

(19) World Intellectual Property Organization
International Bureau



PCT



(43) International Publication Date
28 February 2008 (28.02.2008)

(10) International Publication Number
WO 2008/024094 A3

(51) **International Patent Classification:**
HOIS 3/115 (2006.01) **HOIS 3/223** (2006.01)
G02F 1/03 (2006.01)

(21) **International Application Number:**
PCT/US2006/026681

(22) **International Filing Date:** 7 July 2006 (07.07.2006)

(25) **Filing Language:** English

(26) **Publication Language:** English

(30) **Priority Data:**
60/706,973 10 August 2005 (10.08.2005) US
11/481,887 6 July 2006 (06.07.2006) US

(71) **Applicant** (for all designated States except US): **COHER-
ENT, INC.** [US/US]; 5100 Patrick Henry Drive, Santa
Clara, CA 95054 (US).

(72) **Inventors; and**

(75) **Inventors/Applicants** (for US only): **HUA, Congxue**
[CN/US]; 39 Merriman Street, Unionville, CT 06085
(US). **SEGUIN, Vernon** [US/US]; 42 Dewey Avenue,
Windsor, CT 06095 (US). **NEWMAN, Leon, A.** [US/US];
75 Cotswold Close, Glastonbury, CT 06033 (US).
MUELLER, Eric, R. [US/US]; 34 Wheeler Drive, West
Suffield, CT 06093 (US).

(74) **Agents:** **POLLOCK, Michael, J.** et al; Stallman & Pol-
lock LLP, 353 Sacramento Street, Suite 2200, San Fran-
cisco, CA 941 11 (US).

(81) **Designated States** (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AT, AU, AZ, BA, BB, BG, **BR**, BW, BY, BZ, CA, CH, CN,
CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI,
GB, GD, GE, GH, GM, HN, **HR**, HU, **ID**, IL, IN, IS, **JP**,
KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT,
LU, LV, LY, MA, MD, ME, MG, MK, MN, MW, MX, MZ,
NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU,
SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT,
TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

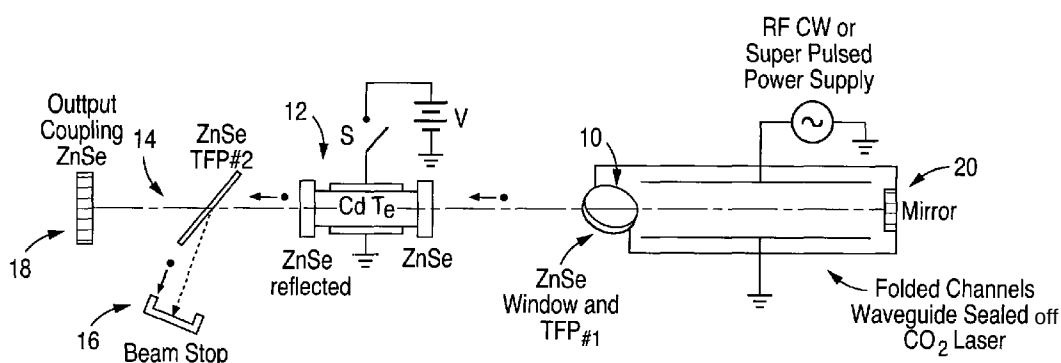
(84) **Designated States** (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM,
ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),
European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI,
FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT,
RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA,
GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report
— before the expiration of the time limit for amending the
claims and to be republished in the event of receipt of
amendments

(88) **Date of publication of the international search report:**
4 September 2008

(54) **Title:** HIGH DAMAGE THRESHOLD Q-SWITCHED CO₂ LASER



(57) **Abstract:** A thin film polarizer (TFP14) and a half -wave CdTe electro-optical crystal (12) are utilized to achieve a higher damage threshold in Q-switching CO₂ lasers for material processing applications. Half-wave CdTe electro-optical modulators can be used without the arcing and corona problems typically associated with the higher drive voltage by placing low dielectric constant insulators (such as BeO) around the CdTe crystal. Doubling the voltage placed across a CdTe crystal enables the crystal to function as a half-wave EO modulator. These half-wave EO switches can be used with TFPs to shape the output pulses, as well as to direct alternate pulses of repetitively pulsed super pulsed slab lasers to alternate scanners, thereby doubling the output of laser hole drilling systems.

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2006/026681

A. CLASSIFICATION OF SUBJECT MATTER

INV. H01S3/115 G02F1/03

ADD. H01S3/223

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)

H01S 603F G02F

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)

EPO-Internal, WPI Data, INSPEC, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 849 719 A (BELEK RONALD E [US] ET AL) 18 July 1989 (1989-07-18)	11-13
Y	column 1, lines 10-15 column 1, line 51 - column 2, line 68; figures 1-3	2
Y	US 2004/179775 A1 (SEGUIN VERNON [US] ET AL) 16 September 2004 (2004-09-16) paragraphs [0010], [0038] - [0043]; figures 1A-2B	1-4
Y	US 4 176 327 A (BUCZEK CARL J [US] ET AL) 27 November 1979 (1979-11-27) column 5, line 28 - column 6, line 64; figure 1	1, 4
	----- -/-- -----	



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A¹" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document 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

¹ 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^{1X} 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^{1Y} 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

26 February 2008

Date of mailing of the international search report

18/07/2008

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

Nugesser, Hermann

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2006/026681

C(Continuation). DOCUMENTS CONSIDERED To BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	SALVESTRINI J P ET AL: "Comparative study of nonlinear optical crystals for electro-optic Q-switching of laser resonators" OPTICAL MATERIALS, ELSEVIER SCIENCE PUBLISHERS B.V. AMSTERDAM, NL, vol . 26, no. 4, September 2004 (2004-09), pages 449-458, XP004527498 ISSN: 0925-3467 page 450 - page 451; figure 1	1
Y	ROTH M ET AL: "Oxide crystals for electro-optic Q-switching of lasers" GLASS PHYSICS AND CHEMISTRY, KLUWER ACADEMIC PUBLISHERS-PLENUM PUBLISHERS, NE ₃ , vol . 31, no. 1, 1 January 2005 (2005-01-01) , pages 86-95, XP019296359 ISSN: 1608-313X page 87; figure 1	1
Y	ARECCHI ET AL. : "Laser with feedback: an optical implementation of competing instabilities, Shilnikov chaos, and transient fluctuation enhancement" JOURNAL OF THE OPTICAL SOCIETY OF AMERICA B ₇ , vol . 5, no. 5, May 1998 (1998-05) , pages 1153-1159, XP002469365 page 1153 - page 1154; figure 1	1,3
A	US 4 884 044 A (PETER J: HEYWOOD ET AL.) 28 November 1989 (1989-11-28) column 1, line 48 - column 2, line 3; figures 1,2	1,11
A	US 3 965 439 A (FIRESTER. ARTHUR H) 22 June 1976 (1976-06-22) column 1, line 30 - column 2, line 42; figures 1-3	1
P,X	US 2006/007966 A1 (LAUGHMAN LANNY [US] ET AL LAUGHMAN LANNY [US] ET AL) 12 January 2006 (2006-01-12) paragraphs [0004] - [0008], [0020] - [0027], [0035]; figure 1	11

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2006/026681

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 4849719	A	18-07-1989	NONE	
US 2004179775	A1	16-09-2004	NONE	
US 4176327	A	27-11-1979	NONE	
US 4884044	A	28-11-1989	AU 2187188 A	09-03-1989
			DE 3829747 A1	23-03-1989
			FR 2620277 A1	10-03-1989
			GB 2209609 A	17-05-1989
			IT 1224729 B	18-10-1990
US 3965439	A	22-06-1976	NONE	
US 2006007966	A1	12-01-2006	NONE	