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— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

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(54) Title: FLEXIBLE GRID TWDM-PON ARCHITECTURE AND INTELLIGENT SET-UP FOR TWDM-PON

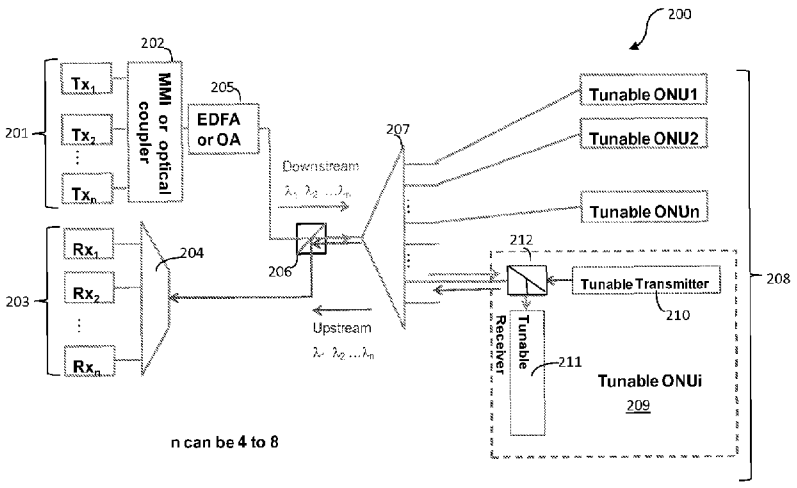

FIG. 2

(57) Abstract: An approach to proving a flexible grid architecture for time and wavelength division multiplexed passive optical networks is described. One embodiment includes an optical transmitter array configured to transmit an optical signal, an optical combiner coupled to the optical transmitter array configured to receive unlocked wavelengths from the optical transmitter array and output a single optical signal, and an optical amplifier coupled to the optical combiner configured to boost downstream optical power. In some embodiments, a WDM filter is coupled to the optical amplifier, and a tunable optical network units (ONUs) coupled to the WDM filter configured to transmit and receive the optical signals. In still other embodiments, a cyclic demultiplexer is coupled to the optical splitter and connects to an optical receiver array configured to receive optical signals.

WO 2015/073733 A3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US14/65560

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - H04J 14/02, 14/08 (2015.01)
CPC - H04J 14/025, 14/0246, 14/0298
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8)-H04J 14/02, 14/08 (2015.01)
CPC-H04J 14/025, 14/0246, 14/0298

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PatSeer (US, EP, WO, JP, DE, GB, CN, FR, KR, ES, AU, IN, CA, INPADOC Data); Google Scholar/Google Patent; IP.com; IEEE.org; demulti*, coupler, band, reject, cycl*, connect, communicate, demultiplex*, optical transmitter array, wave, grid, time, wavelength

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	WO 2013/066520 A1 (GOOGLE INC.) May 10, 2013, paragraphs [0020]-[0030], [0037]-[0039]	1 --- 2-8
Y	US 7706643 B1 (MELI, F et al.) April 27, 2010, column 4, lines 18-22; column 5, lines 29-37	2-8
Y	US 2011/0085794 A1 (LEI, H et al.) April 14, 2011, paragraphs [0030]-[0044]	5-6
Y	US 6606433 B2 (OGUMA, M. et al.) August 12, 2003, column 6, lines 1-18, column 8, lines 45-55	7-8

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 March 2015 (19.03.2015)	01 SEP 2015
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Shane Thomas PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US14/65560

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

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

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

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

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

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fee must be paid.

Group I: Claims 1-8 are directed toward an apparatus for performing time and wavelength division multiplexing.

Group II: Claims 9-21 are directed toward methods of performing channel analysis for a tunable optical network unit (ONU).

The inventions listed as Groups I and II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

-***-See Supplemental Page-***-

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-8

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

-***-Continued from Box III: Lack of Unity of Invention-***-
The special technical features of Group I include an optical combiner coupled to the optical transmitter array and configured to receive the optical signal from the optical transmitter array and output a multi-wavelength optical signal; and an optical amplifier coupled to the optical combiner and configured to boost downstream optical power, wherein the optical combiner is further configured to receive a first optical signal having a first wavelength and a second optical signal having a second wavelength, different from the first wavelength, and wherein an output of the first optical transmitter and an output of the second optical transmitter comprise intermediate grid wavelength values, which are not present in Group II.

The special technical features of Group II include tuning a downstream channel of the tunable ONU based on the first channel number; a channel checking and matching message; and transferring upstream information from the tunable ONU to the OLT, wherein the upstream information relates to an ONU receiving channel, which are not present in Group I.

The common technical features shared by Groups I and II are transmitting and receiving optical signals using one or more transceivers on one or more downstream channels.

However, these common features are previously disclosed by US 2012/0093502 A1 to Gottwald, E et al. (hereinafter 'Gottwald'). Gottwald discloses transmitting and receiving optical signals using one or more transceivers on one or more downstream channels (an ONU comprising a tunable laser receives a downstream incoming signal and outputs an upstream outgoing signal on one of several channels, paragraphs [0009], [0040], [0048], and [0050]-[0052]).

Since the common technical features are previously disclosed by the Gottwald reference, these common features are not special and so Groups I and II lack unity.