optimal network operation.

[0069] As described herein, the provided methodology allows a Raman control algorithm to ignore channel power deviations from targets which cannot be corrected through the adjustment of Raman pump lasers. By focusing on the correctable errors, embodiments according to the invention results in a more stable, faster converging control which is also more robust to hardware measurement errors and noise. Improved amplifier control translates directly into a more optimally functioning optical network.

[0070] Figure 5 is a graphical illustration of the projected space for a plurality of channels in an example embodiment according to the principles described herein. Figure 5 may be viewed in conjunction with the example method described with respect to Figure 4. E_i illustrates deviations of respective measured channel powers from respective target channel powers for a plurality of channels. The Raman control methodology provided herein seeks to minimize the sum of these deviations. Note that the number of channels (i) varies from embodiment to embodiment. Thus, the number of channels is not fixed for all embodiments. For example, there may be one-hundred-twenty eight (128) channels. However, more or less channels may be utilized in any optical transmission system employing the Raman amplification according to the principles described herein. Figure 5 illustrates nine (9) channels for ease of illustration.

[0071] A number of Raman pumps are provided to enable Raman amplification. By combining the Raman amplification effect of multiple pump waves selected carefully in the wavelength domain, a broad Raman gain bandwidth can be achieved. As illustrated, the letter 'A' denotes pump laser utilized to create the Raman gain bandwidth (A_1 a first pump laser, A_2 a second pump laser, etc.). For example and for ease of

illustration, five pumps are illustrated as being utilized to create the Raman gain bandwidth. A greater or lesser number of pumps may be utilized in an embodiment.

[0072] P_{ij} is a projector into the subspace spanned by the column vectors of the Raman gain matrix. The projector (P_{ij}) is used to project the deviations into the column space of the Raman gain coupling matrix. The Raman gain matrix is a matrix R_{ij} which couples pumps (indexed by j) to signals (indexed by i) so if there are n pumps and m signals, j goes from 1 to n and i goes from 1 to m . The projector P_{ij} is a square ($m \times m$) matrix which when multiplied with a vector of channel powers (these vectors are of length m) will produce a new vector (also of length m) of the channel powers which are correctable via pump changes.

[0073] To form the projector matrix P_{ij} , one starts with the columns of R_{ij} . There are n columns (one for each pump) and these columns are all vectors of length m . An orthonormal set of vectors which span the same space as the columns of R is found. As noted above, the projector can be obtained using the Gram-Schmidt procedure on the columns of R . If there are no linear dependencies, n orthogonal vectors of length m are obtained (these are the ψ of Equation (8)). Taking the outer product of these vectors produces the P_{ij} matrix. When a vector (like the error vector E_i) is multiplied by P_{ij} , one finds the portion of that vector which is representable by the set of orthogonal vectors - which is the changes that can be impacted by changing the pumps. In this manner, the contributions to a deviation vector that are correctable through adjustment of Raman pumps can be utilized as a control while disregarding non-correctable deviations.

[0074] The functions of the various elements described above with respect to the example methods may be provided through the use of dedicated hardware as well as being readily carried out by special or general purpose digital information processing devices acting under appropriate instructions embodied, e.g., in software, firmware, hardware or some combination of these. For example, an element may be implemented as dedicated hardware. Dedicated hardware elements may be referred to as "processors", "controllers", "control units" or some similar terminology. When provided by a processor, the functions may be provided by a single dedicated processor, by a single shared processor, or by a plurality of individual processors, some of which may be

shared. Moreover, explicit use of the terms “processor”, “controller” and “control unit” should not be construed to refer exclusively to hardware capable of executing software, and may implicitly include, without limitation, digital signal processor (DSP) hardware, a network processor, application specific integrated circuit (ASIC) or other circuitry, field programmable gate array (FPGA), read only memory (ROM) for storing software, random access memory (RAM), non volatile storage, logic, or some other physical hardware component or module. For example, functional modules of the DSP and the other logic circuits can be implemented as an ASIC (Application Specific Integrated Circuit) constructed with semiconductor technology and may also be implemented with FPGA (Field Programmable Gate Arrays) or any other hardware blocks.

[0075] Also, an element may be implemented as instructions executable by a processor or a computer to perform the functions of the element. Some examples of instructions are software, program code, and firmware. The instructions are operational when executed by the processor to direct the processor to perform the functions of the element. The instructions may be stored on storage devices that are readable by the processor. Some examples of the storage devices are digital or solid-state memories, magnetic storage media such as a magnetic disks and magnetic tapes, hard drives, or optically readable digital data storage media.

[0076] Although specific embodiments were described herein, the scope of the invention is not limited to those specific embodiments. The scope of the invention is defined by the following claims and any equivalents thereof.

[0077] It should be noted that all of the preceding discussion merely illustrates the general principles of the invention. It will be appreciated that those skilled in the art will be able to devise various other arrangements which, although not explicitly described or shown herein, embody the principles of the invention and are included within its spirit and scope. Furthermore, all examples and conditional language recited herein are principally intended expressly to be only for pedagogical purposes to aid the reader in understanding the principles of the invention and the concepts contributed by the inventor to furthering the art, and are to be construed as being without limitation to such specifically recited examples and conditions. Moreover, all statements herein reciting

principles, aspects, and embodiments of the invention, as well as specific examples thereof, are intended to encompass both structural and functional equivalents thereof. It is also intended that such equivalents include both currently known equivalents as well as equivalents developed in the future--i.e., any elements developed that perform the same function, regardless of structure.

[0078] Thus, for example, it will be appreciated by those skilled in the art that the block diagrams herein represent conceptual views of illustrative circuitry embodying the principles of the invention. Similarly, it will be appreciated that any flow charts, flow diagrams, state transition diagrams, pseudocode, and the like represent various processes which may be substantially represented in computer readable medium and so executed by a computer or processor, whether or not such computer or processor is explicitly shown. Thus, the blocks shown, for example, in such flowcharts may be understood as potentially representing physical elements, which may, for example, be expressed in the instant claims as means for specifying particular functions such as are described in the flowchart blocks. Moreover, such flowchart blocks may also be understood as representing physical signals or stored physical data, which may, for example, be comprised in such aforementioned computer readable medium such as disc or semiconductor storage devices.

CLAIMS

What is claimed is:

1. A method comprising:
 - receiving measured channel powers;
 - determining deviations of respective measured channel powers from respective target channel powers;
 - projecting the deviations into a space that defines Raman gain profiles achievable with a set of channels and pump lasers whereby projected deviations are formed; and
 - determining power setting values for the pump lasers based on the projected deviations.
2. The method of claim 1 further comprising:
 - applying the power setting values determined to the pump lasers.
3. The method of claim 2 wherein the method is repeated until the projected deviations satisfy a convergence criteria.
4. The method of claim 1 further comprising:
 - compensating the deviations for fiber propagation loss.
5. The method of claim 1 further comprising:
 - determining deviations that are not correctable based on the projected deviations;
 - and
 - passing the deviations that are not correctable to a wavelength selectable switch for diagnostic purposes.
6. The method of claim 1 further comprising:
 - measuring channel power for a plurality of channels.

7. The method of claim 1 wherein determining power setting values comprises:
solving an optimization problem using the projected deviations.
8. The method of claim 7 wherein the optimization problem is a first-order optimization problem, a linear programming optimization problem, a steepest descent optimization problem, genetic optimization problem, or simulated annealing optimization problem.
9. A method comprising:
removing a feature which cannot be corrected by the adjustment of a plurality of Raman pumps from a set of measured deviations from targeted optical channel powers;
and
optimizing power setting values for the plurality of Raman pumps based on a space of correctable changes, the space of correctable changes comprising the set of measured deviations from targeted optical channel powers after the feature is removed.
10. The method of claim 9 wherein optimizing power settings comprises:
solving an optimization problem with use of the space of correctable changes to thereby determine the power setting values for the plurality of Raman pumps for subsequent use in setting one or more Raman pump powers.
11. The method of claim 10 wherein the optimization problem is a first-order optimization problem, a linear programming optimization problem, a steepest descent optimization problem, genetic optimization problem, or simulated annealing optimization problem and the like.
12. The method of claim 10 wherein the optimization problem is directed to determining one or more of the power setting values for the plurality of Raman pumps which substantially minimize the measured deviations from targeted optical channel powers after the feature is removed.

13. A method comprising:

- receiving power measurements for a plurality of optical channels;
- creating deviation measurements representing a difference between respective power measurements and corresponding power targets for the plurality of optical channels;
- determining correctable deviations for the plurality of optical channels based on the deviation measurements; and
- determining a pump setting for a plurality of pumps based upon the correctable deviations for each channel.

14. The method of claim 13 wherein the correctable deviations for respective optical channels depend on Raman pump gain profiles of a set of the plurality of pumps that address the respective optical channel and corresponding deviation measurements that are directed to the respective optical channel.

15. The method of claim 13 wherein determining correctable deviations comprises:

- determining a correctable deviation vector Y_i , wherein $Y_i = \sum(j) P_{ij} E_j$ wherein i, j are channel numbers of one of the plurality of channels, P_{ij} is a projector into the space spanned by the column vectors of the Raman gain matrix, and E_j is the deviation measurement for channel j .

16. The method of claim 13 wherein determining a pump setting for a plurality of pumps comprises:

- solving an optimization problem using the correctable deviations for each channel.

17. The method of claim 13 further comprising:

- applying the pump setting for the plurality of pumps to the pumps.

18. The method of claim 13 further comprising:

determining non-correctable deviations for the plurality of optical channels based on the correctable deviations; and

forwarding the non-correctable deviations for subsequent use setting one or more optical channel powers.

19. An apparatus comprising:

a processor configured to receive measured channel powers and to determine deviations of respective measured channel powers from respective target channel powers, wherein the processor is further configured to project the deviations into a space that defines Raman gain profiles achievable with a set of channels and pump lasers whereby projected deviations are formed, and wherein the processor is further configured to determine power setting values for the pump lasers based on the projected deviations.

20. A computer readable medium having stored thereon instructions comprising machine executable code which when executed by at least one processor, causes the processor to

receive power measurements for a plurality of optical channels;

create deviation measurements representing a difference between respective power measurements and corresponding power targets for the plurality of optical channels;

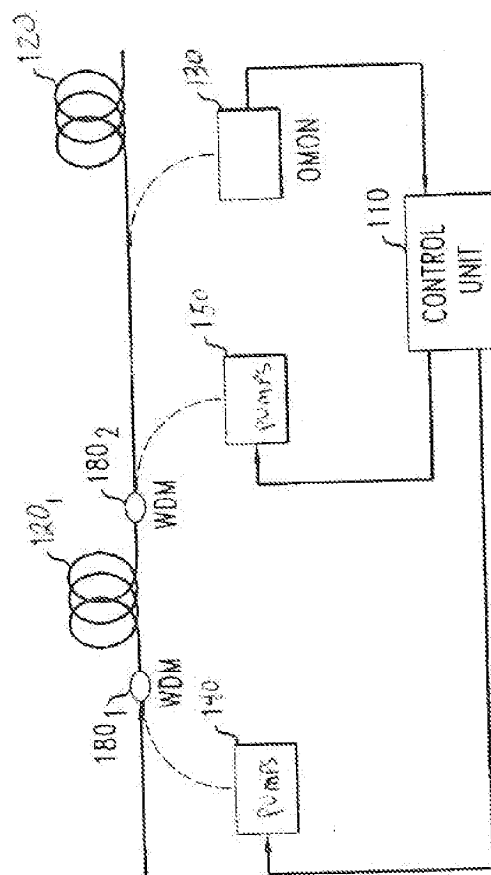
determining correctable deviations for the plurality of optical channels; and

determining a pump setting for a plurality of pumps based upon the correctable deviations for each channel.

Abstract Of The Disclosure

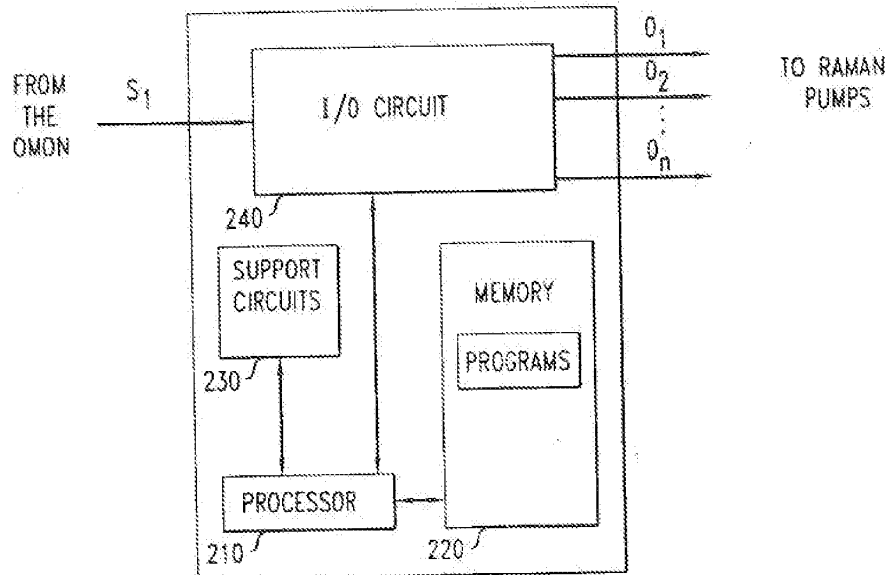
An example method includes receiving power measurements for a plurality of optical channels. Deviation measurements representing a difference between respective power measurements and corresponding power targets for the plurality of optical channels are created. Correctable deviations for the plurality of optical channels are determined based on the deviation measurements. The correctable deviations may be determined by projecting the measured deviations into a space that defines Raman gain profiles achievable with a set of channels and pumps. Pump settings for a plurality of pumps are determining based upon the correctable deviations for each channel by solving an optimization problem. The pump setting so determined may be applied to the plurality of pumps.

FIG. 1



100

FIG. 2



110

NORMALIZED RAMAN GAIN

FIG 3

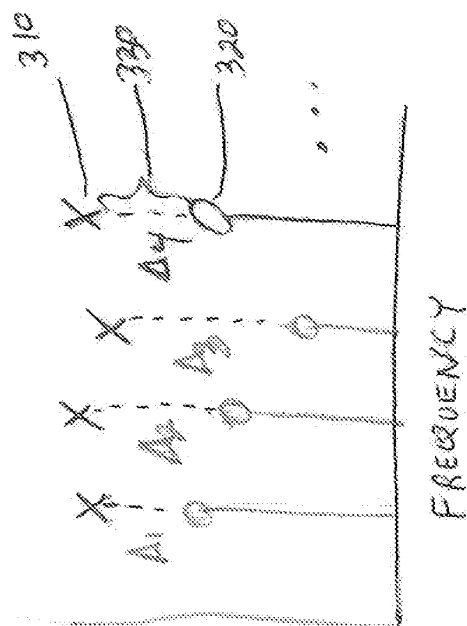


FIG 5

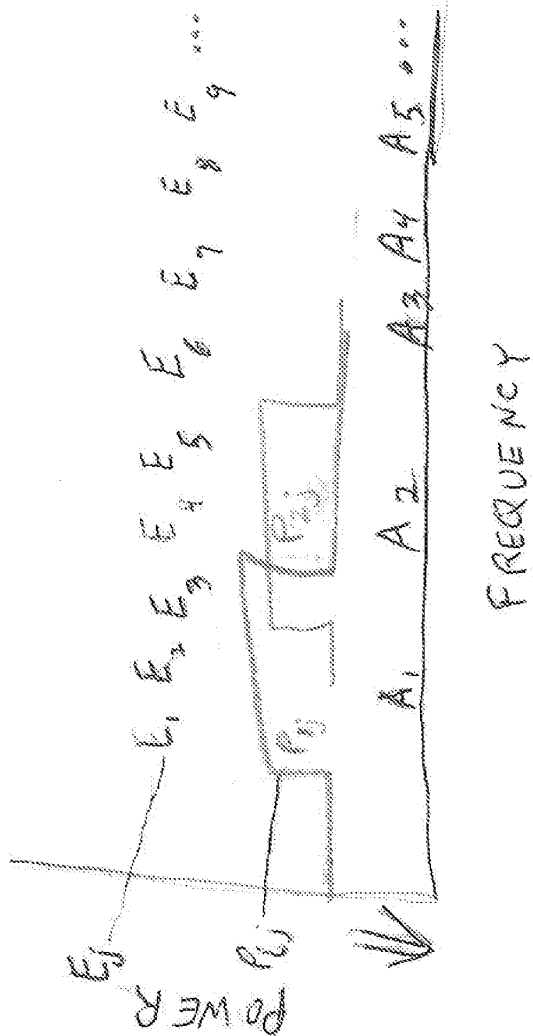
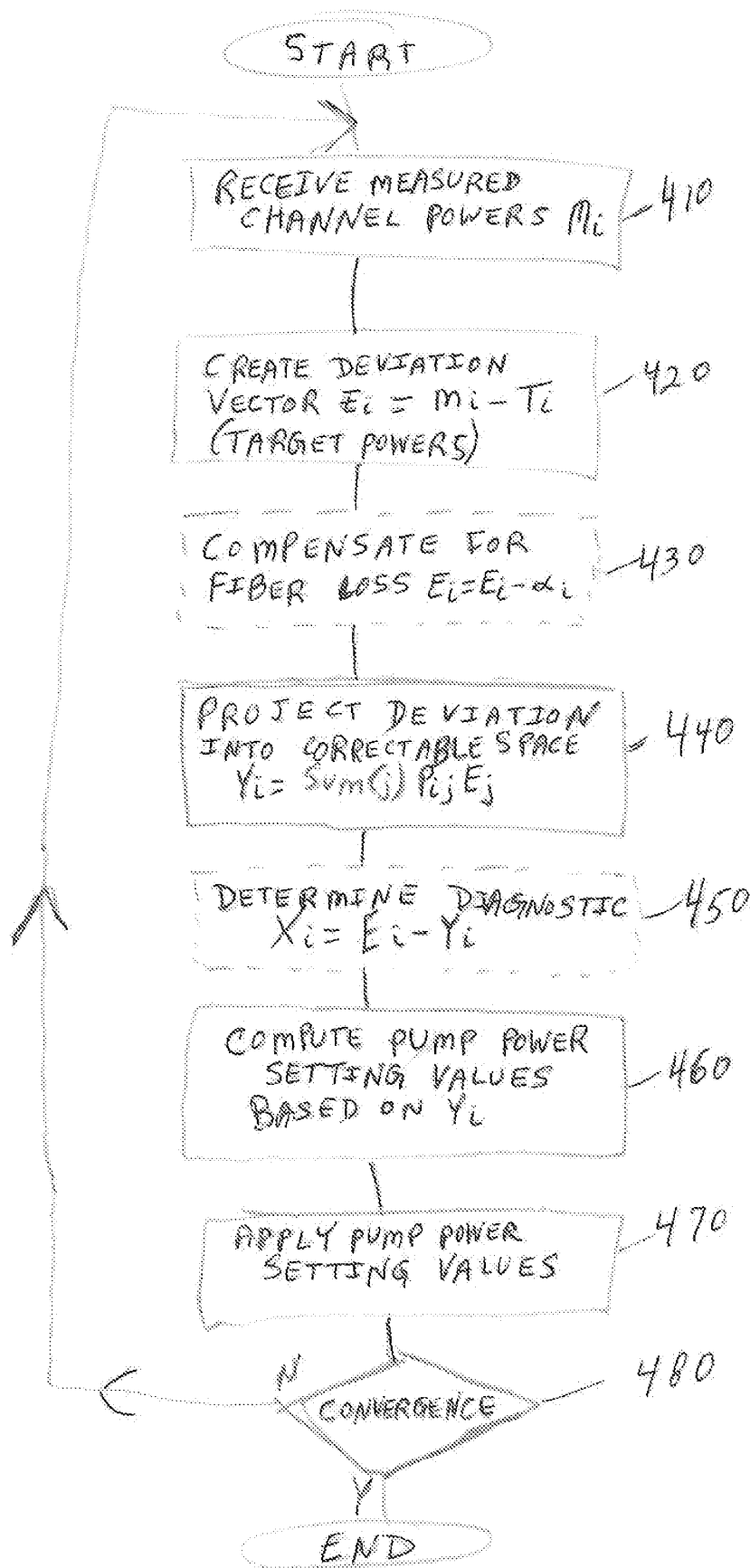


FIG 4



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Substitute for form 1449/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT <i>(Use as many sheets as necessary)</i>		Complete if Known <table border="1"> <tr> <td>Application Number</td> <td>TBA</td> </tr> <tr> <td>Filing Date</td> <td>December 30, 2009</td> </tr> <tr> <td>First Named Inventor</td> <td>Christopher A White</td> </tr> <tr> <td>Art Unit</td> <td>TBA</td> </tr> <tr> <td>Examiner Name</td> <td>TBA</td> </tr> <tr> <td>Attorney Docket Number</td> <td>White 17</td> </tr> </table>		Application Number	TBA	Filing Date	December 30, 2009	First Named Inventor	Christopher A White	Art Unit	TBA	Examiner Name	TBA	Attorney Docket Number	White 17
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Examiner Name	TBA														
Attorney Docket Number	White 17														
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Complete if Known

Application Number	TBA
Filing Date	December 30, 2009
First Named Inventor	Christopher A White
Art Unit	TBA
Examiner Name	TBA
Attorney Docket Number	White 17

[illegible]

Examiner Signature		Date Considered	
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Electronic Patent Application Fee Transmittal				
Application Number:				
Filing Date:				
Title of Invention:		SYSTEM AND METHOD OF RAMAN AMPLIFIER PUMP CONTROL		
First Named Inventor/Applicant Name:		Christopher A White		
Filer:		David Michael La Bruno		
Attorney Docket Number:		White 17		
Filed as Large Entity				
Utility under 35 USC 111(a) Filing Fees				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Utility application filing	1011	1	330	330
Utility Search Fee	1111	1	540	540
Utility Examination Fee	1311	1	220	220
Pages:				
Claims:				
Independent claims in excess of 3	1201	2	220	440
Miscellaneous-Filing:				
Petition:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				1530

Electronic Acknowledgement Receipt	
EFS ID:	6725594
Application Number:	12649460
International Application Number:	
Confirmation Number:	5576
Title of Invention:	SYSTEM AND METHOD OF RAMAN AMPLIFIER PUMP CONTROL
First Named Inventor/Applicant Name:	Christopher A White
Customer Number:	22046
Filer:	David Michael La Bruno
Filer Authorized By:	
Attorney Docket Number:	White 17
Receipt Date:	30-DEC-2009
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Time Stamp:	11:09:21
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Payment Type	Deposit Account
Payment was successfully received in RAM	\$1530
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	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Specification		1	20	
	Claims		21	24	
	Abstract		25	25	
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