



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification <sup>6</sup> : <b>H01S 3/06</b></p>	<p><b>A3</b></p>	<p>(11) International Publication Number: <b>WO 97/26688</b>                   (43) International Publication Date: 24 July 1997 (24.07.97)</p>
<p>(21) International Application Number: PCT/US97/00306                  (22) International Filing Date: 10 January 1997 (10.01.97)                  (30) Priority Data:                  08/588,747 19 January 1996 (19.01.96) US                  (71) Applicant: SDL, INC. [US/US]; 80 Rose Orchard Way, San Jose, CA 95134 (US).                  (72) Inventors: WAARTS, Robert, G.; 4543 Northdale Drive, Fremont, CA 94536 (US). SANDERS, Steven; 2270 Cornell Street, Palo Alto, CA 94306 (US). WELCH, David, F.; 1894 Oak Knoll Lane, Menlo Park, CA 94024 (US). SCIFRES, Donald, R.; 80 Rose Orchard Way, San Jose, CA 95134 (US).                  (74) Agent: CAROTHERS, W., Douglas, Jr.; SDL, Inc., 80 Rose Orchard Way, San Jose, CA 95134 (US).</p>		<p>(81) Designated States: CA, JP, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).   <b>Published</b>  <i>With international search report.</i>  <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>                   (88) Date of publication of the international search report:                  18 September 1997 (18.09.97)</p>
<p>(54) Title: OPTICAL AMPLIFIERS PROVIDING HIGH PEAK POWERS WITH HIGH ENERGY LEVELS</p>		
<p>(57) Abstract</p> <p>Two approaches are provided for achieving an optical amplifier system capable of producing high peak power, high energy pulse outputs while suppressing scattering noise. The first approach relates to an optical amplifier system which has at least one laser diode pulsed or cw pumped double clad fiber amplifier utilized for receiving a high frequency modulated injected signal pulse of short duration from the laser diode, via the fiber core, for amplification by coupling pump light into the inner cladding of the fiber. The average signal power is sufficient to saturate the gain of the fiber so as to minimize significant onset and buildup of forward and backward scattering noise. The duty cycle of the injected signal source pulse is chosen to allow adequate gain recovery in the fiber amplifier between pulses. The second approach relates to a cascaded optical amplifier system having at least two optical amplifying stages with two pulsed pump sources provided and two amplifying media, the first of which receives the injection and at least one pump signal wherein the injection pulsed signal is amplified to a first power and energy level. The second amplifying medium, optically coupled to the first, amplifies the first level signal to a second level amplified, injection pulsed signal. The duty cycle of the injection pulsed optical signal is synchronized with the first and second pulsed pump signals with the first pulsed pump signal having a different duration in the duty cycle than the second pulsed pump signal.</p>		

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# INTERNATIONAL SEARCH REPORT

Intern. Patent Application No  
PCT/US 97/00306

<b>A. CLASSIFICATION OF SUBJECT MATTER</b> IPC 6 H01S3/06		
According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b>		
Minimum documentation searched (classification system followed by classification symbols) IPC 6 H01S		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used)		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	OPTICS LETTERS, vol. 20, no. 17, 1 September 1995, pages 1797-1799, XP000520902 MINELLY J D ET AL: "FEMTOSECOND PULSE AMPLIFICATION IN CLADDING-PUMPED FIBERS"	1-6, 11, 17, 18, 21-23, 25, 27
Y	see abstract; figure 2 see page 1798, right-hand column, line 7 - line 12	12-16
Y	--- US 5 175 643 A (ANDREWS JOHN R) 29 December 1992 cited in the application see figure 1 ---	14-16
--- / ---		
<input checked="" type="checkbox"/> Further documents are listed in the continuation of box C.		
<input checked="" type="checkbox"/> Patent family members are listed in annex.		
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"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  <p style="text-align: center;">25 July 1997</p>	Date of mailing of the international search report  <p style="text-align: center;">1 08. 97</p>	
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax (+ 31-70) 340-3016	Authorized officer  <p style="text-align: center;">Galanti, M</p>	

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## INTERNATIONAL SEARCH REPORT

Intern. Patent Application No

PCT/US 97/00306

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

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	APPLIED PHYSICS LETTERS, 2 AUG. 1993, USA, vol. 63, no. 5, ISSN 0003-6951, pages 586-588, XP000388102 DESTHIEUX B ET AL: "111 kW (0.5 mJ) pulse amplification at 1.5 mu m using a gated cascade of three erbium-doped fiber amplifiers" cited in the application	1,2,11, 17,18, 21,22
Y	see page 586, left-hand column, line 26 - line 35; figures 1,3,4 ---	12,13
A	OPTICS LETTERS, 15 DEC. 1993, USA, vol. 18, no. 24, ISSN 0146-9592, pages 2099-2101, XP002031680 NILSSON J ET AL: "Modeling and optimization of low-repetition-rate high-energy pulse amplification in cw-pumped erbium-doped fiber amplifiers" see the whole document ---	1,2
A	IEEE PHOTONICS TECHNOLOGY LETTERS, DEC. 1994, USA, vol. 6, no. 12, ISSN 1041-1135, pages 1436-1438, XP002031681 K O K Y ET AL: "Transient analysis of erbium-doped fiber amplifiers" see the whole document ---	1,2
X	US 4 136 929 A (SUZAKI YASUZI) 30 January 1979	29
Y	see column 4, line 67 - column 5, line 23  see column 5, line 49 - line 53; figures 4B,5C ---	30-33, 35-44, 48,49, 57-62, 64-66
Y	APPLIED OPTICS, 20 AUG. 1993, USA, vol. 32, no. 24, ISSN 0003-6935, pages 4471-4479, XP000388171 SWEETSER J ET AL: "Efficient high repetition rate synchronous amplification of a passively mode-locked femtosecond dye laser" see paragraph 1 see paragraph 5 --- -/--	35,57, 59,61

INTERNATIONAL SEARCH REPORT

Intern. Application No  
PCT/US 97/00306

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	<p>IEEE JOURNAL OF QUANTUM ELECTRONICS, vol. 27, no. 2, 1 February 1991, pages 283-287, XP000202931 ZHU LEI ET AL: "HIGH-REPETITION TUNABLE PICOSECOND DYE LASER PUMPED BY A COPPER BROMIDE LASER" see page 286, left-hand column, line 15 - line 19</p> <p style="text-align: center;">---</p>	36-38,62
Y	<p>US 5 050 949 A (DIGIOVANNI DAVID J ET AL) 24 September 1991</p> <p>see abstract</p> <p style="text-align: center;">---</p>	30-33, 39-44, 48,49, 58,60, 64-66
X	<p>US 5 232 404 A (FELSTEHUSEN EUGENE F) 3 August 1993 see column 1, line 40 - line 48</p> <p style="text-align: center;">-----</p>	29

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 97/00306

**Box I Observations where certain claims were found unsearchable (Continuation of item 1 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 II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)**

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

1. CLAIMS : 1-28
2. CLAIMS : 29-77

1.  As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
  
2.  As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
  
3.  As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
  
4.  No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- The additional search fees were accompanied by the applicant's protest.
- No protest accompanied the payment of additional search fees.

# INTERNATIONAL SEARCH REPORT

Information on patent family members

Intern. Application No  
PCT/US 97/00306

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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US 4136929 A	30-01-79	JP 1117518 C JP 51062743 A JP 57009041 B	15-10-82 31-05-76 19-02-82
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