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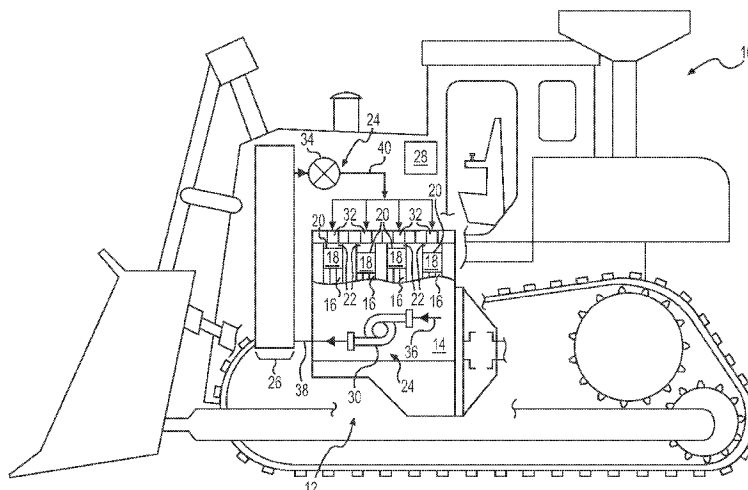


FIG. 1

(57) Abstract: A cooling system (26) is provided having a first heat exchanger (44) configured to remove heat from at least a portion of a first fluid and a second heat exchanger (46) configured to remove heat from a portion of a second fluid. The second heat exchanger is located downstream of the first heat exchanger relative to the flow of air passing through the first heat exchanger so that a substantial portion of the air passing through the first heat exchanger also passes through the second heat exchanger. The cooling system also has a valve (68) located to regulate the flow of the second fluid through the second heat exchanger. The cooling system further has a controller (86) configured to actuate the valve to regulate the flow of the second fluid through the second heat exchanger when the first heat exchanger is removing heat from the first fluid.



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2009/043335**A. CLASSIFICATION OF SUBJECT MATTER*****F28D 1/00(2006.01)i, F28D 5/00(2006.01)i, F28F 9/00(2006.01)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)

IPC: F28D, B60H, B60K

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 since 1975

Japanese Utility models and applications for Utility models since 1975

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

eKOMPASS (KIPO internal) & Keywords: heat, exchanger, tier, control, valve, downstream

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2004/0045749 A1 (ARUN KUMAR JAURA et al.) 11 March 2004 See Paragraph [0030] - Paragraph [0038] and Figures 2,3.	1-10
A	US 2003/0106669 A1 (PETER AMBROS et al.) 12 June 2003 See Paragraph [0026] - Paragraph [0034] and Figure 3.	1-10
A	EP 0522288 B1 (MERCEDES-BENZ AG) 14 September 1994 See Claims 1, 2 and Figure 2.	1-10
A	JP 2003-185384 A (SHIN CATERPILLAR MITSUBISHI LTD.) 3 July 2003 See Paragraph [0024] - Paragraph [0033] and Figures 1-3	1-10



Further documents are listed in the continuation of Box C.



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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2004-0045749 A1	11.03.2004	EP 1396370 A1 JP 4139294 B2 JP 2004-100956 A JP 04-139294 B2	10.03.2004 27.08.2008 02.04.2004 13.06.2008
US 2003-0106669 A1	12.06.2003	DE 19928193 A1 SE 520741 C2 SE 9902650 L SE 9902650 D0 SE 9902650 A US 06957689 B2 US 06619379 B1 US 2006-0048922 A1	13.01.2000 19.08.2003 10.01.2000 09.07.1999 10.01.2000 25.10.2005 16.09.2003 09.03.2006
EP 0522288 B1	14.09.1994	AT 139792 A AT 402839 B DE 4122899 C1 EP 0522288 A1 EP 0522471 A1 EP 0522471 B1	15.01.1997 25.09.1997 03.09.1992 13.01.1993 13.01.1993 27.04.1994
JP 2003-185384 A	03.07.2003	None	