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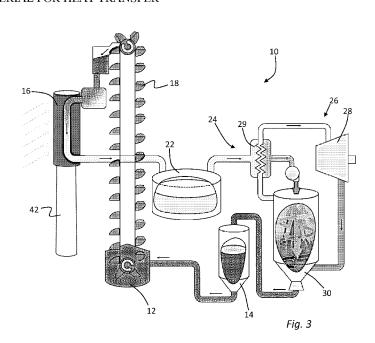
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- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

[Continued on next page]

(54) Title: CONCENTRATING SOLAR POWER METHODS AND SYSTEMS WITH LIQUID-SOLID PHASE CHANGE MATERIAL FOR HEAT TRANSFER



(57) Abstract: Concentrating solar power systems and methods featuring the use of a solid-liquid phase change heat transfer material (HTM). The systems and methods include a solar receiver to heat and melt a quantity of solid HTM. Systems also include a heat exchanger in fluid communication with the solar receiver providing for heat exchange between the liquid HTM and the working fluid of a power generation block. The systems and methods also include a hot storage tank in communication with the solar receiver and the heat exchanger. The hot storage tank is configured to receive a portion of the liquid HTM from the solar receiver for direct storage as a thermal energy storage medium. Thus, the system features the use of a phase change HTM functioning as both a heat transfer medium and a thermal energy storage me-



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#### INTERNATIONAL SEARCH REPORT

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PCT/US2012/045425 A. CLASSIFICATION OF SUBJECT MATTER
INV. F03G6/06 F24J2/07 F24J2/24 F03G6/06 ADD. 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) F03G F24J 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) EPO-Internal, WPI Data C. DOCUMENTS CONSIDERED TO BE RELEVANT Category\* Citation of document, with indication, where appropriate, of the relevant passages Relevant to claim No. χ US 4 727 930 A (BRUCKNER ADAM P [US] ET 1-6, 9-11,14, AL) 1 March 1988 (1988-03-01) 16-18, 27, 29-32.34 the whole document Υ 12,13,15 Χ US 2011/067398 A1 (SLOCUM ALEXANDER H [US] 1,2,5, 16,17, ET AL) 24 March 2011 (2011-03-24) 29,30,32 the whole document χ DE 10 2008 048655 A1 (FRAUNHOFER GES 1,7,8, 11,29, FORSCHUNG [DE]) 25 March 2010 (2010-03-25) 33,34 the whole document -/--Х Х 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 earlier application or patent but published on or after the international "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive filing date document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be special reason (as specified) 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 document published prior to the international filing date but later than the priority date claimed "&" document member of the same patent family Date of the actual completion of the international search Date of mailing of the international search report 7 November 2013 18/11/2013 Name and mailing address of the ISA/ Authorized officer

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European Patent Office, P.B. 5818 Patentlaan 2

## **INTERNATIONAL SEARCH REPORT**

International application No
PCT/US2012/045425

	Name and the second property of the second pr	PCT/US2012/045425						
C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT								
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.						
Υ	WO 2011/001546 A1 (MITSUBISHI HEAVY IND LTD [JP]; KOBAYASHI KAZUTA [JP]; TAGAWA MASASHI [) 6 January 2011 (2011-01-06) abstract; figures 2,4,5	12,13,15						
X,P	FR 2 966 567 A1 (CENTRE NAT RECH SCIENT [FR]; TOULOUSE INST NAT POLYTECH [FR]) 27 April 2012 (2012-04-27)	1-4,9, 12-14, 16, 18-23, 25-27, 29-32						
	the whole document							
Х	WO 2010/029411 A2 (INTERNEW ELECTRONICS S R L [IT]; STMG S R L [IT]; DE MARTINO PASQUALE) 18 March 2010 (2010-03-18)	18-20, 25-27						
Υ	abstract; figures 1,2	21-24						
Υ	US 2004/086021 A1 (LITWIN ROBERT ZACHARY [US]) 6 May 2004 (2004-05-06) abstract; figures 1-3	21-24						
А	DE 28 47 989 A1 (SOELCH ROLAND) 14 May 1980 (1980-05-14) the whole document	1-34						
A	US 4 586 334 A (NILSSON SR JACK E [US] ET AL) 6 May 1986 (1986-05-06) the whole document	1-34						
А	US 2011/083436 A1 (WHITE MAURICE [US] ET AL) 14 April 2011 (2011-04-14) the whole document	1-34						
Α	US 4 441 318 A (THECKSTON ALEXANDER [AU]) 10 April 1984 (1984-04-10) the whole document	1-34						
Α	WO 2010/093235 A2 (NEM B V [NL]; DE BRUIJN JACOBUS JOHANNES [NL]; MEERKERK ARIE [NL]; ROP) 19 August 2010 (2010-08-19) the whole document	1-34						

International application No. PCT/US2012/045425

## **INTERNATIONAL SEARCH REPORT**

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:								
Claims Nos.: because they relate to subject matter not required to be searched by this Authority, namely:    Authority								
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 additional sheet								
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 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.:								
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.  X  No protest accompanied the payment of additional search fees.								

# FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-17, 29-34

Relating to a concentrating solar power system provided with a heat exchanger for heat exchange between a heat transfer material and a working fluid of a power cycle and a hot storage tank for thermal energy storage using the heat transfer material as thermal energy storage medium. The technical effect can be considered to use the heat transfer material directly as thermal energy storage, thereby reducing the overall cost of the solar power system.

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2. claims: 18-28

Relating to a solar receiver provided with multiple receiver tubes oriented vertically. The technical effect can be considered to improve the heat absorption efficiency of the solar receiver.

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## **INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No
PCT/US2012/045425

	atent document d in search report		Publication date	Patent family member(s)		Publication date
US	4727930	Α	01-03-1988	NONE		
US	2011067398	A1	24-03-2011	AU 201029537 CN 10279202 KR 2012008342 US 201106739 US 201106769 WO 201103523	2 A 5 A 8 A1 0 A1	05-04-2012 21-11-2012 25-07-2012 24-03-2011 24-03-2011 24-03-2011
DE	102008048655	A1	25-03-2010	DE 10200804865 EP 233802 US 201127795 WO 201003448	1 A2 6 A1	25-03-2010 29-06-2011 17-11-2011 01-04-2010
WO	2011001546	A1	06-01-2011	AU 200934904 EP 245054 US 201125279 WO 201100154	8 A1 7 A1	07-07-2011 09-05-2012 20-10-2011 06-01-2011
FR	2966567	A1	27-04-2012	AU 201131741 CN 10327014 EP 263021 FR 296656 US 201328416 WO 201205266	4 A 9 A2 7 A1 3 A1	30-05-2013 28-08-2013 28-08-2013 27-04-2012 31-10-2013 26-04-2012
WO	2010029411	A2	18-03-2010	AU 200929052 CN 10220352 EP 233188 MA 3269 US 201119758 WO 201002941	0 A 3 A2 9 B1 5 A1	18-03-2010 28-09-2011 15-06-2011 02-10-2011 18-08-2011 18-03-2010
US	2004086021	A1	06-05-2004	NONE		
DE	2847989	A1	14-05-1980	NONE		
US	4586334	Α	06-05-1986	NONE		
US	2011083436	A1	14-04-2011	EP 249690 US 201108343 WO 201104708	6 A1	12-09-2012 14-04-2011 21-04-2011
US	4441318	A	10-04-1984	AU 490877 DE 293321 FR 243365 GB 202781 JP S5513737 SE 790673 US 444131	3 A1 1 A1 4 A 3 A 8 A	21-02-1980 28-02-1980 14-03-1980 27-02-1980 27-10-1980 15-02-1980
WO	2010093235	A2	19-08-2010	EP 239660 US 201203109 WO 201009323	4 A1	21-12-2011 09-02-2012 19-08-2010