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(11) **EP 1 405 991 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
07.04.2004 Bulletin 2004/15

(51) Int Cl.7: **F01P 7/16, F01P 3/02**

(21) Application number: **03022278.0**

(22) Date of filing: **01.10.2003**

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IT LI LU MC NL PT RO SE SI SK TR**
Designated Extension States:
AL LT LV MK

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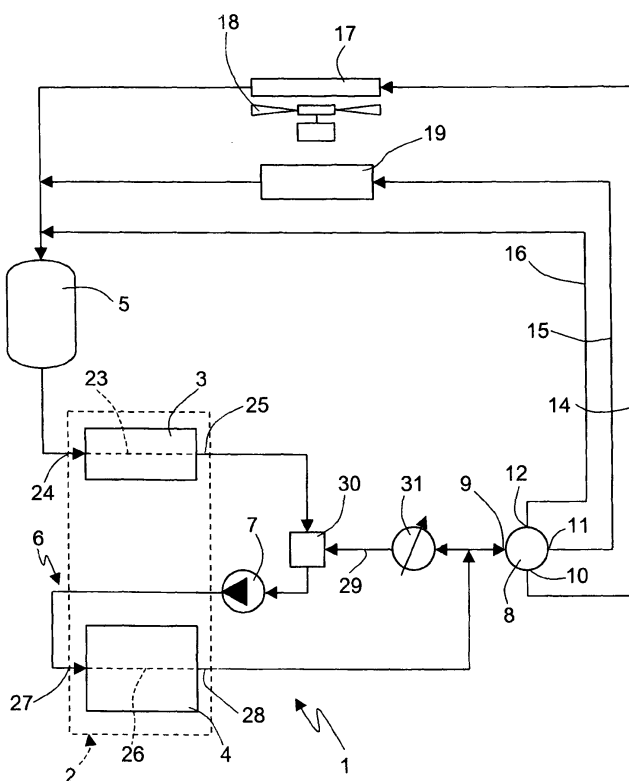
(30) Priority: **02.10.2002 IT TO20020853**

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(54) **Vehicle internal combustion engine cooling circuit**

(57) A cooling circuit (1) for a vehicle internal combustion engine (2), having a first circuit branch (23) for cooling the cylinder head (3) of the engine (2); a second circuit branch (26) for cooling the engine block (4) of the engine (2) and connected in series to the outlet (25) of the first circuit branch (23); a feedback line (29) extending between the outlet (28) and the inlet (27) of the sec-

ond circuit branch (26); and a valve (31) for controlling flow along the feedback line (29); the temperature of the coolant in the second circuit branch (26) is therefore higher than the temperature of the coolant in the first circuit branch (23), thus enabling the cylinder head (3) and the engine block (4) to be maintained at noticeably different operating temperatures.



EP 1 405 991 A1

Description

[0001] The present invention relates to a vehicle internal combustion engine cooling circuit.

[0002] As is known, internal combustion engines of vehicles, and motor vehicles in particular, comprise an engine block defining the cylinders; and a cylinder head fixed to the engine block, and which defines the combustion chambers of the cylinders and houses the valves and relative control members.

[0003] Known engines are normally water-cooled, or rather by a coolant comprising a mixture of water and additives; and the cooling circuit normally comprises a cooling line inside the engine, defined by a number of channels formed in the engine block and cylinder head and communicating with one another through openings in the cylinder head seal.

[0004] The engine cooling line is known to comprise a first circuit branch for cooling the cylinder head; and a second circuit branch for cooling the engine block, and which is connected in series with and downstream from the first. In known cooling circuits, the same amount of coolant flows through the cylinder head and the engine block, and, even with the above series arrangement of the circuit branches, it is impossible to obtain any great difference in temperature between the cylinder head and the engine block.

[0005] In terms of performance and efficiency, on the other hand, it would be more desirable to keep the cylinder head substantially cooler than the engine block.

[0006] Lowering the temperature of the cylinder head would increase the compression ratio and therefore the power of the engine. On the other hand, increasing the temperature of the engine block would increase the mechanical efficiency of the engine by reducing the viscosity of the oil adhering to the cylinder walls, would increase the organic efficiency of the engine, and would also be beneficial in reducing pollutant emissions, in particular unburned hydrocarbons (HC).

[0007] It is an object of the present invention to provide an improved cooling circuit designed to solve the aforementioned problems typically associated with known circuits.

[0008] According to the present invention, there is provided a cooling circuit for a vehicle internal combustion engine, comprising a first circuit branch for cooling a cylinder head of said engine; and a second circuit branch for cooling an engine block of said engine; said first and said second circuit branch being in series with each other; and an outlet of the first circuit branch being connected to an inlet of said second circuit branch; characterized by comprising a feedback line connecting an outlet of said second circuit branch to said inlet of said second circuit branch.

[0009] A preferred, non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying diagram.

[0010] Number 1 in the accompanying diagram indicates as a whole a cooling circuit for an internal combustion engine 2 of a motor vehicle.

[0011] Engine 2 comprises, in known manner, a cylinder head 3 and an engine block 4; and cylinder head 3 is fitted to engine block 4, in known manner not shown, with the interposition of a seal.

[0012] Cooling circuit 1 substantially comprises a tank 5; a cooling line 6 for cooling engine 2; a coolant circulating pump 7 in series with line 6; a known thermostatic distributor 8 having an inlet 9 connected to the cooling line, and a number of outlets 10, 11, 12; and a number of return lines 14, 15, 16 connecting respective outlets 10, 11, 12 of distributor 8 to tank 5. Lines 14, 15, 16 are shown and described purely by way of example, may differ in number and configuration, and do not form part of the present invention.

[0013] One of the return lines (14) comprises, in known manner, a radiator 17 for heat exchange with an air stream, which may be natural, i.e. produced simply by the speed of the vehicle with respect to the outside air, and/or forced with the aid of a fan 18 facing radiator 17.

[0014] Another return line (15) supplies auxiliary user devices, indicated as a whole by 19, such as an exchanger for heating the passenger compartment, and an exchanger for cooling recirculated exhaust gas (EGR). The third return line (16) is a bypass line.

[0015] Coolant distribution between return lines 14, 15, 16 by thermostatic distributor 8 may be effected in any known manner, and is not described by not forming part of the invention.

[0016] Cooling line 6 comprises a first circuit branch 23 for cooling cylinder head 3, and having an inlet 24 connected to tank 5, and an outlet 25; and a second circuit branch 26 for cooling engine block 4, and having an inlet 27 connected to outlet 25 of first circuit branch 23, and an outlet 28 connected to distributor 8.

[0017] According to the present invention, circuit 1 comprises a feedback line 29 connecting outlet 28 of second circuit branch 26 to inlet 27 of the second circuit branch.

[0018] More specifically, feedback line 29 comes out inside a mixing node 30 located between outlet 25 of first circuit branch 23 and inlet 27 of second circuit branch 26, and conveniently defined by a mixing chamber 30, which may be external to the engine or, preferably, formed in the casing, e.g. in engine block 4.

[0019] A valve 31, e.g. a proportional valve, is located along feedback line 29 to regulate coolant flow back to the mixing chamber.

[0020] In a preferred embodiment of the invention, pump 7 is located downstream from mixing chamber 30, between

mixing chamber 30 and inlet 27 of the second circuit branch.

[0021] Cooling circuit 1 operates as follows.

[0022] When valve 31 is closed, circuit branch 23 of cylinder head 3 and 26 of engine block 4 receive the same amount of coolant, so that circuit 1 operates in the normal way, with very little difference in temperature between cylinder head 3 and engine block 4.

[0023] When valve 31 is opened at least partly, a fraction of the coolant flow from second circuit branch 26 of engine block 4 is fed back to mixing chamber 30, where it mixes with the coolant from first circuit branch 23, so that the temperature of the coolant at inlet 27 of second circuit branch 26 is higher than it would be in a conventional circuit, i. e. with no feedback line 29.

[0024] By regulating the opening of valve 31, it is therefore possible to obtain a predetermined difference in temperature between the coolant in first circuit branch 23 and in second circuit branch 26, and therefore a given difference in (mean) temperature between the engine block and cylinder head.

[0025] Valve 31 may be controlled, e.g. on the basis of values memorized beforehand in an electronic central control unit, as a function of the main operating variables measurable on the engine (cylinder head or engine block outflow coolant temperature, metal temperature, engine power output, etc.), so that the valve can be opened or closed by a straightforward electronic control.

[0026] The flow and temperature values in first and second circuit branch 23, 26 alongside variations in the opening of valve 31, and therefore in coolant feedback, and the corresponding difference in mean temperature between cylinder head 3 and engine block 4 are shown in the Table below:

Flow [l/min]		Temperature [°C]				
		Cyl. head		Engine block		Mean block-head difference
Q23	Q26	T24	T25	T27	T28	
115	115	119	122	123	130	6
115	100	117	121	123	130	8
115	80	114	119	123	130	10
115	50	104	112	123	130	19
115	30	87	101	123	130	33

where:

Q23 is coolant flow in first circuit branch 23;

Q26 is coolant flow in second circuit branch 26;

T24 is the coolant temperature at inlet 24 of first circuit branch 23;

T25 is the coolant temperature at outlet 25 of first circuit branch 23;

T27 is the coolant temperature at inlet 27 of second circuit branch 26;

T28 is the coolant temperature at outlet 28 of second circuit branch 26.

[0027] The advantages of cooling circuit 1 according to the present invention will be obvious from the foregoing description.

[0028] In particular, using a feedback line 29, by which a fraction of coolant flow is fed back to second circuit branch 26, provides for a considerable difference in temperature between cylinder head 3 and engine block 4.

[0029] Lowering the temperature of the cylinder head increases the compression ratio and therefore the power of the engine; and increasing the temperature of the engine block increases the mechanical efficiency of the engine by reducing the viscosity of the oil adhering to the cylinder walls, increases the organic efficiency of the engine, and also reduces pollutant emissions, in particular unburned hydrocarbons (HC).

[0030] Location of pump 7 downstream from mixing chamber 30 provides for establishing in cooling line 6 and feedback line 29 the pressures required for ensuring correct flow direction; and location of pump 7 upstream, as opposed to downstream, from second circuit branch 26 enables pump 7 to operate at a lower temperature (T27 as opposed to T28 in the Table) and therefore in conditions less subject to cavitation.

[0031] Clearly, changes may be made to cooling circuit 1 without, however, departing from the scope of the accompanying Claims.

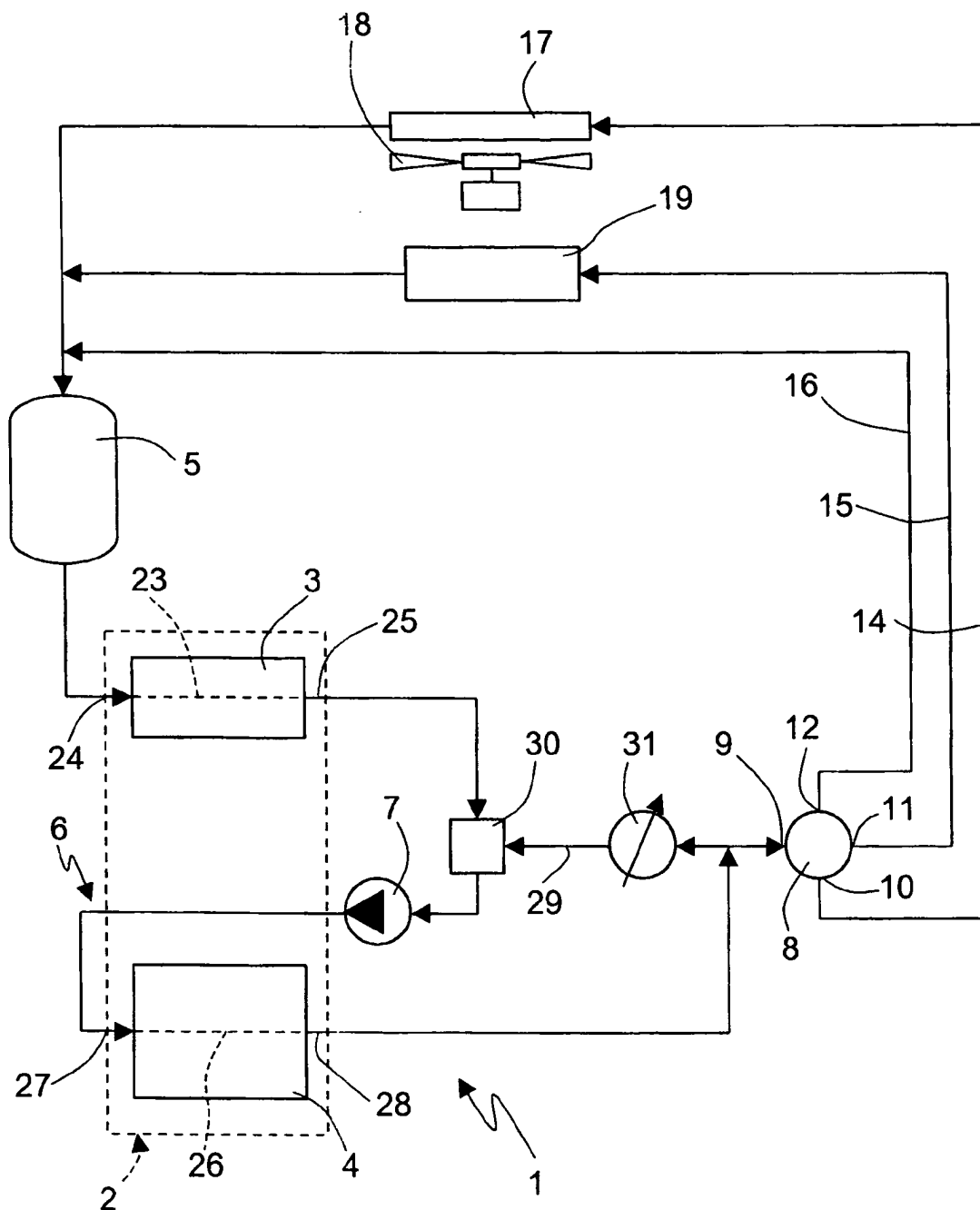
[0032] For example, valve 31 may be controlled on the basis of a, possibly self-adapting, mathematical model.

[0033] Alternatively, valve 31 may be replaced by a fixed-section constriction of line 29, when flow along line 29 in

the form of a fixed fraction of flow from second circuit branch 26 is acceptable.

Claims

1. A cooling circuit for a vehicle internal combustion engine (2), comprising a first circuit branch (23) for cooling a cylinder head (3) of said engine (2); and a second circuit branch (26) for cooling an engine block (4) of said engine (2); said first and said second circuit branch (23, 26) being in series with each other; and an outlet of the first circuit branch (23) being connected to an inlet (27) of said second circuit branch (26); **characterized by** comprising a feedback line (29) connecting an outlet (28) of said second circuit branch (26) to said inlet (27) of said second circuit branch (26) .
2. A circuit as claimed in Claim 1, **characterized by** comprising means (31) for controlling coolant flow along said feedback line (29).
3. A circuit as claimed in Claim 2, **characterized in that** said means for controlling coolant flow along said feedback line (29) comprise a flow regulating valve (31).
4. A circuit as claimed in Claim 1, **characterized in that** said feedback line (29) comprises a fixed constriction.
5. A circuit as claimed in any one of the foregoing Claims, **characterized by** comprising a circulating pump (7) downstream from said first circuit branch (23).
6. A circuit as claimed in Claim 5, **characterized in that** said circulating pump (7) is interposed between said first circuit branch (23) and said second circuit branch (26) .
7. A circuit as claimed in any one of the foregoing Claims, **characterized by** comprising a mixing node (30) connected to said outlet (25) of said first circuit branch (23) and to said feedback line (29).
8. A circuit as claimed in Claim 7, **characterized in that** said circulating pump (7) is located between said mixing node (30) and said second circuit branch (26).
9. A circuit as claimed in Claim 7 or 8, **characterized in that** said mixing node is defined by a mixing chamber (30).
10. A circuit as claimed in Claim 9, **characterized in that** said mixing chamber (30) is formed in said engine (2) .





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EUROPEAN SEARCH REPORT

Application Number
EP 03 02 2278

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	PATENT ABSTRACTS OF JAPAN vol. 0070, no. 81 (M-205), 5 April 1983 (1983-04-05) -& JP 58 008222 A (TOYOTA JIDOSHA KOGYO KK), 18 January 1983 (1983-01-18) * abstract *	1-9	F01P7/16 F01P3/02
X	PATENT ABSTRACTS OF JAPAN vol. 0070, no. 24 (M-189), 29 January 1983 (1983-01-29) -& JP 57 176316 A (TOYOTA JIDOSHA KOGYO KK), 29 October 1982 (1982-10-29) * abstract *	1-3, 5-9	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			F01P
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		5 January 2004	Kooijman, F
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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 03 02 2278

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The members are as contained in the European Patent Office EDP file on
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05-01-2004

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
JP 58008222	A	18-01-1983	NONE	
JP 57176316	A	29-10-1982	NONE	

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82