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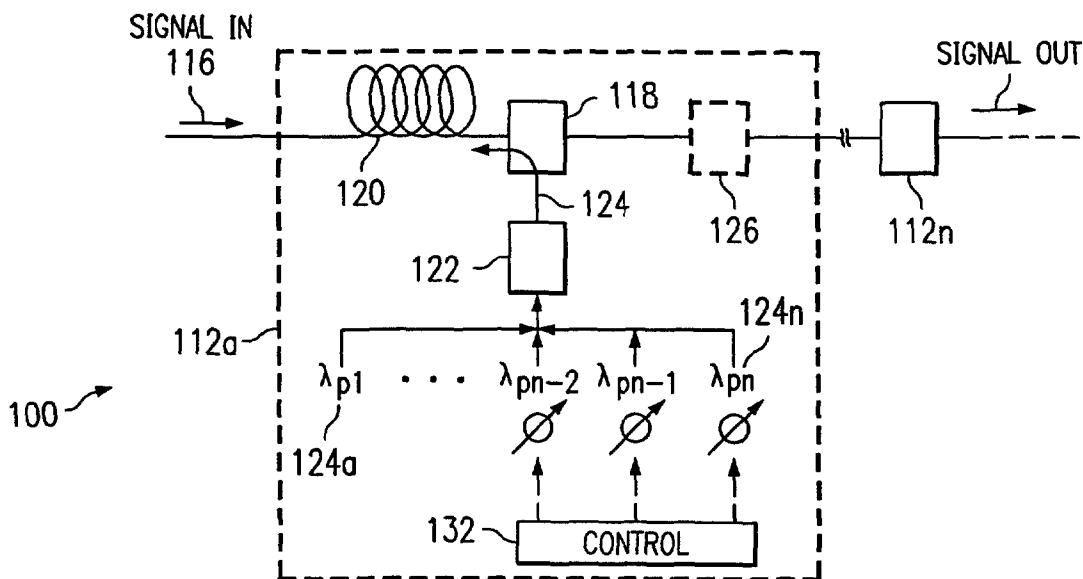
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Declarations under Rule 4.17:  
— as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))

[Continued on next page]

(54) Title: CONTROLLING NOISE FIGURE IN RAMAN AMPLIFIERS



(57) Abstract: An optical amplifier (12(a)), operable to amplify a plurality of optical wavelength signals (116) at least in part through. Raman, amplification is disclosed. The amplifier includes an input operable to receive a plurality of wavelength signals and an output operable to communicate an amplified version of at least some of the plurality of wavelength signals. The amplifier further includes a pump assembly operable to generate one or more pump signals (124(a)-124(n)) and a gain medium (120) operable to receive the signals and to facilitate amplification of at least some of the plurality of wavelength signals. The amplifier has associated with it a noise figure having a shape- varying as a function of wavelength. At least one of the one or more pump signals is operable to have its power varied to selectively control the shape of the noise figure.

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— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US02/23943

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(7) : H01S 3/00, 3/30.  
US CL : 359/334, 337

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)  
U.S. : 359/334, 337, 337.1, 161

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)  
IBBB Xplore (search terms: Raman, noise figure, SNR, noise, pump(-ed, -ing))

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
<input checked="" type="checkbox"/> X, P <input type="checkbox"/> Y, P	US 6,388,801 B1 (SUGAYA et al.) 14 May 2002 (14.05.2002), Figs. 1, 6; columns 1-3 (entire), column 5, lines 20-24 columns 6-8 (entire)	1-4, 6-10, 13, 16-17, 19-31, 34, 36, 39, 41-42, 46-47, 49, 52-53, 55-59, 61-64, 66-67, 69-71, 74-75, 77-83, 86, 89-90, and 92-93  5, 11-12, 14, 18, 20-25, 32-33, 35, 37-38, 40, 43-45, 48, 51, 53-57, 60-61, 65, 68, 70, 72-73, 76, 81, 84-85, 87-88, 91
<input checked="" type="checkbox"/> X <input checked="" type="checkbox"/> Y	AGRAWAL, G.P. Fiber-Optic Communication Systems, 2nd Ed. John Wiley & Sons, Inc. pages 365-366 (1997). CHIEN-JEN et al. Transient Effects in Saturated Raman Amplifiers. Elect. Lett. 15 March 2001 (15.03.2001) vol. 37, No. 6, pp. 371-373.	2, 20-25, 27, 36, 53, 55-57, 61, 70, 81 20-25, 53, 55-57, 61, 70, 81

Further documents are listed in the continuation of Box C.  See patent family annex.

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

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## INTERNATIONAL SEARCH REPORT

## C. (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y, E ✓	EMORI et al. 100 nm Bandwidth Flat Gain Raman Amplifier Pumped and Gain Equalized by 12-Wavelength-Channel WDM High Power Laser Diodes. <i>Elect. Lett.</i> vol. 35, No. 16, 05 August 2002 (05.08.2002), pages 1355-1356.	5, 32, 51, 60, 65
Y	US 5,995,275 A (SUGAYA, Yasushi) 30 November 1999 (30.11.1999), column 7, lines 45-51.	11, 33, 72-73, 84
Y, P ✓	US 6,396,624 B1 (NISSOV et al.) 28 May 2002 (28.05.2002), Fig. 1	12, 18, 35, 40, 85, 91
Y, P	US 6,344,922 B1 (GRUBB et al.) 05 February 2002 (05.02.2002), column 4, lines 1-17; 34-50; column 5, lines 53-56.	14, 37, 38, 54, 76, 87-88
Y, P ✓	US 2001/0050802 A1 (NAMIKI et al.) 13 December 2001 (13.12.2001), paragraphs [0098], [0125], Fig. 9.	43-45, 48, 68
A, P ✓	US 6,417,959 B1 (BOLSHYANSKY et al.) 09 July 2002 (09.07.2002).	1-93
A, P ✓	US 6,356,383 B1 (CORNWELL et al.) 12 March 2002 (12.03.2002).	1-93
A, P ✓	US 6,282,002 B1 (GRUBB et al.) 28 August 2001 (28.08.2002).	1-93
A ✓	HAUS, H.A. Optimum Noise Performance of Optical Amplifiers. <i>IEEE J. Quantum Elect.</i> vol. 37, No. 6, June 2001, pages 813-823.	1-93
A ✓	FLÜDGER et al. Fundamental Noise Limits in Broadband Raman Amplifiers. * OFC 2001, March 2001, pages MA5/1-MA5/3.	1-93
A ✓	KAWAI et al. Ultra-wide, 75-nm 3dB gain-band optical amplifier utilizing erbium-doped fiber and Raman fiber. OFC'98, Tech. Digest, 1998, pages 32-33.	1-93
A ✓	CHERNIKOV et al. Broadband Raman Amplifiers in the Spectral Range of 1480nm-1620nm. * OFC/IOOC'99 Tech. Digest, vol. 2, pages 117-119.	1-93

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PCT/US02/23943

**Continuation of Item 4 of the first sheet:**

The title is not precise, as the claims are directed to Raman amplifiers and systems and methods for controlling the noise figure therein. See PCT Rule 4.3.

The new title is:

**Controlling Noise Figure in Raman Amplifiers**