

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
20 April 2006 (20.04.2006)

PCT

(10) International Publication Number
WO 2006/041943 A3

(51) International Patent Classification:
G02B 5/10 (2006.01)

(21) International Application Number:
PCT/US2005/035866

(22) International Filing Date: 4 October 2005 (04.10.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10/958,778 5 October 2004 (05.10.2004) US

(71) Applicant (for all designated States except US): **RESIDENTIAL RENEWABLES** [US/US]; 1718 Mulberry Lane, San Jose, California 95125 (US).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **LICHY, Joseph, I.** [US/US]; 1718 Mulberry Lane, San Jose, California 95125 (US).

(74) Agent: **THOMAS, Mark, A.**; MARK A. THOMAS, P.C., 10138 South Cottoncreek Drive, Highlands Ranch, Colorado 80130-3848 (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, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, 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).

Declarations under Rule 4.17:

- as to the identity of the inventor (Rule 4.17(i))
- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))

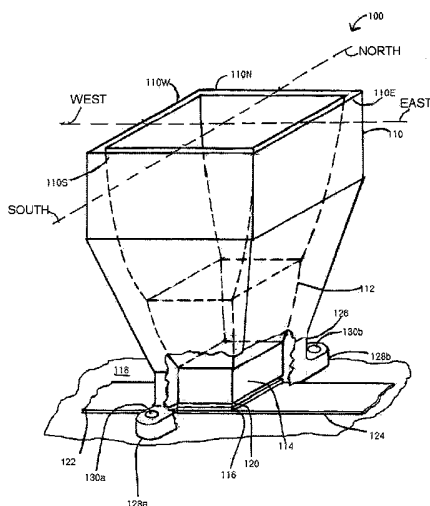
Published:

- with international search report

(88) Date of publication of the international search report:
16 November 2006

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: ASYMETRIC, THREE-DIMENSIONAL, NON-IMAGING, LIGHT CONCENTRATOR



(57) Abstract: A radiant energy concentrator (100) of sunlight adapted for use with a photovoltaic cell (116). The radiant energy concentrator has a hollow first stage (110) formed by two pairs of facing reflective sides (110N-110S, 110W-110E) curved to different parabolas. The first stage (110) is optically coupled to a solid second stage (112) with two pairs of facing reflective sides (110N-110S, 110W-110E) curved to different parabolas. The second stage (112) is optically coupled to a solid light diffuser (114) in some embodiments. The solid light diffuser (114) is optically coupled to the photovoltaic cell (116) with a clear encapsulant (120). The radiant energy concentrator (100) is mounted on a metal substrate (118) for thermal management. The radiant energy concentrator (100) can operate efficiently with only single axis tracking of the Sun in part because the reflective sides form orthogonal acceptance angles corresponding to the annual and daily apparent passage of the Sun on Earth.

WO 2006/041943 A3

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US05/35866

A. CLASSIFICATION OF SUBJECT MATTER
 IPC: **G02B 5/10**(2006.01)

USPC: 359/853,851
 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. : 359/853,851,597,598,728,730

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
 Welford's "The Optics of Nonimaging Concentrators"

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,146,248 (Duwaer et al) Col. 2	1,2,4
---		-----
Y		3,5,24-27,40-42
Y	US 4,340,034 (Hopper)	3,5
Y	US 5,699,201 (Lee)	1-5, 24-27, 40-42
Y	US 3,899,672 (Levi-Setti)	1-5, 24-27, 40-42
Y	US 4,045,246 (Mlavsky et. al)	1-5, 24-27, 40-42
Y	US 3,923,381 (Winston)	1-5, 24-27, 40-42

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

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier application or patent published on or after the international filing date	"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
"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)	"&"	document member of the same patent family
"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		

Date of the actual completion of the international search 12 May 2006 (12.05.2006)	Date of mailing of the international search report 16 AUG 2006
---	--

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 Drew Dunn <i>Lydia Dune Jor</i> Telephone No. 571-272-2800
---	---

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US05/35866

C. (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4,003,638 (Winston)	1-5, 24-27, 40-42
Y	US 5,971,551 (Winston)	1-5, 24-27, 40-42
Y	W.T. Welford and R. Winston, The optics of nonimaging concentrators: Light and Solar Energy, 1978, Academic Press, Pages 48-52, 77-79, 162-163	1-5, 24-27, 40-42
Y	US 6,541,694 (Winston)	1-5, 24-27, 40-42

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US05/35866

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:
Please See Continuation Sheet

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 any 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.:
- 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.

BOX III. OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING

Group 1, claims 1-5, drawn to a radiant energy concentrator with specifics of first and second pairs of facing curved reflective sides, classified in class 359, subclass 853.

Group 2, claims 6-14, drawn to a radiant energy concentrator with specifics of first and second reflectors each having two pair of facing curved reflecting sides, classified in class 359, subclass 853.

Group 3, claims 15-23, drawn to a radiant energy concentrator with specifics of first and second reflectors each having two pair of facing curved reflecting sides and a light spreader, classified in class 359, subclass 853.

Group 4, claims 24-27 and 40-42, drawn to a radiant energy concentrator with specifics of first and second reflectors each having two pair of facing curved reflecting sides, a light spreader, and a photovoltaic cell, classified in class 359, subclass 853.

Group 5, claims 28-31, drawn to a radiant energy concentrator with specifics of first and second reflectors each having two pair of facing curved reflecting sides, and a photovoltaic cell, classified in class 359, subclass 853.

Group 6, claims 32-35, drawn to a radiant energy concentrator with specifics of first and second pairs of facing curved reflective sides positioned around a solid medium, classified in class 359, subclass 853.

Group 7, claims 36-38, drawn to a radiant energy concentrator with specifics of a light spreader containing a solid medium, and a photovoltaic cell, classified in class 359, subclass 599.

Group 8, claims 39, drawn to a radiant energy concentrator with specifics of a solid reflector having first and second pairs of facing curved reflective sides, a light spreader, and a photovoltaic cell classified in class 359, subclass 853.

Group 9, claims 43-47, drawn to an optical element coupled to a photovoltaic cell with a coupling material with an index of refraction of at least 89% of the index of refraction of the optical element.

Group 10, claims 48-51, drawn to an optical element coupled to a photovoltaic cell with a coupling material composed of a gel.