



- (51) International Patent Classification:
B60H 1/02 (2006.01)
- (21) International Application Number:
PCT/US2011/067678
- (22) International Filing Date:
28 December 2011 (28.12.2011)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
12/982,990 31 December 2010 (31.12.2010) US
13/212,860 18 August 2011 (18.08.2011) US
- (71) Applicant (for all designated States except US): **CUMMINS INC.** [US/US]; 500 Jackson Street, Columbus, IN 47202 (US).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **MADURAI KUMAR, Mahesh** [IN/US]; 82 Salzburg Boulevard, Apt. #F, Columbus, IN 47201 (US). **ANDREAE, Morgan, M.** [US/US]; 13417 State Road 46 West, Columbus, IN 47201 (US).
- (74) Agents: **WILLS, J., Stephen** et al.; Krieg DeVault LLP, One Indiana Square, Suite 2800, Indianapolis, IN 46204 (US).
- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.
- (84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: HYBRID VEHICLE POWERTRAIN COOLING SYSTEM

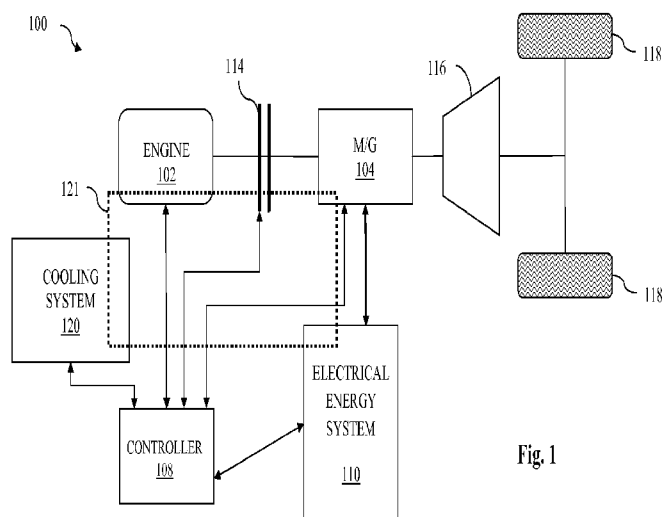


Fig. 1

(57) Abstract: Some exemplary embodiments include a hybrid vehicle cooling system comprising a closed loop coolant flowpath including a valve operable to direct coolant flow to an internal combustion engine or to an internal combustion engine bypass, a thermostat operable to direct coolant flow from the internal combustion engine or the internal combustion engine bypass to a radiator or a radiator bypass, a plurality of hybrid powertrain components positioned in parallel to receive coolant flow from the radiator or the radiator bypass, a mechanically driven coolant pump operable to pump coolant through the closed loop coolant flowpath, and an electrically driven coolant pump operable to pump coolant through the closed loop coolant flowpath. Additional exemplary embodiments include methods of operation and/or control of hybrid vehicle cooling systems.

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

7 September 2012

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2011/067678

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - B60H 1/02 (2012.01)

USPC - 237/12.3B

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(8) - B60H 1/00, 1/02, 1/04 (2012.01)

USPC - 237/12.1, 12.3B; 180/65.1, 65.2

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)

PatBase, Google Patent Search, Google Scholar

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2003/0127528 A1 (SABHAPATHY et al) 10 July 2003 (10.07.2003) entire document	1-11
Y	US 6,607,142 B1 (BOGGS et al) 19 August 2003 (19.08.2003) entire document	1-11
A	US 2004/0069546 A1 (LOU et al) 15 April 2004 (15.04.2004) entire document	1-11
A	US 2010/0270874 A1 (STERVIK et al) 28 October 2010 (28.10.2010) abstract; paragraphs 9-10, 37, 42, claim 1	1-11

☐ Further documents are listed in the continuation of Box C.


* 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 application or patent 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

28 June 2012

Date of mailing of the international search report

13 JUL 2012

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450

Facsimile No. 571-273-3201

Authorized officer:

Blaine R. Copenheaver

PCT Helpdesk: 571-272-4300
PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2011/067678

Box No. 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 No. 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 extra 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 additional fees, this Authority did not invite payment of additional fees.
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.:
1-11

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

Continuation of Box III.

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I, claims 1-11, drawn to a hybrid vehicle cooling system comprising a valve operable to direct coolant flow, a thermostat, a plurality of hybrid powertrain components positioned in parallel, a radiator or a radiator bypass, a mechanically driven coolant pump, an electrically driven coolant pump.

Group II, claims 12-23, drawn to a hybrid vehicle and method comprising power electronics operable to provide power to the electric machine, a controller operable to control the electric machine and the power electronics to provide power to the electric machine, the controller is operable to selectively increase the temperature of the internal combustion engine.

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: the special technical feature of the Group I invention: a valve, a thermostat, a plurality of hybrid powertrain components positioned in parallel, a radiator or a radiator bypass, a mechanically driven coolant pump, an electrically driven coolant pump, as claimed therein is not present in the invention of Group II. The special technical feature of the Group II invention: power electronics and a controller, as claimed therein is not present in the invention of Groups I.

Groups I and II lack unity of invention because even though the inventions of these groups require the technical feature of a hybrid vehicle cooling system comprising a closed loop coolant flowpath including an internal combustion engine, measuring the temperature of the device, pumping the coolant through the flowpath, this technical feature is not a special technical feature as it does not make a contribution over the prior art in view of US 2010/0270874 A1 (STERVIK et al) 28 October 2010 (28.10.2010) abstract; paragraphs 9-10, 37, 42, claim 1.

Since none of the special technical features of the Group I or II inventions are found in more than one of the inventions, unity of invention is lacking.