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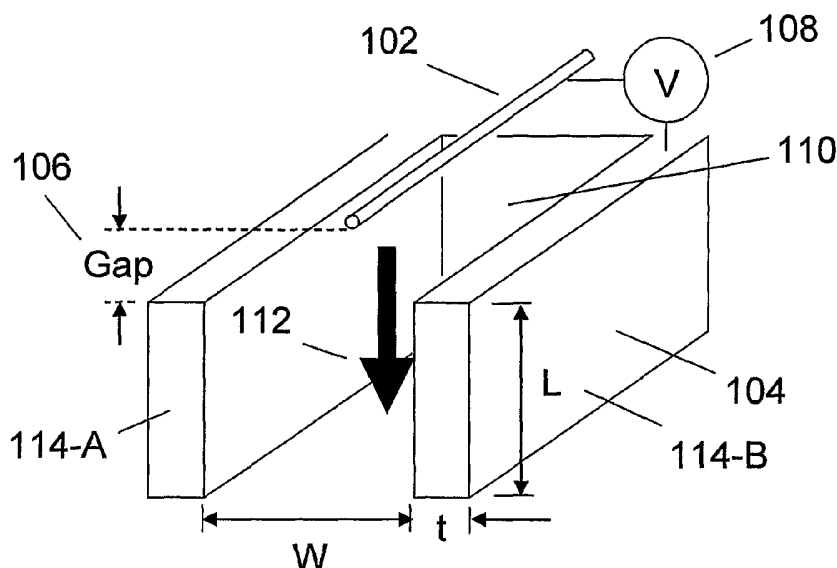
— with international search report

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

30 November 2006

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: ELECTRO-HYDRODYNAMIC PUMP AND COOLING APPARATUS COMPRISING AN ELECTRO-HYDRODYNAMIC PUMP



(57) Abstract: The present invention relates to cooling systems, and in particular to cooling systems providing forced convective gaseous flow. According to one aspect, a cooling system employs a heat sink in combination with an EHD pumping mechanism such as corona wind or micro-scale corona wind or by a temporally controlled ion-generation technique. A channel-array structure can be employed to embody the heat sink. The EHD pumps are located at the inlet or outlet of the heat sink channels. Many advantages are achieved by the cooling system of the invention, including that the entire system can have similar or better performance than a conventional heat sink and fan system but with one-tenth the volume and weight and can operate silently. The present invention also relates to a method of fabricating a micro-channel heat sink employing EHD gas flow.

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2006/002631

A. CLASSIFICATION OF SUBJECT MATTER

INV. F04B19/00 F04B17/00 F04B35/00

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)

F04B

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 practical, search terms used)

EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2005/007726 A1 (SCHLITZ DANIEL J ET AL) 13 January 2005 (2005-01-13) cited in the application abstract paragraph [0011] - paragraph [0031] figures -----	9-11, 14-16, 18,19, 22,34, 39-46, 48,49,51
X	US 2003/090209 A1 (KRICHTAFOVITCH IGOR A ET AL) 15 May 2003 (2003-05-15) abstract paragraph [0034] - paragraph [0062] figures ----- -/--	1-5,7,8



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 document 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

23 May 2006

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

International application No

PCT/US2006/002631

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2004/155612 A1 (KRICHTAFOVITCH IGOR A) 12 August 2004 (2004-08-12) abstract paragraph [0019] - paragraph [0060] figures -----	1-5,7,8
X	WO 99/35893 A (THE UNIVERSITY OF TENNESSEE RESEARCH CORPORATION; THE GOVERNMENT OF TH) 15 July 1999 (1999-07-15) abstract page 7, line 20 - page 9, line 34 figures 1-4 -----	1-3,5
A	US 2004/244406 A1 (SAVITSKY ANATOLY-IVANOVICH [RU] ET AL) 9 December 2004 (2004-12-09) abstract paragraph [0080] - paragraph [0081] figure 11 -----	1-3,5-7
A	US 3 267 860 A (BROWN THOMAS TOWNSEND) 23 August 1966 (1966-08-23) column 2, line 35 - column 3, line 54 figures -----	1,5-7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2006/002631**Box 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 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 fee, this Authority did not invite payment of any additional fee.
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.:

1-8

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ 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: 1-8

An electro-hydrodynamic pump

2. claims: 9-50

A cooling apparatus

3. claims: 51-58

A method of fabricating a cooling apparatus

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2006/002631

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2005007726 A1	13-01-2005	NONE	
US 2003090209 A1	15-05-2003	NONE	
US 2004155612 A1	12-08-2004	US 2005151490 A1	14-07-2005
WO 9935893 A	15-07-1999	AU 3180099 A	26-07-1999
US 2004244406 A1	09-12-2004	WO 03019763 A1	06-03-2003
US 3267860 A	23-08-1966	NONE	