(19) Europäisches Patentamt / European Patent Office / Office européen des brevets

(11) EP 3 358 162 A1

(12) # EUROPEAN PATENT APPLICATION

published in accordance with Art. 153(4) EPC

(43) Date of publication:
08.08.2018 Bulletin 2018/32

(21) Application number: **16851078.2**

(22) Date of filing: **08.09.2016**

(51) Int Cl.:
F01P 7/16 *(2006.01)* ***F01P 11/08*** *(2006.01)*
F01P 7/14 *(2006.01)*

(86) International application number:
PCT/JP2016/076458

(87) International publication number:
WO 2017/056904 (06.04.2017 Gazette 2017/14)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(30) Priority: **30.09.2015 JP 2015194807**

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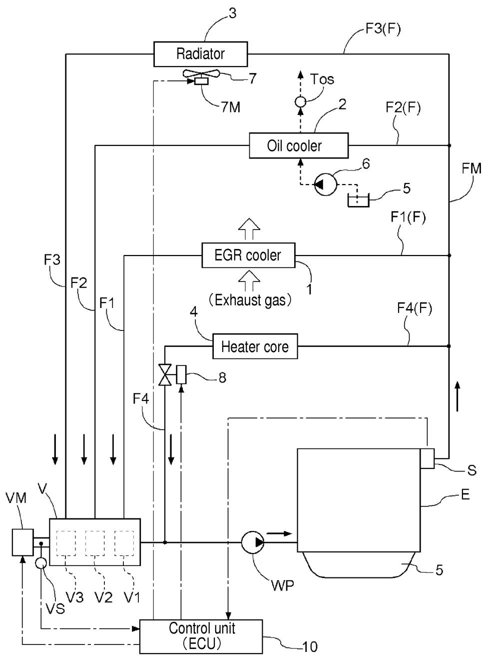
(54) **COOLING CONTROL DEVICE**

(57) A cooling control device includes a coolant pump being driven at an internal combustion engine to supply a coolant of the internal combustion engine, a heat exchanger being provided at each of plural flow paths that are formed in parallel to one another, a flow amount control valve controlling the coolant being supplied to the plural flow paths, and a control portion controlling the flow amount control valve. The control portion performs a control in a first supply mode in which the coolant is supplied to a first flow path, and a second supply mode in which the coolant is supplied to a second flow path during a supply of the coolant to the first flow path. The control portion operates a switching control shifting to the second supply mode temporarily in a state of being in the first supply mode, and returning to the first supply mode.

FIG. 1



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Description

TECHNICAL FIELD

[0001] The present invention relates to a cooling control device managing a temperature level of an internal combustion engine using a coolant.

BACKGROUND ART

[0002] A technology including a water pump, an Exhaust Gas Recirculation cooler, or an EGR cooler, and a radiator is disclosed in Patent reference 1 as a cooling control device including the aforementioned configuration. The water pump circulates a coolant of the internal combustion engine. The EGR cooler is supplied with the coolant. The radiator is supplied with the coolant.

[0003] In Patent reference 1, a control mode promoting the warm-up of the internal combustion engine by maintaining a state in which the coolant is not supplied to the radiator while supplying the coolant to the EGR cooler when the temperature level of the coolant is low by including a thermostat at a flow path supplying the coolant from the internal combustion engine to the radiator.

[0004] Patent reference 2 discloses a technology including a water pump circulating a coolant of an internal combustion engine, an EGR cooler being supplied with the coolant, and a radiator being supplied with the coolant.

[0005] Patent reference 2 discloses a control mode in which the water pump is configured to be transmitted with a drive force from a crankshaft of the internal combustion engine via an electromagnetic clutch, the control mode inhibiting boiling of the coolant at the EGR cooler by operating the water pump in a case where the temperature level of the coolant increases when the water pump is in a stopped state.

DOCUMENT OF PRIOR ART

PATENT DOCUMENT

[0006]

Patent document 1: JP2014-9634A
Patent reference 2: JP2012-41904A

OVERVIEW OF INVENTION

PROBLEM TO BE SOLVED BY INVENTION

[0007] When the engine, which includes a cooling control device having a configuration supplying a coolant of an internal combustion engine to an EGR cooler and an oil cooler other than a radiator, is warmed up, because the engine is required to be warmed up early, the coolant is not supplied to the radiator, however, the coolant is required to be supplied to the EGR cooler and the oil cooler.

[0008] In both Patent references 1 and 2, the control supplying the coolant to the EGR cooler is performed in a state where the coolant is not supplied to the radiator. In addition, a control mode, which supplies the coolant to the oil cooler other than the EGR cooler when the EGR cooler is supplied with the coolant, is required.

[0009] That is, in the warm up operation, the temperature level of lubricating oil is often low, and, in order to decrease the viscosity of the lubricating oil, the increase of the temperature level of the lubricating oil is required by the supply of the coolant to the oil cooler early. However, in a case where the sequence is set such that the control supplying cooling water to the EGR cooler is performed prior to that the cooling water is supplied to the oil cooler when the water temperature level of the cooling water increases up to a predetermined value, the cooling water cannot be supplied to the oil cooler until the temperature level of the coolant reaches a predetermined value, and therefore, there is a room for improvement.

[0010] Consequently, it is desired that a cooling control device is configured, at which even in a state where a coolant of an internal combustion engine is supplied to a specific one of plural heat exchangers, the coolant may be supplied to another heat exchangers as required.

MEANS FOR SOLVING PROBLEM

[0011] A characteristic of the present invention is that a cooling control device includes a coolant pump being driven by a drive force of an internal combustion engine, a heat exchanger being provided at each of a plurality of flow paths to which a coolant sent by the coolant pump is supplied in parallel to one another, a flow amount control valve controlling a flow of the coolant relative to the plurality of flow paths, and a control portion controlling the flow amount control valve. The control portion performs a control in a first supply mode in which the coolant is supplied to a first flow path constituting one of the plurality of flow paths by a control of the flow amount control valve, and a second supply mode in which the coolant is supplied to a second flow path constituting another one of the plurality of flow paths, during a supply of the coolant to the first flow path, by the control of the flow amount control valve. The control portion operates a switching control shifting to the second supply mode temporarily based on a control signal in a state of being in the first supply mode, and returning to the first supply mode.

[0012] According to the configuration, for example, even though the heat exchanger that should perform heat exchange with the coolant prefentially is provided at the first flow path, the control portion may shift to the second supply mode temporarily in a state where the coolant is continuously supplied to the heat exchanger by the switching control in a case where the control portion acquires the control information. In addition, after shifting to the second supply mode, the control portion automatically returns to the first supply mode. Accordingly, the efficiency of the heat exchange at the heat exchanger of the first flow path is not deteriorated. That is, comparing to a case where the control portion always shifts to the second supply mode, the control portion may supply the coolant to the second flow path to allow heat exchange at the heat exchanger of the second flow path by the switching control while inhibiting the temperature level of the fluid from decreasing. Accordingly, even in a state where the coolant of the internal combustion engine is supplied to a specific one of the plural heat exchangers, the cooling control device is configured to be able to supply the coolant to another one of the heat exchangers as required.

[0013] The present invention may be that the control signal is outputted based on request information requesting heat exchange of a cooling water by the heat exchanger provided at the second flow path.

[0014] Accordingly, even in a state where the control portion exchanges heat by a predetermined heat exchanger in the first supply mode, the coolant may be supplied to the heat exchanger which requires heat exchange by the cooling control device that shifts to the second supply mode by generating control signals in a case where the control portion receives request information requesting the heat exchange at another one of the heat exchangers.

[0015] The present invention may be that the control portion performs the first supply mode before a warm up of a first heat exchanger of the plurality of heat exchangers is completed, the first heat exchanger being provided at the first flow path, the control portion performs the second supply mode after the warm up is completed, and in the switching control, the control portion supplies the coolant of a required flow amount to the second flow path even before the warm up is completed.

[0016] Accordingly, in a case where the temperature level of fluid is relatively low, for example, before the warm-up of the heat exchanger provided in the first flow path is completed, the control portion supplies the coolant to the targeted heat exchanger by the first supply mode while increasing the temperature level of the cooling water by the warm-up of the internal combustion engine. Next, in a case where the temperature level of fluid reaches equal to or greater than a set value, for example, after the warm-up of the heat exchanger provided in the first flow path is completed, the control portion may automatically shift to the second supply mode, and may supply the coolant to the heat exchanger of the second flow path. Even before the completion of the warm-up of the heat exchanger provided in the first flow path, the control portion may supply the coolant of the required flow amount to the second flow path.

[0017] The present invention may be that the required flow amount corresponds to a fluid amount of the coolant that is accumulated from an outlet of the internal combustion engine to an outlet of a second heat exchanger of the plurality of heat exchangers at the second flow path.

[0018] Accordingly, the coolant having the fluid amount corresponding to the coolant arranged in the flow path from an outlet of the internal combustion engine to an outlet of the heat exchanger is flown to the flow path. Accordingly, when the coolant existed in the outlet of the internal combustion engine reaches the outlet of the heat exchanger, the coolant existed inside the internal combustion engine relative to the outlet thereof is supplied to the heat exchanger. Accordingly, because only the least required amount of flow amount of the coolant is flown, the coolant heated by the internal combustion engine may be supplied to the heat exchanger of the second flow path without disturbing the warm-up of the heat exchanger of the first flow path and of an engine main body.

[0019] The present invention may be that the first supply mode is established by the flow amount control valve that operates by a drive force of an actuator to increase an opening of a valve portion relative to the first flow path, and the second supply mode is established by the flow amount control valve by a further operation of the actuator to increase the opening of the valve portion relative to the second flow path while the opening of the valve portion relative to the first flow path is maintained in a fully-open state.

[0020] Accordingly, because the flow amount control valve is configured to perform the adjustment of the opening and the switching of the supply modes, the flow amount of the coolant at the first supply mode and the second supply mode is adjustable by the operation of the actuator, and at the same time, the switching of the first supply mode and the second supply mode is available. Accordingly, the number of components may be reduced.

[0021] The present invention may be that one of the plurality of heat exchangers corresponds to an Exhaust Gas Recirculation cooler to which a part of combustion gas of the internal combustion engine is supplied, another one of the plurality of heat exchangers corresponds to an oil cooler to which a lubricating oil of the internal combustion engine is supplied by a lubricating oil pump, and the control portion controls the lubricating oil pump to increase a supplied amount of the lubricating oil in a case of setting the second supply mode.

[0022] Accordingly, in the first supply mode at the EGR cooler, the EGR cooler which is in a low temperature level may be warmed up by the coolant in order to introduce an EGR operation, and in the second supply mode at the oil cooler, the viscosity of the rubricating oil may be decreased by applying heat of the coolant to the lubricating oil during the maintenance of the warm up of the EGR cooler.

DESCRIPTION OF DRAWINGS

[0023]

[Fig. 1] is a view of a configuration of a cooling control device;

[Fig. 2] is a chart illustrating an opening of each of valve portions relative to each of operating amounts of valve bodies;

[Fig. 3] is a graph illustrating a relationship between a flow amount of a coolant and an oil temperature level of a lubricating oil;

[Fig. 4] is a graph illustrating a relationship between a valve opening and a flow amount relative to a speed of an engine;

[Fig. 5] is a flowchart of a cooling control routine;

[Fig. 6] is a flowchart of an intermittent control routine; and

[Fig. 7] is a timing chart of the intermittent control routine.

MODE FOR CARRYING OUT THE INVENTION

[0024] An embodiment of a present invention will hereunder be explained with reference to the drawings.

[Basic configuration]

[0025] As shown in Fig. 1, a cooling control device is configured with a control unit 10 (an example of a control portion) including a cooling circuit and setting an opening of a flow amount control valve V. The cooling circuit includes a water pump WP, plural flow paths F, heat exchangers, and a flow amount control valve V. The water pump WP sends a cooling water (an example of a coolant) of an engine E serving as an internal combustion engine. The plural flow paths F (a superordinate concept of a first flow path F1, a second flow path F2, a third flow path F3, and a fourth flow path F4) are formed in parallel to one another. The heat exchangers each is provided at each of the plural flow paths F. The flow amount control valve V controls the flow of the cooling water (an example of the coolant).

[0026] In the cooling control device, a water temperature sensor S (an example of a fluid temperature sensor) detects the water temperature level of the cooling water (coolant), and the control unit 10 controls the flow amount control valve V in response to the detected result to manage the heat exchange between a first supply mode M1 and a second supply mode M2 which will be described later.

[0027] An Exhaust Gas Recirculation cooler 1 or an EGR cooler 1, an oil cooler 2, and a radiator 3, which will be described later, are provided as heat exchangers in which the cooling water is controlled by the flow amount control valve V. A heater core 4 is provided as a heat exchanger in which the cooling water is independently controlled. The water pump WP (a coolant pump) is driven by a crankshaft of the engine E, and is disposed between the flow amount control valve V and the engine E.

[0028] The cooling control device is configured to manage the temperature level of the engine E (the internal combustion engine) of a vehicle of, for example, an automobile. The engine E includes a water jacket formed at an area over a cylinder block and a cylinder head. The cooling control device is configured to send the cooling water of the water jacket to the flow paths F, and to return the cooling water to the water jacket by the water pump WP after supplying the cooling water to the heat exchanger to exchange heat. In addition, the engine E is configured to transmit a drive force from the crankshaft serving as an output shaft to a transmission device. The engine E may be used for whole internal combustion engines other than a reciprocating engine. The engine E does not necessarily apply the drive force directly to the transmission device, and may transmit the drive force to an electric motor of, for example, a hybrid-type vehicle.

[Flow path, heat exchanger]

[0029] The water temperature sensor S is provided at the engine E, and the plural flow paths F are formed in a mode of being divided from a main flow path FM to which the cooling water is sent from the engine E. The first flow path F1, the second flow path F2, the third flow path F3 and the fourth flow F4 are formed as the plural flow paths F. The EGR cooler 1 is provided at the first flow path F1 as the heat exchanger. The oil cooler 2 is provided at the second flow path F2 as the heat exchanger. The radiator 3 is provided at the third flow path F3 as the heat exchanger. The heater core 4 is provided at the fourth flow path F4 as the heat exchanger.

[0030] A technology, which performs the improvement of an element within an exhaust gas by retrieving a part of the exhaust gas of the engine E and by returning the part to an intake system, the technology improving the energy consumption, is referred to as Exhaust Gas Recirculation (EGR). The EGR cooler 1 exchanges heat (cools) the part of the exhaust gas retrieved from the engine E by the cooling water.

[0031] The oil cooler 2 includes a configuration in which the lubricating oil reserved in an oil pan 5 of the engine E is supplied by an oil pump 6 (an example of a lubricating oil pump), and exchanges the heat between the lubricating oil and the coolant. The lubricating oil having the heat exchange at the oil cooler 2 is supplied to a variable valve timing control device, or lubricating parts of parts of the engine E. The oil pump 6 corresponds to a variable oil pressure mechanical oil pump that can control the oil pressure level by equal to or higher than two stages, and is driven by the engine E. An oil path sending the lubricating oil that passes the oil cooler 2 includes an oil temperature sensor Tos detecting the oil temperature.

[0032] The radiator 3 includes a function managing the temperature level of the engine E by radiating heat of the cooling water, and is supplied with cooling wind by a radiator fan 7. The radiator fan 7 is driven by a fan motor 7M configured as an electric motor. The heater core 4 heats an environment of, for example, a cabin of the vehicle. An electromagnetic valve 8 controlling the flow of the cooling water is provided at the fourth flow path F4.

[Flow amount control valve]

[0033] The flow amount control valve V is rotational type, and houses valve bodies that are rotatable inside a valve case. The flow amount control valve V includes a valve motor VM and a valve sensor VS. The valve motor VM corresponds to the electric motor serving as an actuator that rotates the valve bodies. The valve sensor VS detects a rotational angle of the valve bodies. The valve sensor VS corresponds to a hall element and a potentiometer, and can detect the opening of the valve portion of the flow amount control valve V at each of supply modes by detecting the rotational angle of the valve bodies of the flow amount control valve V. Alternatively, the flow amount control valve V may be slide operation type that houses the valve bodies sliding inside the valve case.

[0034] The flow amount control valve V includes a first valve portion V1 opening and closing the first flow path F1, a second valve portion V2 opening and closing the second flow path F2, and a third valve portion V3 opening and closing the third flow path F3. In the flow amount control valve V of this configuration, Fig. 2 illustrates the openings of the first valve portion V1, the second valve portion V2, and the third valve portion V3 relative to the operating amount of the valve bodies. The first valve portion V1, the second valve portion V2, and the third valve portion V3 are collectively referred to as the valve portion.

[0035] Fig. 2 illustrates the openings of the first valve portion V1, the second valve portion V2, and the third valve portion V3 in a longitudinal axis (the opening is shown by percentage), and the operating amounts (rotational amounts) of the valve bodies in a lateral axis. As understood from Fig. 2, when the valve bodies are in the initial position, the first valve portion V1, the second valve portion V2, and the third valve portion V3 are in a fully-closed mode M0 where the first valve portion V1, the second valve portion V2, and the third valve portion V3 are closed, and the cooling water does not flow in the first flow path F1, the second flow path F2, and the third flow path F3.

[0036] Next, by the operation of the valve body in an opening direction from the fully-closed mode M0, the control unit 10 shifts to the first supply mode M1 where the opening of the first valve portion V1 is adjustable while maintaining the second valve portion V2 and the third valve portion V3 in a closed state.

[0037] In addition, by the operation of the valve body from the first supply mode M1 in the opening direction that is beyond the fully-open state, the control unit 10 shifts to the second supply mode M2 in which the opening of the second valve portion V2 is adjustable in a state where the opening of the first valve portion V1 is maintained in a fully-open state (while maintaining the third valve portion V3 in the closed state).

[0038] By operating the valve body in the opening direction that is beyond the fully-open state from the second supply mode M2, the control unit 10 shifts to the third supply mode M3 in which the opening of the third valve portion V3 is adjustable in a state where the opening of the first valve portion V1 and the opening of the second valve portion V2 are maintained in the fully-open state.

[0039] Specifically, the flow amount control valve V does not supply the cooling water at the second valve portion V2 before the opening of the first valve portion V1 reaches the fully-opening state. Similarly, the flow amount control valve V does not supply the cooling water at the third valve portion V3 before the opening of the second valve portion V2 reaches the fully-opening state.

[Control unit, control mode]

[0040] The control unit 10 manages the whole engine E and manages an amount of heat exchanged in the heat exchanger by controlling the amount of cooling water flown in the flow path F at the flow amount control valve V when the engine E is driven. The control mode of the control unit 10 is illustrated in a flowchart shown in Fig. 5. Further, in this control, the valve motor VM is driven to detect the opening by the valve sensor VS when the opening (a target opening) of the flow amount control valve V is set.

[0041] That is, the control unit 10 acquires the temperature level of the cooling water detected by the water temperature sensor S, and operates to warm up the engine E by maintaining the flow amount control valve V in the fully-closed mode M0 before the warm up of the engine E is completed. (Step#01 to Step#03)

[0042] In a case where the warm up of the engine E is not completed, for example, like immediately after the startup of the engine E, the control unit 10 closes the first valve portion V1, the second valve portion V2, and the third valve portion V3 to increase the temperature level of the engine E without supplying the cooling water to any of the flow paths F.

[0043] Next, when the warm-up of the engine E is completed and the warm-up of the EGR cooler is not completed, the control unit 10 performs the control in the first supply mode M1 in which the warm-up of the engine E continues, the cooling water is supplied to the EGR cooler 1, and the opening of the first valve portion V1 increases in response to the increase of the water temperature level (Step #04, Step #05).

[0044] In the control of the first supply mode M1, the second supply mode M2 and the third supply mode M3 which will be described later, the control setting the corresponding valve portion to a target opening, the control, which will be described later, supplying the cooling water intermittently as required., is performed.

[0045] In the control of the first supply mode M1, for example, when the temperature level of the lubricating oil is required to be increased, the second supply mode M2 is forcibly set by opening the second valve portion V2 temporarily so as to supply the cooling water to the oil cooler 2 while maintaining a state where the cooling water is supplied to the first flow path F1 (Step #06, Step #07). That is, switching information (request information) is acquired in Step #06, and in Step #07, the control units 10 shifts to the second supply mode by the setting time by the control signal based on the switching information, and the oil supply amount increases. As such, as a switching control, the control unit 10 performs the control temporarily shifting to the second supply mode M2 based on the control signal in a state of being in the first supply mode M1, and returns to the first supply mode.

[0046] As such, when the second supply mode M2 is forcibly set and the cooling water is supplied to the second flow path F2, the opening and the opening time of the second valve portion V2 are set so as to supply the required flow amount. The required water amount corresponds to a value substantially corresponding to a water amount (a fluid amount) accumulated in the flow passage F from an exit (an outlet) of the cooling water of the engine E to an outlet of the cooling water of the oil cooler 2 at the second flow passage F2.

[0047] Accordingly, in a case where the cooling water of the required flow amount is supplied in the second supply mode M2, the cooling water arranged inside the engine E from the outlet of the engine E reaches the oil cooler 2. Because the water temperature level of the cooling water may be inhibited from dropping by the supply of the cooling water of the minimum required flow amount, both of the warm-up of the EGR cooler 1 and the warm-up of the oil cooler 2 may be accomplished. Fig. 1 illustrates a main flow passage FM with a long dimension, however, is relatively short in an actual dimension.

[0048] When the cooling water is supplied in the second supply mode M2, the amount of oil exchanging heat with the cooling water at the oil cooler 2 may be increased by increasing a discharged pressure level of the oil pump 6.

[0049] Next, when the warm-up of the EGR cooler 1 is completed and the warm-up of the coil cooler 2 is not completed, the cooling water is supplied to the EGR cooler 1, and is supplied to the oil cooler 2. In this supply, the control unit 10 performs the control in the second supply mode M2 in which the opening of the second valve portion V2 is increased in response to the increase of the water temperature level (Step #08, Step #09).

[0050] In this second supplied mode M2, in a case where the oil pressure level applied to the lubricating oil by the oil pump 6 is set at plural levels, the relationship between the flow amount of the cooling water supplied to the second flow passage F2 and the temperature level of the lubricating oil is illustrated in Fig. 3. As illustrated in Fig. 3, the larger the oil pressure level is, and the larger the temperature level difference (Δ water temperature level - oil temperature level) between the cooling water and the lubricating oil, the less the flow amount of the cooling water comes to be. From the temperature level difference between the cooling water and the lubricating oil, the target flow amount of the cooling water is calculated. Accordingly, when the estrangement between the water temperature level and the oil temperature level is large and the oil flow amount is great, the large decrease of the water temperature level by the oil that takes the heat from the water is inhibited by decreasing of the water flow amount supplied to the oil cooler 2.

[0051] After that, when the water temperature level of the cooling water increases equal to or greater than a second switching value, the cooling water is supplied to the EGR cooler 1, and the cooling water is supplied to the radiator 3 while maintaining a state where the cooling water is supplied to the oil cooler 2. In this supply, the control unit 10 performs the control in the third supply mode in which the opening of the third valve portion V3 is increased in response the increase of the water temperature level (Step #010).

[0052] In the third supply mode M3, because the temperature level of the engine E reaches the temperature level required to be cooled, the cooling water is supplied to the radiator 3, and the control unit 10 manages the temperature level by driving the radiator fan 7 by driving the fan motor 7M when the engine rotates in a low speed and the water temperature level is high.

[0053] Fig. 4 illustrates a relationship between the opening (the valve opening) of the third valve portion V3 and the flow amount of the cooing water in a case where the speed of the engine E is set at one of plural speeds in the third supply mode M3. As illustrated in Fig. 4, the higher the speed of the engine E is and the greater the valve opening is, the more the cooling water supplied to the third flow passage F3 comes to be. Thus, the control unit 10 corrects the opening of the third valve portion V3 based on the target flow amount of the cooling water and the speed of the engine E. Because the tendencies shown in Fig. 4 are shown in the first supply mode M1 and the second supply mode M2, the control unit 10 corrects similarly in the first supply mode M1 and the second supply mode M2.

[0054] In a case where the heat exchange is performed by the heater core 4, the control mode is set such that electromagnetic valve 8 is open by the operation of, for example, switches, at a timing when the driver requires.

[0055] In the first supply mode M1, the second supply mode M2, and the third supply mode M3, not only the opening of the valve portion is set, but also the control mode is set so as to supply the cooling water intermittently when required. The summary of the control mode is shown in a flow chart in Fig. 6. As a specified example of the intermittent supply of the cooling water, the timing chart in the second supply mode M2 is shown in Fig. 7.

[0056] As illustrated in the flowchart in Fig. 6, the control unit 10 calculates the water flow time based on the speed of the engine E and the required flow amount that should be supplied to the flow path F, opens the valve portion to supply the cooling water only by the calculated water flow time, and closes the valve portion (Step #101 to Step #103).

[0057] As a specific mode of this control, Fig. 7 shows a chart of a control mode when the second valve portion V2 in the second supply mode M2 is set at the target opening only by the calculation time. The first valve portion V1 is set at 100 percent in a case where the second valve portion V2 is set at the target opening.

[0058] Next, the closing time is calculated based on the temperature level of the cooling water, the temperature level of a heat exchanging target, and the flow speed of the heat exchanging target, and the valve portion is closed only by the calculated time (Step #104, Step #105).

[0059] That is, when the heat exchange is operated between the cooling water and the targeted heat exchanger, only the minimum required flow amount of the cooling water is flown by the intermittent supply of the cooling water. Accordingly, the cooling water heated by the oil cooler 2 may be supplied without the inhibition of the warm-up of the EGR cooler 1 and the engine E. Moreover, the subtle adjustment of the heat exchange that cannot be controlled only by the setting of the opening of the valve portion is available.

[0060] Next, after the valve portion is closed only by the calculated time, the temperature levels of the water and of the target for heat exchange are acquired, and whether or not the intermittent control is required. When the control is required to be continued, the control is operated again from the control of the Step #101. When not required, the control is terminated (Step #106 and Step #107).

[Actions and effects of the embodiment]

[0061] As such, according to the configuration of this invention, in a case where the temperature level of the cooling water increases by the drive of the engine E, firstly, the cooling water is started to be supplied to the first flow passage F1, and secondly, the cooling water is started to be supplied to the second flow path F2, and then, the cooling water is started to be supplied to the third flow path F3. Accordingly, the temperature level of the exhaust gas returned to the intake system of the engine E is managed at the EGR cooler 1, next, the temperature level of the lubricating oil is managed at the oil cooler 2, and the temperature level of the cooling water is managed at the radiator 3.

[0062] This sequence is set based on a priority relationship that is important for driving the engine E favorably. However, for example, in a state where the cooling water is supplied to the EGR cooler 1 (the cooling water is supplied to the first flow path F1), there is a case in which the temperature level of the lubricating oil is required to be increased to decrease the viscosity of the lubricating oil.

[0063] In a case where the cooling water is supplied to the oil cooler 2, the temperature level of the lubricating oil may be efficiently increased by the increase of the discharged pressure level of the oil pump 6.

[0064] In addition, the supplying amount of the cooling water is supposed to be controlled with high precision by the use of the water pump driven by the electric motor to manage the temperature level of the engine E. Here, in the configuration of this invention in which the flow amount of the cooling water is set by the setting of the opening of the flow amount control valve V, the cost may be reduced because the water pump WP driven by the engine E may be used.

[Other embodiment]

[0065] The present invention may be configured as below other than the aforementioned embodiment (components including the same functions as those of the embodiment are marked with common numbers or reference numerals as those of the embodiment).

(a) As the control mode in which the control unit 10 shifts to the second supply mode M2 temporarily in a state of being in the first supply mode M1, and then, returns to the first supply mode M1, for example, a control mode, which performs the control shifting to the second supply mode M2 for only a relatively short time and for plural times intermittently, may be set.

(b) In the embodiment, the EGR cooler 1, the oil cooler 2, and the radiator 3 are shown as the heat exchangers. Other than these, for example, a heater core, a device exchanging heat of an oil of a transmission device, and a device exchanging heat of an oil of a supercharger, may be provided as the heat exchangers.

As a specific example, the flow passage F may be configured to supply a coolant to the oil cooler 2 in the first supply mode M1, and to supply a coolant to the EGR cooler 1 in the second supply mode M2.

(c) When being used, the heat exchanger may be disposed any positions of the plural flow paths F on which the heat exchangers are disposed. In addition, a state in which the coolant is flown in the second flow path F2 may be set as the first supply mode M1, and a state in which the coolant is flown in the third flow path F3 may be set as the second supply mode M2.

(d) The oil pump 6 may be configured to drive the electric motor. By having this configuration, the amount oil supplied to the oil pump 6 may be easily adjusted.

(e) The temperature level of oil may be detected to determine whether the warm up is completed. That is, in a case where the detected temperature level of the oil is greater than a set value, it is determined that the warm up is terminated.

INDUSTRIAL APPLICABILITY

[0066] The present invention can be used for a cooling control device in which a coolant managing a temperature level of an internal combustion engine is supplied to a heat exchanger at plural flow passages.

EXPLANATION OF REFERENCE NUMERALS

[0067]

1. heat exchanger (EGR cooler)
2 heat exchanger (oil cooler)
3 heat exchanger (radiator)
6 lubricating oil pump (oil pump)
10 control portion (control unit)
E internal combustion engine (engine)
F flow path
F1 first flow path
F2 second flow path
V flow amount control valve
V1 valve portion (first valve portion)
V2 valve portion (second valve portion)
V3 valve portion (third valve portion)
VM actuator (valve motor)
WP coolant pump (water pump)
M1 first supply mode
M2 second supply mode

Claims

1. A cooling control device comprising:

a coolant pump being driven by a drive force of an internal combustion engine;
a heat exchanger being provided at each of a plurality of flow paths to which a coolant sent by the coolant pump is supplied in parallel to one another;
a flow amount control valve controlling a flow of the coolant relative to the plurality of flow paths; and
a control portion controlling the flow amount control valve, wherein
the control portion performs a control in a first supply mode in which the coolant is supplied to a first flow path constituting one of the plurality of flow paths by a control of the flow amount control valve, and a second supply mode in which the coolant is supplied to a second flow path constituting another one of the plurality of flow paths, during a supply of the coolant to the first flow path, by the control of the flow amount control valve, and
the control portion operates a switching control shifting to the second supply mode temporarily based on a control signal in a state of being in the first supply mode, and returning to the first supply mode.

2. The cooling control device according to claim 1, wherein the control signal is outputted based on request information requesting heat exchange of a cooling water by the heat exchanger provided at the second flow path.

3. The cooling control device according to either claim 1 or 2, wherein

the control portion performs the first supply mode before a warm up of a first heat exchanger of the plurality of heat exchangers is completed, the first heat exchanger being provided at the first flow path,
the control portion performs the second supply mode after the warm up is completed, and
in the switching control, the control portion supplies the coolant of a required flow amount to the second flow path even before the warm up is completed.

4. The cooling control device according to claim 3, wherein the required flow amount corresponds to a fluid amount of the coolant that is accumulated from an outlet of the internal combustion engine to an outlet of a second heat exchanger of the plurality of heat exchangers at the second flow path.

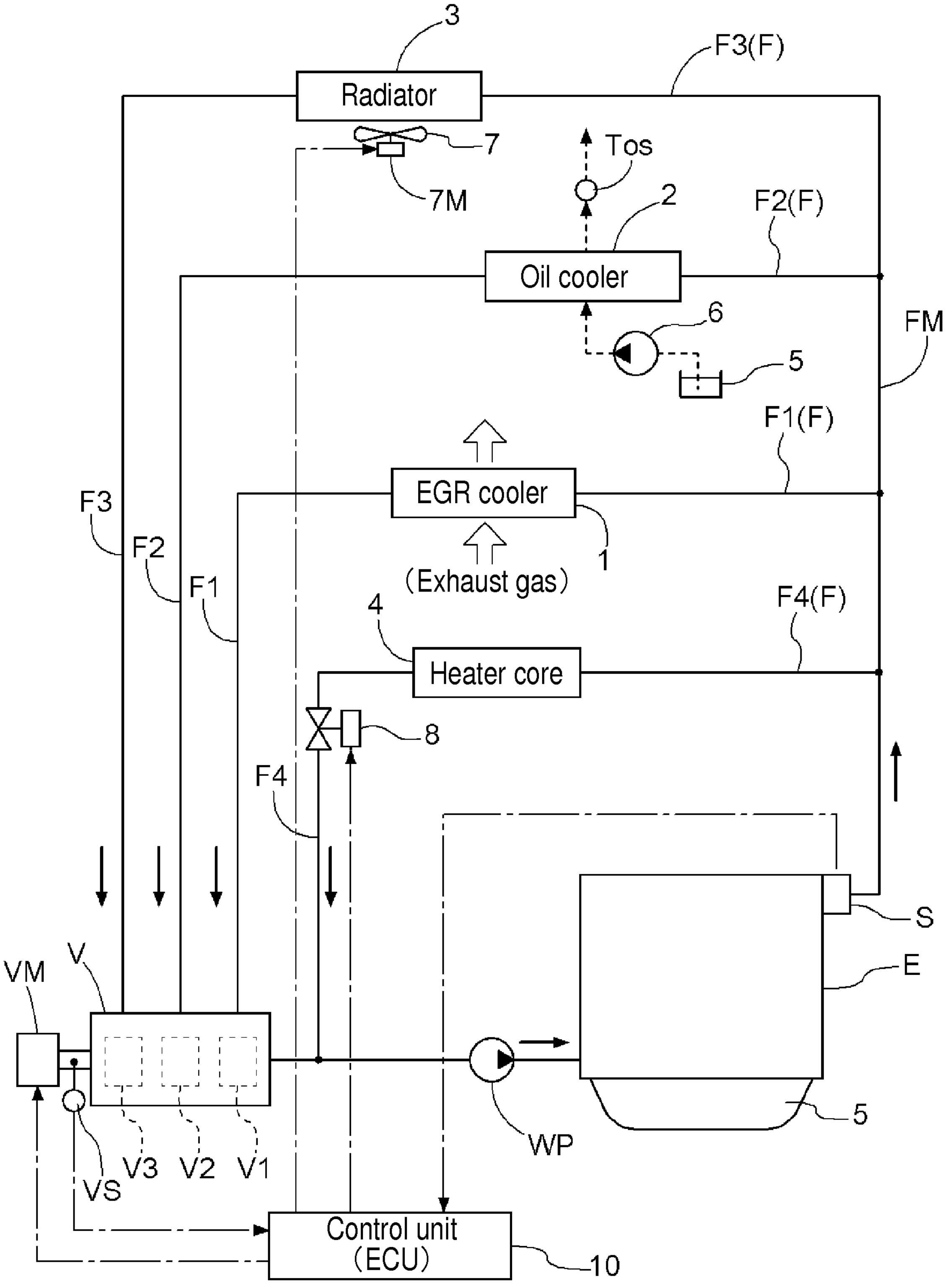
5. The cooling control device according to either claim 3 or 4, wherein

the first supply mode is established by the flow amount control valve that operates by a drive force of an actuator to increase an opening of a valve portion relative to the first flow path, and
the second supply mode is established by the flow amount control valve by a further operation of the actuator to increase the opening of the valve portion relative to the second flow path while the opening of the valve portion relative to the first flow path is maintained in a fully-open state.

6. The cooling control device according to one of claims 1 to 5, wherein

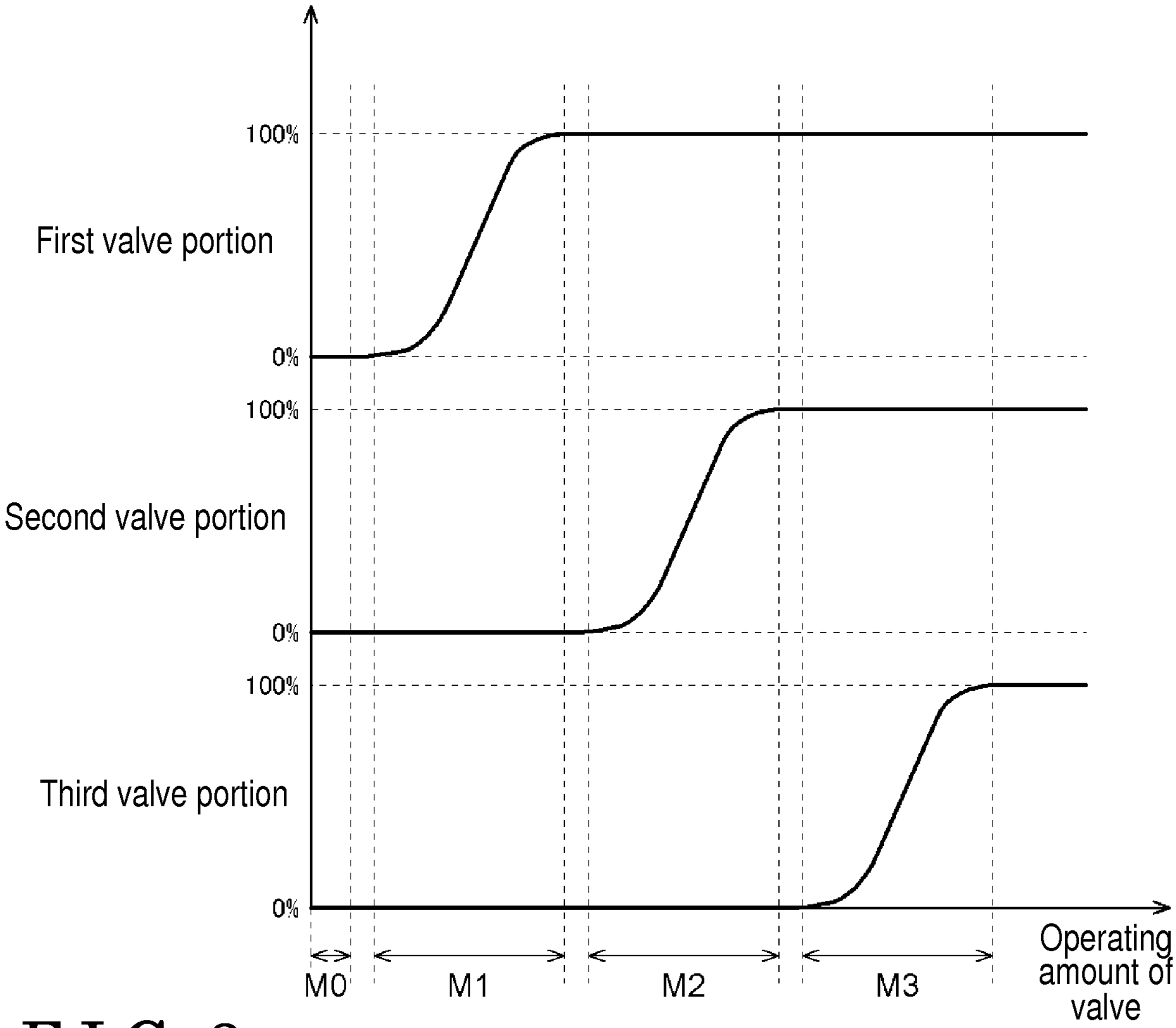
one of the plurality of heat exchangers corresponds to an Exhaust Gas Recirculation cooler to which a part of combustion gas of the internal combustion engine is supplied,
another one of the plurality of heat exchangers corresponds to an oil cooler to which a lubricating oil of the internal combustion engine is supplied by a lubricating oil pump, and
the control portion controls the lubricating oil pump to increase a supplied amount of the lubricating oil in a case of setting the second supply mode.

FIG. 1

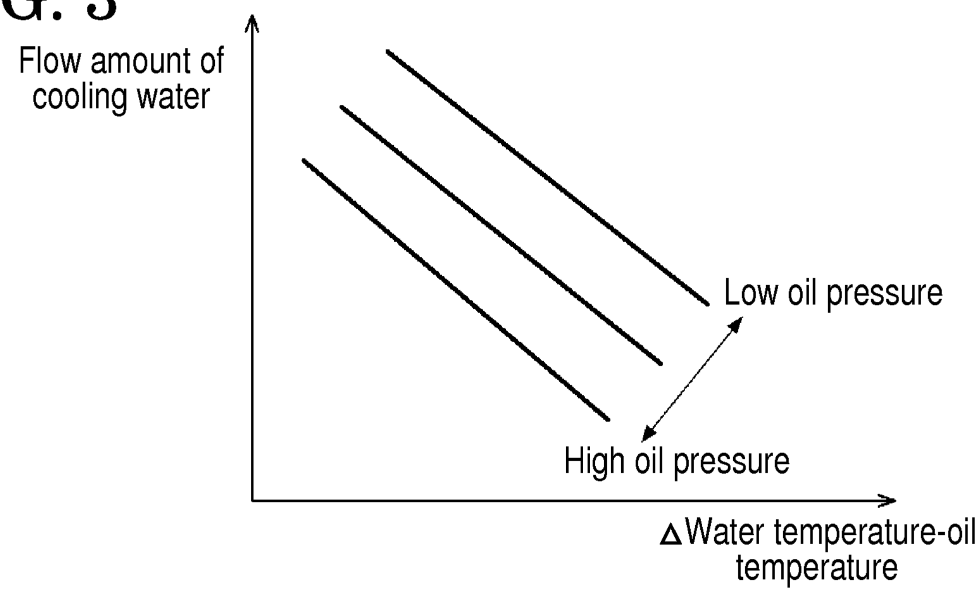


3
Radiator
F3(F)
7
Tos
7M
2
F2(F)
Oil cooler
6
FM
5
F1(F)
EGR cooler
F3
1
F2
(Exhaust gas)
F1
4
F4(F)
Heater core
8
F4
S
V
E
VM
5
WP
V3
V2
V1
VS
Control unit
(ECU)
10

F I G. 2


100%
First valve portion
0%
100%
Second valve portion
0%
100%
Third valve portion
0%
M0
M1
M2
M3
Operating amount of valve

F I G. 3


Flow amount of cooling water
Low oil pressure
High oil pressure
ΔWater temperature-oil temperature

F I G. 4

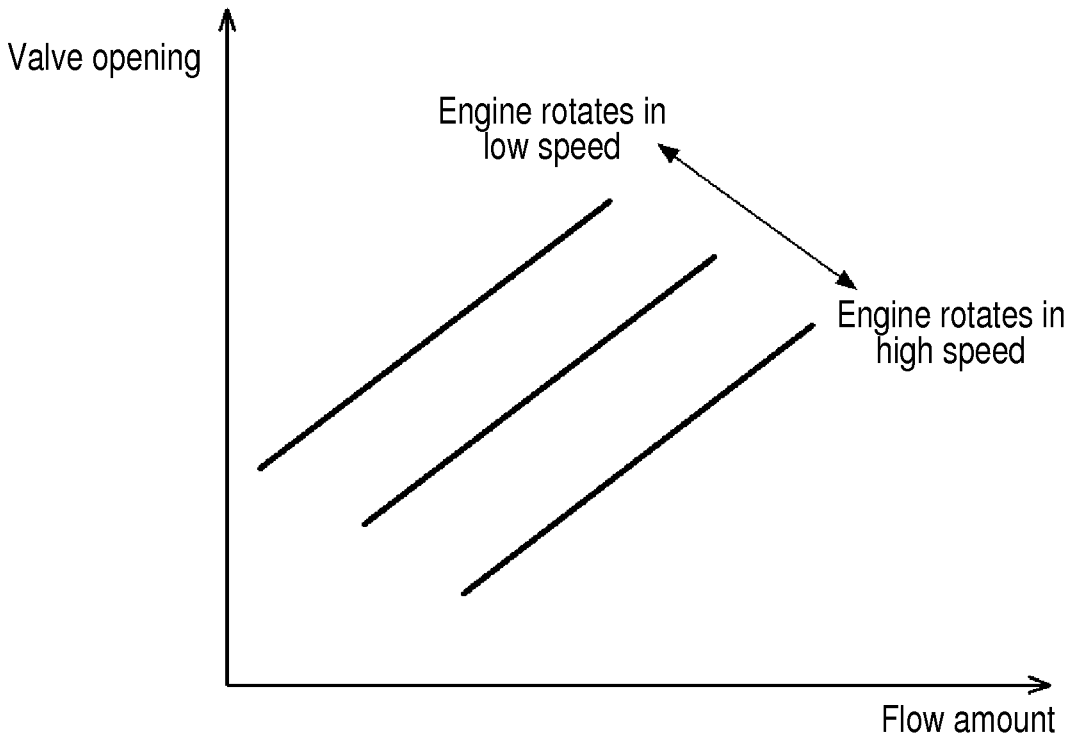

Valve opening
Engine rotates in low speed
Engine rotates in high speed
Flow amount

FIG. 5

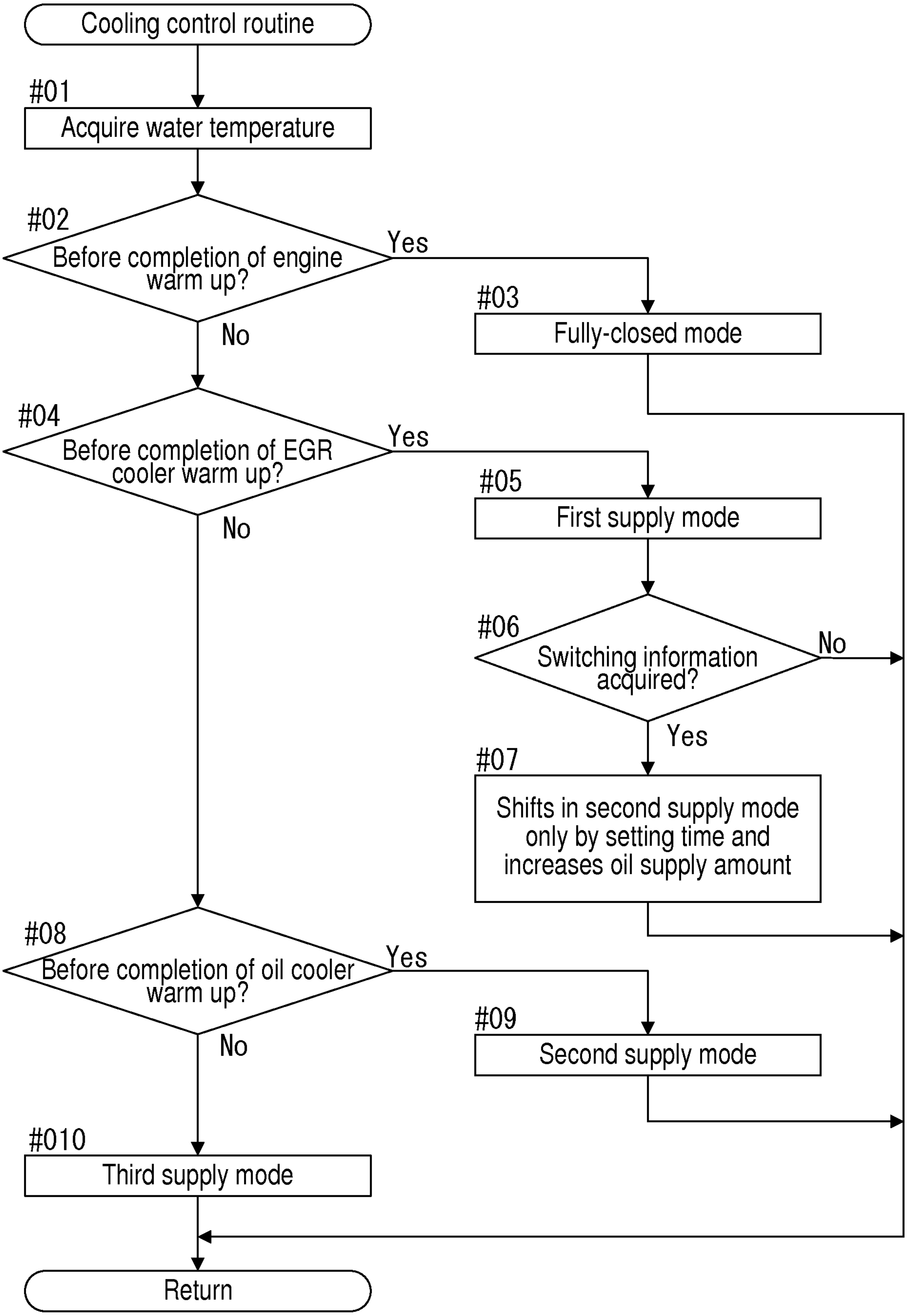
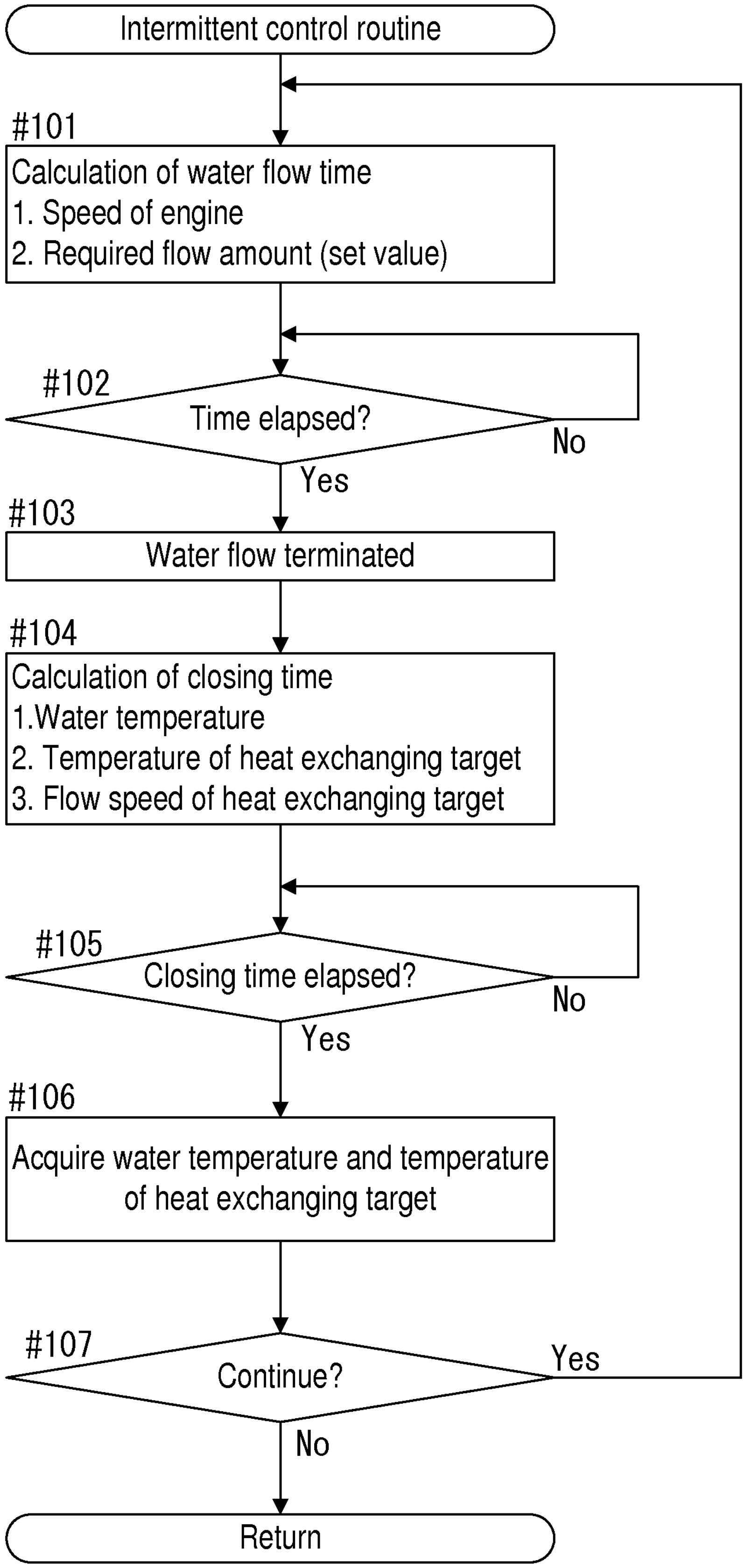
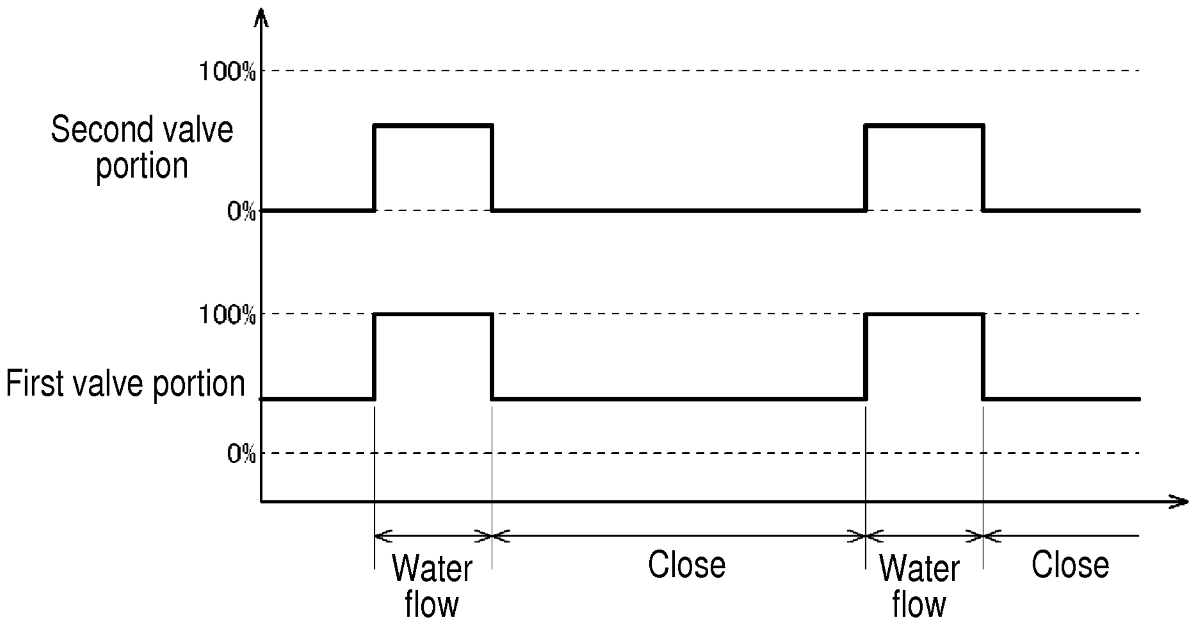

Cooling control routine
#01
Acquire water temperature
#02
Before completion of engine warm up?
Yes
#03
Fully-closed mode
No
#04
Before completion of EGR cooler warm up?
Yes
#05
First supply mode
No
#06
Switching information acquired?
No
Yes
#07
Shifts in second supply mode only by setting time and increases oil supply amount
#08
Before completion of oil cooler warm up?
Yes
#09
Second supply mode
No
#010
Third supply mode
Return

FIG. 6


Intermittent control routine
#101
Calculation of water flow time
1. Speed of engine
2. Required flow amount (set value)
#102
Time elapsed?
No
Yes
#103
Water flow terminated
#104
Calculation of closing time
1.Water temperature
2. Temperature of heat exchanging target
3. Flow speed of heat exchanging target
#105
Closing time elapsed?
No
Yes
#106
Acquire water temperature and temperature of heat exchanging target
#107
Continue?
Yes
No
Return

F I G. 7


100%
Second valve portion
0%
100%
First valve portion
0%
Water flow
Close
Water flow
Close

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/076458

A. CLASSIFICATION OF SUBJECT MATTER
F01P7/16(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)
F01P7/16

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2016
Kokai Jitsuyo Shinan Koho	1971-2016	Toroku Jitsuyo Shinan Koho	1994-2016

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	JP 2004-301041 A (Mitsubishi Motors Corp.), 28 October 2004 (28.10.2004), paragraphs [0005] to [0006], [0012] to [0016], [0019] to [0020], [0056] to [0058], [0061] to [0066]; fig. 1, 8, 10 (Family: none)	1-2 3-6
A	JP 2010-209736 A (Toyota Motor Corp.), 24 September 2010 (24.09.2010), entire text; all drawings (Family: none)	1-6
A	JP 2011-27012 A (Toyota Motor Corp.), 10 February 2011 (10.02.2011), entire text; all drawings (Family: none)	1-6

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 November 2016 (11.11.16)	22 November 2016 (22.11.16)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/076458

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2014/192747 A1 (Nissan Motor Co., Ltd.), 04 December 2014 (04.12.2014), entire text; all drawings (Family: none)	1-6
A	JP 2014-946 A (Denso Corp.), 09 January 2014 (09.01.2014), entire text; all drawings & US 2015/0129161 A1 & WO 2013/175710 A1 & DE 112013002630 T & CN 104379895 A	1-6

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2014009634 A **[0006]**
- JP 2012041904 A **[0006]**