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Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

— *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))*

(88) Date of publication of the international search report:
13 March 2014

(54) Title: HIGH TEMPERATURE DIRECT SOLAR THERMAL CONVERSION

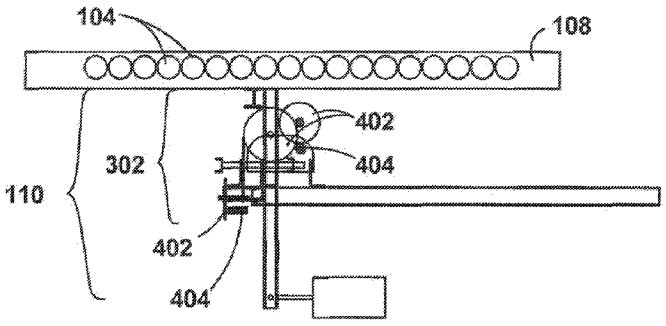

Figure 4

(57) Abstract: Technical challenges of efficiently and cost-effectively deriving energy from the sun are addressed using a manifold and an array of evacuated tubes in fluid connection, in a butterfly or other planar arrangement. Tube and manifold fluid guides are plumbed for coaxial flow and/or parallel flow, and thermally protected by sleeves, stainless steel piping, and/or vacuum. Tubes are provided with a selective low emissivity coating and/or internal mirror to reduce thermal loss. The solar absorption surface of evacuated tubes may be five square meters or more, with only low-quality concentration optics, or no concentration optics used. The tubes array tracks the sun with a two-axis motion platform. Fluid operating temperatures range from 150 to 300 degrees centigrade, depending on the sunlight exposure, working fluid, and supplemental heat source if any. Fluid may circulate heat between the manifold and heat engine, cogeneration facility, and/or other module.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/048903

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - F24J 2/24 (2014.01)
USPC - 126/663
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) - F24J 2/05, 2/14, 2/24, 2/48 (2014.01)
USPC - 126/651, 652, 655, 658, 660, 661, 663, 676, 677, 678

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
CPC - F24J 2/055, 2/14, 2/485; Y02E 10/44, 10/46 (2013.01)

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X -- Y	US 2010/0108055 A1 (DAVIS et al) 06 May 2010 (06.05.2010) entire document	1, 4-12, 18, 21, 22 ---------- 19, 20
Y	US 4,554,908 A (HANLET et al) 26 November 1985 (26.11.1985) entire document	19
Y	US 2008/0308091 A1 (CORIO) 18 December 2008 (18.12.2008) entire document	20
A	US 4,346,694 A (MOAN) 31 August 1982 (31.08.1982) entire document	1-23
A	WO 2011/021172 A2 (PELAN et al) 24 February 2011 (24.02.2011) entire document	1-23
A	US 2010/0018522 A1 (SCHEDLETZKY) 28 January 2010 (28.01.2010) entire document	1-23

☐ 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	Date of mailing of the international search report
31 January 2014	14 FEB 2014
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: Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/048903

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 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 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.:
1-23

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.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/US2013/048903

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 1-23 are drawn to a system.

Group II, claims 24-33 are drawn to a method of transforming sunlight into contained heat.

The inventions listed as Groups I - 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 features of Group I, each fluid guide is a direct flow coaxial flow fluid guide having a fluid return pipe coaxially inside a fluid supply pipe, and the fluid return pipe is stainless steel or another material having a thermal conductivity lower than a copper pipe of the same size and configuration; each fluid guide is a direct flow coaxial flow fluid guide having a fluid return pipe coaxially inside a fluid supply pipe, and the fluid return pipe is thermally insulated (e.g., by a sleeve) from the interior of the fluid supply pipe; each fluid guide is a direct flow coaxial flow fluid guide having a fluid return pipe coaxially inside a fluid supply pipe, a supply fitting is located at a junction of the manifold fluid supply and the tube fluid supply, a return fitting is located at a junction of the manifold fluid return and the tube fluid return, and the return fitting is contained, within a fluid supply, are not present in Group II; and the special technical features of Group II, the method receives sunlight which is at least ninety percent direct; the method receives sunlight on at least five square meters of absorber surfaces within the evacuated tubes; the method receives sunlight on at least ten square meters of absorber surfaces within the evacuated tubes; the method heats the fluid to at least 150 degrees centigrade within the fluid return within the manifold without requiring solar concentration; the method heats the fluid to at least 200 degrees centigrade within the fluid return within the manifold without requiring solar concentration; the method heats the fluid to at least 250 degrees centigrade within the fluid return within the manifold without requiring solar concentration; the method heats the fluid to at least 300 degrees centigrade within the fluid return within the manifold without requiring solar concentration; the method receives sunlight that is redirected (namely, reflected and/or concentrated) via imaging optics (e.g., non-anidolic optics) to the front and/or back of the absorber surfaces in addition to direct sunlight received on the absorber front surface, are not present in Group I.

Further, Groups I and II share the technical features of multiple evacuated tubes; a manifold; the manifold comprising a manifold fluid supply; and a manifold fluid return. However, these technical features do not represent a contribution over the prior art. Specifically, WO 2009/063117 A1 to Torrens teaches a hydraulic manifold for solar collectors with heat dissipater to prevent overheating (Title), comprising multiple evacuated tubes (100, 101); a hydraulic manifold (120); the hydraulic manifold comprising inlets and outlets at the hottest ends of the solar collectors. The hydraulic manifold (120) comprises: an inlet connector (124) or manifold fluid return, for the line (16) returning from the installation; an outlet connector (125) or manifold fluid supply for the line (11) leading to the installation (Abstract).

Since none of the special technical features of the Groups I - II inventions is found in more than one of the inventions, unity is lacking.