Title: USE OF UNIDIRECTIONAL FLOW MODES OF MAGNETIC COOLING SYSTEMS

Abstract: A dual-mode magnetic refrigeration apparatus includes beds of magnetocaloric material, a magnet to apply a time-varying magnetic field to the beds, a heat transfer fluid (HTF), a pump to circulate the HTF, a hot side heat exchanger (HHEX), a cold side heat exchanger (CHEX), valves to direct flow of the HTF, and a controller configured to control periodic switching of the valves to allow the apparatus to operate in a first mode and in a second mode. The first mode transfers heat from the CHEX to the HHEX. In the second mode of operation, the periodic switching of the valves is suspended to allow unidirectional flow of the HTF through the HHEX, the beds, and the CHEX such that heat is transferred from the HHEX to the CHEX.
**INTERNATIONAL SEARCH REPORT**

**International application No.**
PCT/US2013/075009

**A. CLASSIFICATION OF SUBJECT MATTER**
F25B 21/02(2006.01)i, F25B 13/00(2006.01)i, F25B 49/00(2006.0) i

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)
F25B 21/02; F25B 21/00; F25B 13/00; F25B 49/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: refrigeration, magnet, heat exchanger, controller, valve, and bed

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

<table>
<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>A</td>
<td>US 5934078 A (LAWTON, JR. et al.) 10 August 1999 See abst ract, column 6, line 51 - column 10, line 4, and figures 1-2.</td>
<td>1-40</td>
</tr>
<tr>
<td>A</td>
<td>US 6526759 B2 (ZIMM et al.) 04 March 2003 See abst ract, column 5, line 5 - column 6, line 37, column 7, line 24 - column 8, line 60, and figures 1,3-5.</td>
<td>1-40</td>
</tr>
<tr>
<td>A</td>
<td>S0 03-016794 AI (ABB AB et al.) 27 February 2003 See abst ract, page 12, line 14 - page 18, line 24, and figures 1-4.</td>
<td>1-40</td>
</tr>
<tr>
<td>A</td>
<td>US 2009-0308079 A (LEE, DONG KWAN) 17 December 2009 See abst ract, paragraphs [0044]- [0060], and figures 4-5.</td>
<td>1-40</td>
</tr>
<tr>
<td>A</td>
<td>US 2011-0146300 AI (DUVAL, JEAN-MARC) 23 June 2011 See abst ract, paragraphs [0029]- [0030], and figure 1.</td>
<td>1-40</td>
</tr>
</tbody>
</table>

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

**Date of the actual completion of the international search**
26 August 2014 (26.08.2014)

**Date of mailing of the international search report**
26 August 2014 (26.08.2014)

**Name and mailing address of the ISA/KR**
International Application Division
Korean Intellectual Property Office
189 Cheongna-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea

Fax E-mail No. +82-42-472-7140

**Authorized officer**
OH, Jae Min

**Telephone No.** +82-42-481-873 1

Form PCT/ISA/210 (second sheet) (July 2009)
<table>
<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>JP 04283994 B2</td>
<td>24/06/2009</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2002-502949 A</td>
<td>29/01/2002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>KR 10-0577716 Bl</td>
<td>10/05/2006</td>
</tr>
<tr>
<td></td>
<td></td>
<td>wo 99-40378 Al</td>
<td>12/08/1999</td>
</tr>
<tr>
<td>US 6526759 B2</td>
<td>04/03/2003</td>
<td>AT 362084 T</td>
<td>15/06/2007</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AU 8642601 A</td>
<td>18/02/2002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BR 0113171 A</td>
<td>24/06/2003</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BR 0113171 Bl</td>
<td>23/02/2010</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CN 100412467 C</td>
<td>20/08/2008</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CN 1468357 A</td>
<td>14/01/2004</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 60128361 D</td>
<td>21/06/2007</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 60128361 T2</td>
<td>17/01/2008</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DK 1307692 T3</td>
<td>10/09/2007</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 1307692 Al</td>
<td>07/05/2003</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 1307692 A4</td>
<td>20/07/2005</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 1307692 Bl</td>
<td>09/05/2007</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ES 2284683 T</td>
<td>16/11/2007</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 04879449 B2</td>
<td>22/02/2012</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2004-506168 A</td>
<td>26/02/2004</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2004-506168 T</td>
<td>26/02/2004</td>
</tr>
<tr>
<td></td>
<td></td>
<td>KR 10-0797681 Bl</td>
<td>23/01/2008</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2002-053209 Al</td>
<td>09/05/2002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>wo 02-12800 Al</td>
<td>14/02/2002</td>
</tr>
<tr>
<td>wo 03-016794 Al</td>
<td>27/02/2003</td>
<td>SE 0102753 DO</td>
<td>17/08/2001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CN 101512250 B</td>
<td>12/01/2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 2038591 Al</td>
<td>25/03/2009</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 2038591 A4</td>
<td>01/05/2013</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 05126992 B2</td>
<td>23/01/2013</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2009-543022 A</td>
<td>03/12/2009</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2009-543022 T</td>
<td>03/12/2009</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 8448452 B2</td>
<td>28/05/2013</td>
</tr>
<tr>
<td></td>
<td></td>
<td>wo 2008-007834 Al</td>
<td>17/01/2008</td>
</tr>
<tr>
<td>US 2011-0146300 Al</td>
<td>23/06/2011</td>
<td>AT 555353 T</td>
<td>15/05/2012</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 2300755 A2</td>
<td>30/03/2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 2300755 Bl</td>
<td>25/04/2012</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FR 2932254 A</td>
<td>11/12/2009</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FR 2932254 Bl</td>
<td>20/08/2010</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 8429920 B2</td>
<td>30/04/2013</td>
</tr>
<tr>
<td></td>
<td></td>
<td>wo 2010-000962 A2</td>
<td>07/01/2010</td>
</tr>
</tbody>
</table>

Form PCT/ISA/210 (patent family annex) (July 2009)
<table>
<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
</tr>
</thead>
<tbody>
<tr>
<td>WO 2010-000962 A3</td>
<td>18/03/2010</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>