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(54) **Title:** HEAT EXCHANGER WITH FOAM FINS

(57) **Abstract:** Heat exchangers are described that employ fins made of a heat conducting foam material to enhance heat transfer. The foam fins can be used in any type of heat exchanger including, but not limited to, a plate-fin heat exchanger, a plate-frame heat exchanger or a shell-and-tube heat exchanger. The heat exchangers employing foam fins described herein are highly efficient, inexpensive to build, and corrosion resistant. The described heat exchangers can be used in a variety of applications, including but not limited to, low thermal driving force applications, power generation applications, and non-power generation applications such as refrigeration and cryogenics. The fins can be made from any thermally conductive foam material including, but not limited to, graphite foam or metal foam.



INTERNATIONAL SEARCH REPORT

International application No

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A. CLASSIFICATION OF SUBJECT MATTER

INV. F28F1/12 F28F13/00 F28F21/02
ADD.

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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F28F

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

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 2 124 009 A2 (BOEING CO [US]) 25 November 2009 (2009-11-25) abstract paragraph [0007] - paragraph [0008] paragraph [0010] - paragraph [0011] paragraph [0013] -----	1-25
X	EP 1 553 379 A1 (BALCKE DUERR GMBH [DE]) 13 July 2005 (2005-07-13) paragraph [0025] - paragraph [0032] -----	1,6,9, 16,22
X	US 2010/006273 A1 (DU JIAN HUA [US] ET AL) 14 January 2010 (2010-01-14) abstract paragraph [0019] - paragraph [0032] ----- -/-	1,9,22



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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 2007/228113 A1 (DUPREE RONALD L [US] ET AL) 4 October 2007 (2007-10-04) paragraph [0018] - paragraph [0024] -----	1,5,9, 10,15,22
A	US 2009/126918 A1 (CAMPAGNA MICHAEL JOSEPH [US] ET AL) 21 May 2009 (2009-05-21) paragraph [0015] - paragraph [0020] -----	1-25

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2012/023788

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2124009	A2	25-11-2009	CA 2659944 A1 20-11-2009
			EP 2124009 A2 25-11-2009
			US 2009288814 A1 26-11-2009

EP 1553379	A1	13-07-2005	CA 2490563 A1 08-07-2005
			CN 1645030 A 27-07-2005
			EP 1553379 A1 13-07-2005
			JP 4014600 B2 28-11-2007
			JP 2005207732 A 04-08-2005
			US 2005178534 A1 18-08-2005

US 2010006273	A1	14-01-2010	NONE

US 2007228113	A1	04-10-2007	CN 101410688 A 15-04-2009
			DE 112007000796 T5 12-02-2009
			US 2007228113 A1 04-10-2007
			WO 2007126474 A1 08-11-2007

US 2009126918	A1	21-05-2009	NONE
