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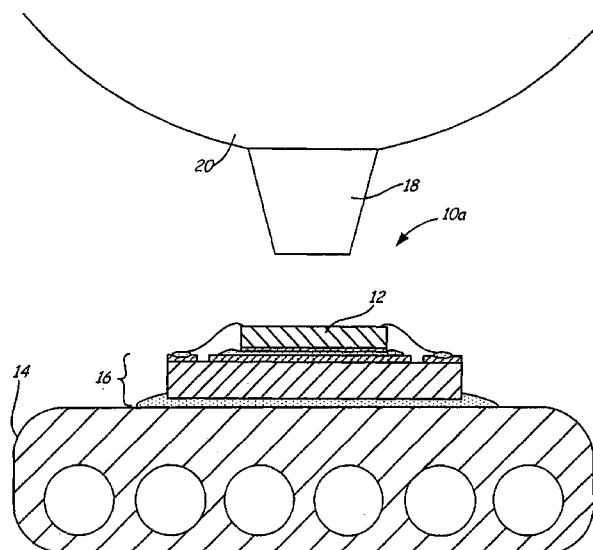
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[Continued on next page]

(54) Title: THERMAL MANAGEMENT OF CONCENTRATOR PHOTOVOLTAIC CELLS



(57) Abstract: A concentrated solar energy system includes a photovoltaic cell (12), an optical concentrator (20), a heat removal system (14), and means (16) for providing thermal contact between the photovoltaic cell (12) and the heat removal system (14). The optical concentrator (20) is configured to direct concentrated solar energy to the photovoltaic cell (12) such that the photovoltaic cell (12) generates electricity and heat. The heat removal system (14) removes heat from the photovoltaic cell (12). The means (16) for providing thermal contact provides an effective thermal conductivity per unit length between the photovoltaic cell (12) and the heat removal system (14) of greater than about 50 kilowatts per square meter per degree Celsius.



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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*

(88) Date of publication of the international search report:

28 August 2008

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2007/020278

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - H01L 31/00 (2008.04)

USPC - 136/259

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) - H01L 31/00, H01L 31/042, H01L 31/024 (2008.04)

USPC - 136/259, 136/246, 136/248, 136/252

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)

MicroPatent, IP.com, Patbase, Google Patent, IEEEEXPLORE, Google Scholar

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,180,414 A (DIAMOND et al) 25 December 1979 (25.12.1979) entire document	1-6,10,15-24, 26-32
Y		7,8,9,11,12,13,14,25
Y	US 5,672,297 A (SOANE) 30 September 1997 (30.09.1997) entire document	7,8
Y	US 5,594,623 A (SCHWEGLER) 14 January 1997 (14.01.1997) entire document	9
Y	US 4,092,697 A (SPAIGHT) 30 May 1978 (30.05.1978) entire document	11,12
Y	US 5,070,046 A (HU) 03 December 1991 (03.12.1991) entire document	13
Y	US 2002/0157818 A1 (NORLEY et al) 31 October 2002 (31.10.2002) entire document	14
Y	US 5,213,704 A (ANDERSON, JR. et al) 25 May 1993 (25.05.1993) entire document	25
Y	US 4,312,709 A (STARK et al) 26 January 1982 (26.01.1982) entire document	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

05 May 2008

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2007/020278

Continuation of Box III.

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 fees must be paid.

Group I, claims 1-17, drawn to a concentrated solar cell system comprising a photovoltaic cell, an optical concentrator; a heat removal system; means for providing thermal contact between the photovoltaic cell and the heat removal system, wherein the means for providing thermal contact provides a thermal conductivity per unit length of greater than about 50 kilowatts per square meter per degree Celsius.

Group II, claims 18-32, drawn to a solar cell and means for removing heat from a solar cell, comprising a solar cell; a heat removal system; and an interface structure positioned between the solar cell and the heat removal system, wherein at least 75 percent of the heat generated by the solar cell is transferred to the heat removal system.

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: the special technical feature of the Group I invention: a thermal contact which provides a thermal conductivity per unit length of greater than about 50 kilowatts per square meter per degree Celsius as claimed therein is not present in the invention of Group II. The special technical feature of the Group II invention: an interface structure wherein at least 75 percent of the heat generated by the solar cell is transferred to the heat removal system as claimed therein is not present in the invention of Group I.

The features of heat sinking devices are well known in the solar cell art, and include varied systems, such as fin configurations and water or air cooling. Therefore, the limitation of "a concentrated solar cell system comprising a photovoltaic cell, an optical concentrator; a heat removal system; a thermal contact between the photovoltaic cell and the heat removal system" is not considered a novel linking special technical feature as this limitation is clearly disclosed by US 4,180,414 A (DIAMOND et al) 25 December 1979, abstract; column 2, lines 17-31.

Since none of the special technical features of the Group I or II inventions are found in more than one of the inventions, unity of invention is lacking.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2007/020278

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:

See extra 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 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.