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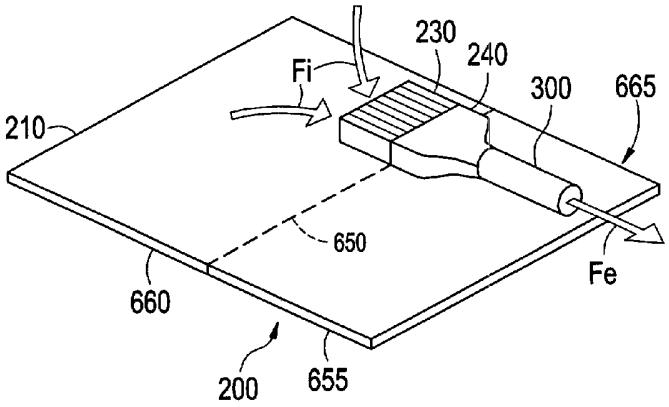
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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: METHOD, SYSTEM AND APPARATUS FOR COOLING HIGH POWER DENSITY DEVICES



(57) Abstract: A turbomachinery system (200) for cooling a high power density device (220) includes a turbomachine (300, 405, 505) configured to deliver a high flux cooling medium and a high power density device (220) arranged in fluid communication with the turbomachine (300, 405, 505), the turbomachine (300, 405, 505) having a motor (310) and a compressor (340) driven by the motor (310).

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INTERNATIONAL SEARCH REPORT

'US 03/37738

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01L23/467 F04D29/58 F04D25/08

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 7 H01L F04D

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 2002, no. 05, 3 May 2002 (2002-05-03) -& JP 2002 026560 A (FUJIKURA LTD), 25 January 2002 (2002-01-25)	1,2,6,9, 14,18, 19, 33-36, 82,83, 85,86
A	abstract	16,40,41
A	US 2002/037225 A1 (JI YOO CHOI ET AL) 28 March 2002 (2002-03-28) the whole document	1,33,40, 41,84
A	US 5 936 836 A (SCHOLDER ERICA) 10 August 1999 (1999-08-10) the whole document	16

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"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
16 June 2004	20 OCT 2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Toussaint, F

Form PCT/ISA/210 (second sheet) (January 2004)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 263 955 B1 (AZAR KAVEH) 24 July 2001 (2001-07-24) figure 34	8
P,X	US 2003/185689 A1 (WANG CHIN-WEN) 2 October 2003 (2003-10-02) the whole document	1,15,33, 37,84

INTERNATIONAL SEARCH REPORT

PCT/US 03/37738

Box I Observations where certain claims were found unsearchable (Continuation of item 1 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 II Observations where unity of invention is lacking (Continuation of item 2 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.:

1-32,40-41;33-41;82-84

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: 1-32, 40-41; 33-41; 82-84

   (i) a turbomachinery system for cooling a high power density density device comprising a turbomachine and a HPDD
   (ii) a turbomachine for delivering a high flux cooling medium to a device
   (iii) a turbomachinery system for cooling a HPDD comprising a surface and a turbomachine

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2. claims: 42-47, 48-49

   (i) a turbomachinery module used for cooling HPDDs comprising a module surface, a turbomachine, a housing, a heat exchanger and a transition duct and
   (i) a method for cooling a HPDD

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3. claims: 50-53

   a method for delivering a high flux medium to a HPDD in a closed loop cycle

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4. claims: 54-57, 58-59

   (i) a micro turbocompressor for delivering a high flux cooling medium to a device comprising a motor, a first stage micro compressor and a second stage micro compressor
   (ii) a micro turbocompressor for delivering a high flux cooling medium to a device comprising a motor and a plurality of micro compressors

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5. claims: 60, 61, 75-77

   (i) a heat exchanger for cooling a HPDD comprising a base and a plurality of cooling fins having a plurality of concavities
   (ii) a heat exchanger for cooling a HPDD comprising a base and a plurality of cooling fins and a localized region of increased surface area
   (ii) a method for enhancing the heat transfer characteristic of a heat exchanger for cooling a HPDD

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6. claims: 62-72, 73-74

   a heat exchanger for cooling a HPDD comprising a base, a plurality of cooling fins and a vortex chamber

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FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

7. claims: 78-80, 81

(i) a transition duct for a turbomachinery system
(ii) a method for transitioning high flux air

INTERNATIONAL SEARCH REPORT

Information on patent family members

US 03/37738

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2002026560 A	25-01-2002	NONE	
US 2002037225 A1	28-03-2002	KR 2002024903 A	03-04-2002
		CN 1346021 A	24-04-2002
		JP 3523205 B2	26-04-2004
		JP 2002106495 A	10-04-2002
US 5936836 A	10-08-1999	NONE	
US 6263955 B1	24-07-2001	US 5957194 A	28-09-1999
		CA 2258896 A1	31-12-1997
		WO 9750125 A1	31-12-1997
		US 2001003302 A1	14-06-2001
		US 2001003303 A1	14-06-2001
		US 2001003304 A1	14-06-2001
		US 6234239 B1	22-05-2001
		US 6161610 A	19-12-2000
		US 6269002 B1	31-07-2001
US 2003185689 A1	02-10-2003	NONE	