



(51) International Patent Classification:

F22B 1/00 (2006.01) *F03G 6/00* (2006.01)
F01K 3/12 (2006.01) *F24J 2/34* (2006.01)
F01K 7/22 (2006.01)

(21) International Application Number:

PCT/IB2012/053874

(22) International Filing Date:

29 July 2012 (29.07.2012)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

61/514,196 2 August 2011 (02.08.2011) US

(71) Applicant (for all designated States except US):

BRIGHTSOURCE INDUSTRIES (ISRAEL) LTD.
 [IL/IL]; 11 Kiryat Mada St., Amot Bldg. #6 P.O. Box
 45220, Har Hotzvim, 91450 Jerusalem (IL).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **AFREMOV, Leon**

[IL/IL]; 17A Boulevard Haaskala, 67890 Tel Aviv (IL).
GANANY, Alon [IL/IL]; 42 Bavli Street, Apt# 6, 6291783
 Tel Aviv (IL).

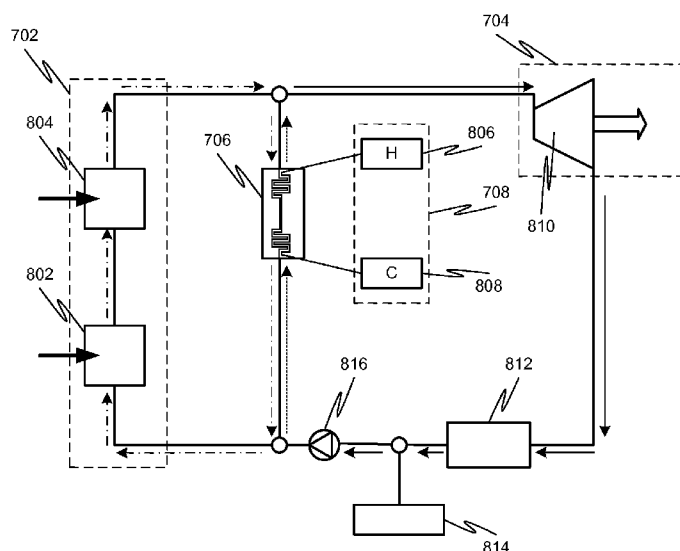
(74) Agent: **SHEFFIELD, Gershon**; c/o BRIGHTSOURCE
 INDUSTRIES ISRAEL LTD., 11 Kiryat Mada Street,
 Amot Bldg. #6, 91450 Jerusalem (IL).

(81) Designated States (unless otherwise indicated, for every
 kind of national protection available): AE, AG, AL, AM,
 AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,
 BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,
 DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
 HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP,
 KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD,
 ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI,
 NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW,
 SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, 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, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ,
 UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,
 TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,
 EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,
 MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
 TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
 ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: SOLAR ENERGY THERMAL STORAGE SYSTEMS AND METHODS

**FIG. 8**

(57) **Abstract:** Insolation can be used to heat pressurized water to produce supercritical steam using an evaporator (802) and superheater (804) for use in generating electricity (e.g., via a steam turbine (810)). During periods of relatively higher insolation, there can be more heat energy (i.e., enthalpy) in the supercritical steam than what is needed or desired for electricity generation or can be used within the capacity constraints of a provided power block. Alternatively or additionally, it may be desirable to store energy from insolation to supplement or provide electricity generation at a later time. In general, enthalpy in supercritical steam produced by the insolation can be stored in a thermal storage system (708) (i.e., charging the storage system) for subsequent use, for example, during periods of relatively lower insolation or at times when supplemental electricity generation is desired. The use of supercritical steam can result in a higher temperature for the thermal storage system, which can be used to generate superheated steam independent of or in addition to insolation steam generation.



Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

— *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))*

Published:

— *with international search report (Art. 21(3))*

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

18 July 2013

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2012/053874

A. CLASSIFICATION OF SUBJECT MATTER INV. F22B1/00 F01K3/12 F01K7/22 F03G6/00 F24J2/34 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) F22B F24J F03G F01K 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 <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>X,P</td> <td> WO 2012/093354 A2 (BRIGHTSOURCE IND ISRAEL LTD [IL]; AFREMOV LEON [IL]) 12 July 2012 (2012-07-12) page 1, line 12 - page 3, line 14 page 5, line 11 - page 9, line 28 page 14, line 1 - page 15, line 18 page 18, line 27 - page 21, line 35; figures ----- </td> <td>37-55</td> </tr> <tr> <td>E</td> <td> WO 2012/107811 A2 (BRIGHTSOURCE IND ISRAEL LTD [IL]; AFREMOV LEON [IL]; GOLDWINE GIDEON [IL]) 16 August 2012 (2012-08-16) page 1, line 14 - page 5, line 2 page 13, line 32 - page 22, line 29; figures ----- -/-- </td> <td>37-55</td> </tr> </tbody> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	X,P	WO 2012/093354 A2 (BRIGHTSOURCE IND ISRAEL LTD [IL]; AFREMOV LEON [IL]) 12 July 2012 (2012-07-12) page 1, line 12 - page 3, line 14 page 5, line 11 - page 9, line 28 page 14, line 1 - page 15, line 18 page 18, line 27 - page 21, line 35; figures -----	37-55	E	WO 2012/107811 A2 (BRIGHTSOURCE IND ISRAEL LTD [IL]; AFREMOV LEON [IL]; GOLDWINE GIDEON [IL]) 16 August 2012 (2012-08-16) page 1, line 14 - page 5, line 2 page 13, line 32 - page 22, line 29; figures ----- -/--	37-55
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.									
X,P	WO 2012/093354 A2 (BRIGHTSOURCE IND ISRAEL LTD [IL]; AFREMOV LEON [IL]) 12 July 2012 (2012-07-12) page 1, line 12 - page 3, line 14 page 5, line 11 - page 9, line 28 page 14, line 1 - page 15, line 18 page 18, line 27 - page 21, line 35; figures -----	37-55									
E	WO 2012/107811 A2 (BRIGHTSOURCE IND ISRAEL LTD [IL]; AFREMOV LEON [IL]; GOLDWINE GIDEON [IL]) 16 August 2012 (2012-08-16) page 1, line 14 - page 5, line 2 page 13, line 32 - page 22, line 29; figures ----- -/--	37-55									
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.											
* 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		Date of mailing of the international search report									
5 March 2013		27/05/2013									
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer									
		Henkes, Roeland									

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2012/053874

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 103 29 623 B3 (DEUTSCH ZENTR LUFT & RAUMFAHRT [DE]) 13 January 2005 (2005-01-13)	37-58
Y	paragraphs [0006] - [0011], [0019] - [0039], [0047] - [0077]; figures 1,3 -----	1-36
X	DE 25 10 168 A1 (DORNIER SYSTEM GMBH) 16 September 1976 (1976-09-16)	37-50
A	page 2, line 27 - page 6, line 30 page 7, lines 12-20 - pages - -----	1-36, 51-55
X	WO 2010/052172 A1 (DEUTSCH ZENTR LUFT & RAUMFAHRT [DE]; OLWIG RALF [DE]; SATTLER CHRISTIA) 14 May 2010 (2010-05-14)	50-58
Y	page 6, line 3 - page 9, line 7; figures	1-36
A	-----	37-49
X	US 2008/276616 A1 (FLYNN BRIAN J [US] ET AL) 13 November 2008 (2008-11-13)	37-50
A	paragraphs [0007], [0010] - [0014], [0074] - [0081]; figures 1-3,12,13 -----	1-36, 51-55
A	US 2009/229264 A1 (GILON YOEL [IL] ET AL) 17 September 2009 (2009-09-17)	1,19,31, 37,44, 50,56
	paragraphs [0028], [0037] - [0039]; claims -----	
X	DE 41 21 460 A1 (DEUTSCHE FORSCH LUFT RAUMFAHRT [DE]) 14 January 1993 (1993-01-14)	19-29, 37,39-58
A	column 5, line 41 - column 8, line 39; figures -----	1-18, 30-36

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2012/053874

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2012093354	A2	12-07-2012	NONE
WO 2012107811	A2	16-08-2012	NONE
DE 10329623	B3	13-01-2005	NONE
DE 2510168	A1	16-09-1976	NONE
WO 2010052172	A1	14-05-2010	DE 102009007915 A1 20-05-2010 US 2011198208 A1 18-08-2011 WO 2010052172 A1 14-05-2010
US 2008276616	A1	13-11-2008	US 2008276616 A1 13-11-2008 WO 2010009053 A2 21-01-2010
US 2009229264	A1	17-09-2009	NONE
DE 4121460	A1	14-01-1993	DE 4121460 A1 14-01-1993 IL 102320 A 15-03-1995 US 5269145 A 14-12-1993

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2012/053874

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 additional 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 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.:

see additional sheet(s)

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.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

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

1. claims: 1-58

A method and system for generating electricity from insulation and from thermal storage fluid, comprising a heat exchanger arrangement designed to generate steam to drive at least one turbine and with a particular design of the heat exchanger - turbine connections.

2. claims: 59-67

A system for generating electricity from insulation and from thermal storage fluid, comprising only a particular heat exchanger arrangement designed to generate steam, without any turbine or other arrangement suitable for producing electricity and while defining in independent claim 59 particularly desired pressure levels in the heat exchanger arrangement.
