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

(11) EP 2 395 209 A1

(12) EUROPEAN PATENT APPLICATION

published in accordance with Art. 153(4) EPC

(43) Date of publication:
14.12.2011 Bulletin 2011/50

(21) Application number: **09839667.4**

(22) Date of filing: **09.02.2009**

(51) Int Cl.:
F01M 5/00 *(2006.01)*

(86) International application number:
PCT/JP2009/052154

(87) International publication number:
WO 2010/089890 (12.08.2010 Gazette 2010/32)

(84) Designated Contracting States:
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 SE SI SK TR

(71) Applicant: **Toyota Jidosha Kabushiki Kaisha**
Toyota-shi, Aichi 471-8571 (JP)

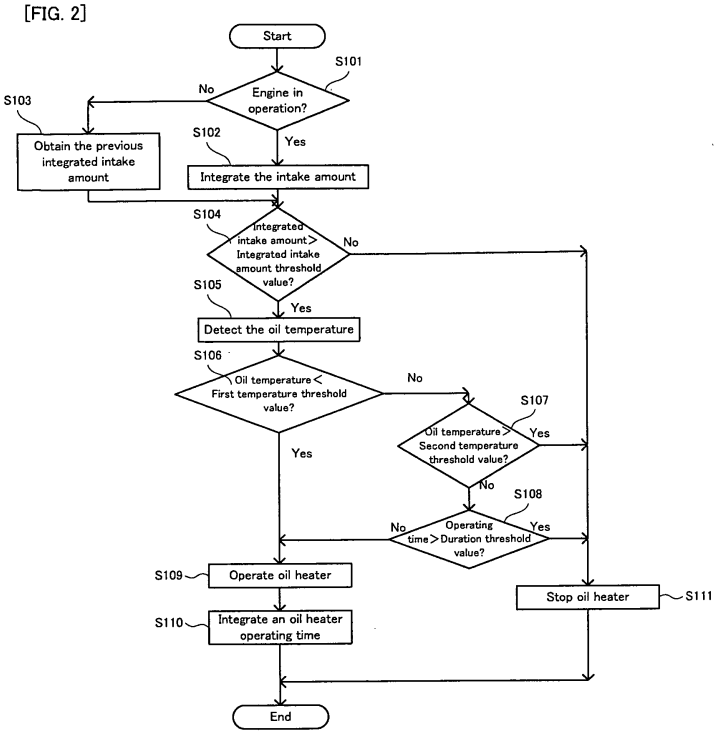
(72) Inventor: **KANAI, Hiroshi**
Toyota-shi
Aichi 471-8571 (JP)

(74) Representative: **Kuhnen & Wacker**
Patent- und Rechtsanwaltsbüro
Prinz-Ludwig-Strasse 40A
85354 Freising (DE)

(54) DEVICE AND METHOD FOR SUPPRESSING DILUTION OF OIL

(57) An oil dilution inhibiting apparatus (100) is mounted on a vehicle provided with an engine (1) in which alcohol fuel can be used, the oil dilution inhibiting apparatus provided with: an intake amount integrating device (31) for integrating amount of an air sucked into the engine while the engine is in operation, thereby calculating an integrated intake amount; a temperature detecting device (34) for detecting oil temperature of engine oil of the engine; and a controlling device (31) for controlling the vehicle to move into an oil heating mode in which the oil temperature is increased in such conditions that the calculated integrated intake amount is greater than an integrated intake amount threshold value and that the detected oil temperature is less than a first temperature threshold value.

[FIG. 2]



EP 2 395 209 A1

Description

Technical Field

[0001] The present invention relates to an oil dilution inhibiting apparatus and method for inhibiting the dilution of engine oil by alcohol fuel, in a vehicle provided with an engine in which the alcohol fuel can be used.

Background Art

[0002] If fuel is mixed into engine oil and thus the engine oil is diluted, for example, the lubricating ability of the engine oil is reduced.

[0003] As this type of apparatus, for example, there has been suggested an internal combustion engine for increasing the temperature of lubricating oil by operating an oil heater if sub injection such as pilot injection and post injection is performed in tandem with main injection (refer to a patent document 1). Alternatively, there has been suggested an apparatus for setting the injection timing of the fuel in accordance with the counter value of a dilution counter associated with the oil dilution at the start of a diesel engine (refer to a patent document 2). Alternatively, there has been suggested an apparatus for forbidding the purge of evaporated fuel by an evaporated fuel processing mechanism provided with a canister, under the condition that a fuel dilution degree about a lubricant is estimated and that the estimated fuel dilution degree is large (refer to a patent document 3).

[0004] Alternatively, there has been suggested an apparatus for heating the engine oil within a fuel evaporating apparatus connected to an oil pan by a lubricant supply channel and return channel, by using a heater, on the basis of a result of comparison between a predetermined threshold value and the value of a detected parameter about the dilution ratio of the engine oil (refer to a patent document 4). Alternatively, there has been suggested an apparatus for increasing the temperature of the engine oil if the dilution ratio of the engine oil at least by water which constitutes alcohol fuel is estimated and if it is judged that the estimated dilution ratio of the engine oil is greater than a first threshold value, in a vehicle in which the alcohol fuel can be used (refer to a patent document 5).

[0005] Incidentally, the "lubricating oil" and the "lubricant" are one example of the "engine oil" of the present invention.

[0006]

Patent document 1: Japanese Patent Application Laid Open No. 2004-190513

Patent document 2: Japanese Patent Application Laid Open No. 2008-38779

Patent document 3: Japanese Patent Application Laid Open No. 2003-322052

Patent document 4: Japanese Patent Application Laid Open No. 2004-293394

Patent document 5: Japanese Patent Application Laid Open No. 2008-121592

Disclosure of Invention

Subject to be Solved by the Invention

[0007] However, according to the aforementioned background art, for example, such a vehicle is not considered that is provided with an engine automatic stop / start apparatus (i.e. an economy run system or idling stop system) or the like and that the start and stop of the engine are repeated relatively frequently. Then, the temperature of the engine becomes relatively low, the fuel that does not volatize increases, and the oil dilution by unburnt fuel likely occurs more than expected, which are technically problematic.

[0008] In view of the aforementioned problems, it is therefore an object of the present invention to provide an oil dilution inhibiting apparatus and method capable of appropriately inhibiting the dilution of engine oil, in a vehicle in which the start and stop of an engine are repeated relatively frequently.

Means for Solving the Subject

[0009] The above object of the present invention can be achieved by an oil dilution inhibiting apparatus mounted on a vehicle comprising an engine in which alcohol fuel can be used, the oil dilution inhibiting apparatus provided with: an intake amount integrating device for integrating amount of an air sucked into the engine while the engine is in operation, thereby calculating an integrated intake amount; a temperature detecting device for detecting oil temperature of engine oil of the engine; and a controlling device for controlling the vehicle to move into an oil heating mode in which the oil temperature is increased in such conditions that the calculated integrated intake amount is greater than an integrated intake amount threshold value and that the detected oil temperature is less than a first temperature threshold value.

[0010] According to the oil dilution inhibiting apparatus of the present invention, the oil dilution inhibiting apparatus is mounted on the vehicle provided with the engine in which the alcohol fuel can be used. Here, the "alcohol fuel" indicates fuel in which alcohol and another fuel, such as gasoline, are mixed (i.e. so-called alcohol blended fuel), or fuel including only alcohol.

[0011] The intake amount integrating device, which is provided with, for example, a memory, a processor, and the like, integrates the amount of the air sucked into the engine in the operation of the engine, thereby calculating the integrated intake amount. Specifically, for example, the intake amount integrating device obtains the amount of the air sucked into the engine via an airflow meter disposed in the intake passage of the engine and integrates the obtained air amount, thereby calculating the integrated intake amount.

[0012] Here, "in the operation of the engine" typically means a period from the start of the engine to the stop of the engine (i.e. 1 trip). Therefore, typically, the integrated intake amount is calculated in each trip, and it is stored in the memory or the like.

[0013] The temperature detecting device, such as a temperature sensor, detects the oil temperature of the engine oil of the engine. The temperature detecting device may directly detect the oil temperature, or predict (i.e. indirectly detect) the oil temperature, for example, on the basis of the temperature of cooling water for cooling the engine.

[0014] The controlling device, which is provided with, for example, a memory, a processor, and the like, controls the vehicle to move into the oil heating mode in which the oil temperature is increased, in such conditions that the calculated integrated intake amount is greater than the integrated intake amount threshold value and that the detected oil temperature is less than the first temperature threshold value. Here, the "oil heating mode" of the present invention indicates a mode in which the oil temperature of the engine oil is increased to evaporate the fuel mixed into the engine oil or the like (specifically, for example, unburnt fuel, water generated in the combustion of the fuel, or the like).

[0015] Specifically, for example, the heating by a heating device, such as a heater, is performed such that the oil temperature is 80 degrees C in consideration of the boiling point of ethanol mainly used for the alcohol fuel. Alternatively, if the vehicle on which the oil dilution inhibiting apparatus is mounted is provided with a motor for driving the vehicle, in addition to the engine, as in a hybrid vehicle or a plug-in hybrid vehicle, the engine is continuously operated (i.e. intermittent operation is forbidden), or an engine load is increased. Alternatively, if the vehicle on which the oil dilution inhibiting apparatus is mounted is provided with a so-called economy run system, the operation of the economy run system is forbidden.

[0016] The "integrated intake amount threshold value" of the present invention is one of the values for determining whether or not to move the vehicle into the oil heating mode, and it is a value set as a fixed value or a variable value according to physical quantity or some parameter in advance. The integrated intake amount threshold value may be set as an integrated intake amount corresponding to the gross heating value of the engine, which can inhibit the fuel or the like from being mixed into the engine oil and which can maintain the appropriate state of the engine oil, or as a value which is higher than the integrated intake amount threshold value by a predetermined value, on the basis of a relation between the integrated intake amount and the gross heating value of the engine corresponding to the integrated intake amount, wherein the relation is obtained experimentally, or experientially, or by simulations.

[0017] Incidentally, "inhibit the fuel or the like from being mixed into" means to evaporate the fuel or the like mixed into the engine oil, and to evaporate the fuel or the like to be mixed into the engine oil, for example, through the cylinder wall surface of the engine.

[0018] The "first temperature threshold value" of the present invention is one of the values for determining whether or not to move the vehicle into the oil heating mode, and it is a value set as a fixed value or a variable value according to physical quantity or some parameter in advance. The first temperature threshold value may be set as an oil temperature which can maintain the appropriate state of the engine oil, or as a value which is higher than the oil temperature by a predetermined value, on the basis of a relation among the oil temperature, the saturated vapor pressure of the fuel or the like, and the amount of the fuel or the like mixed into the engine oil, wherein the relation is obtained experimentally, or experientially, or by simulations.

[0019] Incidentally, for the amount of the fuel or the like mixed into the engine oil, an existing estimation method may be used, such as estimating on the basis of the amount of fuel injected from the fuel injection valve of the engine, the temperature of the engine (or the temperature of cooling water), the engine load, or the like.

[0020] According to the study of the present inventors, even if the calculated integrated intake amount is greater than the integrated intake amount threshold value, the temperature of the engine decreases during the stop of the engine in a vehicle in which the start and stop of the engine are repeated relatively frequently. As a result, the fuel or the like, which is in a gas state within the engine, is condensed and mixed into the engine oil. In other words, the amount of the fuel or the like mixed into the engine oil become larger than a predicted amount. In particular, if an air heating function is used, the rate of decrease in engine temperature is relatively high. Thus, the amount of the fuel or the like mixed into the engine oil is likely significantly increased, in comparison with the predicted amount.

[0021] Incidentally, the so-called economy run system or the like allows the engine to be stopped, for example, if the temperature of cooling water of the engine is higher than a temperature at which the air heating function can be ensured (e.g. 60 degrees C). Thus, it has been found that if the alcohol fuel including ethanol with a boiling point of 78 degrees C is used, for example, most of the ethanol on the cylinder wall surface is mixed into the engine oil.

[0022] In the present invention, however, the vehicle is controlled by the controlling device to move into the oil heating mode in which the oil temperature is increased, in such conditions that the calculated integrated intake amount is greater than the integrated intake amount threshold value and that the detected oil temperature is less than the first temperature threshold value. In other words, for example, even if the calculated integrated intake amount is greater than the integrated intake amount threshold value which is the integrated intake amount corresponding to the gross heating value which can maintain the appropriate state of the engine oil, if the

detected oil temperature is less than the first temperature threshold value which is the oil temperature capable of maintaining the appropriate state of the engine oil, the vehicle is controlled by the controlling device to move into the oil heating mode.

[0023] Thus, the engine oil is heated to increase the oil temperature, and the fuel or the like mixed into the engine oil can be evaporated. As a result, it is possible to inhibit the dilution of the engine oil.

[0024] In one aspect of the oil dilution inhibiting apparatus of the present invention, the controlling device includes a judging device for judging whether or not the calculated integrated intake amount is greater than the integrated intake amount threshold value and whether or not the detected oil temperature is less than the first temperature threshold value, and controls the vehicle to move into the oil heating mode if it is judged that the calculated integrated intake amount is greater than the integrated intake amount threshold value and if it is judged that the detected oil temperature is less than the first temperature threshold value.

[0025] According to this aspect, it is possible to relatively easily judge whether or not the calculated integrated intake amount is greater than the integrated intake amount threshold value and whether or not the detected oil temperature is less than the first temperature threshold value, so that it is extremely useful in practice.

[0026] The judging device, which is provided with, for example, a memory, a processor, a comparator, and the like, judges whether or not the calculated integrated intake amount is greater than the integrated intake amount threshold value and whether or not the detected oil temperature is less than the first temperature threshold value. The controlling device controls the vehicle to move into the oil heating mode if it is judged that the calculated integrated intake amount is greater than the integrated intake amount threshold value and if it is judged that the detected oil temperature is less than the first temperature threshold value.

[0027] On the other hand, if it is judged that the calculated integrated intake amount is less than the integrated intake amount threshold value, typically, the controlling device controls the vehicle not to move into the oil heating mode. Moreover, if it is judged that the calculated integrated intake amount is greater than the integrated intake amount threshold value and if it is judged that the detected oil temperature is greater than the first temperature threshold value, the controlling device controls the judging device to perform another conditional judgment (specifically, for example, to compare the detected oil temperature with another temperature threshold value, or perform a similar operation).

[0028] Incidentally, if the calculated integrated intake amount is equal to the integrated intake amount threshold value, it may be treated by being included in one or the other of the aforementioned cases. In the same manner, if the detected oil temperature is equal to the first temperature threshold value, it may be treated by being included in one or the other of the aforementioned cases.

[0029] In another aspect of the oil dilution inhibiting apparatus of the present invention, it is further provided with a duration detecting device for detecting a time in which the vehicle continues to be in the oil heating mode, and the controlling device controlling the vehicle to maintain the oil heating mode in such conditions that the detected oil temperature is less than a second temperature threshold value and that the detected time is less than a duration threshold value.

[0030] According to this aspect, the duration detecting device, which is provided with, for example, a memory, a processor, and the like, detects the time in which the vehicle continues to be in the oil heating mode. Here, "continues to be in the oil heating mode" means being in a period from when the vehicle is moved into the oil heating mode to when the oil heating mode is canceled. Incidentally, the duration detecting device stops the detection of the duration if the oil heating mode is canceled. Specifically, for example, the duration detecting device stops a count indicating the duration and then resets it if the oil heating mode is canceled.

[0031] The controlling device controls the vehicle to maintain the oil heating mode in such conditions that the detected oil temperature is less than the second temperature threshold value and that the detected time is less than the duration threshold value. Here, the "second temperature threshold value" of the present invention is one of the values for determining whether or not to maintain the oil heating mode, and it is a value set as a fixed value or a variable value according to physical quantity or some parameter in advance. The second temperature threshold value may be set as an oil temperature corresponding to the upper limit of an acceptable range of the extent of the oxidation and thermal degradation of the engine oil, or as a value which is lower than the oil temperature by a predetermined value, on the basis of a relation between the oil temperature and the extent of the oxidation and thermal degradation of the engine oil, wherein the relation is obtained experimentally, or experientially, or by simulations.

[0032] The "duration threshold value" of the present invention is one of the values for determining whether or not to maintain the oil heating mode, and it is a value set as a fixed value or a variable value according to physical quantity or some parameter in advance. The duration threshold value may be set as a heating time corresponding to the upper limit of an acceptable range of the extent of the oxidation and thermal degradation of the engine oil, or as a value which is lower than the heating time by a predetermined value, on the basis of a relation between the heating time of the engine oil and the extent of the oxidation and thermal degradation of the engine oil if the engine oil is continuously heated, wherein the relation is obtained experimentally, or experientially, or by simulations.

[0033] Therefore, according to this aspect, it is possible to inhibit the oxidation and thermal degradation of the

engine oil, so that it is extremely useful in practice.

[0034] Alternatively, in another aspect of the oil dilution inhibiting apparatus of the present invention, it is further provided with: a vehicle state detecting device for detecting a vehicle state of the vehicle; an oil-level height detecting device capable of detecting oil-level height of the engine oil in an oil pan of the engine; and a duration detecting device for detecting a time in which the vehicle continues to be in the oil heating mode, the controlling device controlling the oil-level height detecting device to detect the oil-level height in such a condition that the detected vehicle state is a predetermined state, the controlling device controlling the vehicle to continue the oil heating mode in such conditions that the detected oil-level height is greater than a height threshold value, that the detected oil temperature is less than a second temperature threshold value, and that the detected time is less than a duration threshold value.

[0035] According to this aspect, the vehicle state detecting device, which is provided with, for example, a memory, a processor, and the like, detects the vehicle state of the vehicle. Here, the "vehicle state" means physical quantity or some parameter indicating the operating state of the vehicle, such as a vehicle speed, vehicle inclination, and the number of revolutions of the engine, or a state indicated by one or more physical quantities and/or parameters.

[0036] The oil-level height detecting device, such as a liquid-level gauge, can detect the oil-level height of the engine oil in the oil pan of the engine. The duration detecting device, which is provided with, for example, a memory, a processor, and the like, detects the time in which the vehicle continues to be in the oil heating mode.

[0037] The controlling device controls the oil-level height detecting device to detect the oil-level height in such a condition that the detected vehicle state is the predetermined state. Here, the "predetermined state" of the present invention means a state in which the oil-level height detected in one opportunity can be relatively easily compared with the oil-level height detected in another opportunity, such as while the vehicle is stopped (i.e. the vehicle speed is zero), while the vehicle is horizontal, and while the engine is stopped (i.e. the number of revolutions of the engine is zero). In other words, the "predetermined state" of the present invention means a reproducible state.

[0038] Then, the controlling device controls the vehicle to continue the oil heating mode in such conditions that the detected oil-level height is greater than the height threshold value, that the detected oil temperature is less than the second temperature threshold value, and that the detected time is less than the duration threshold value. Here, the "height threshold value" of the present invention is one of the values for determining whether or not to maintain the oil heating mode, and it is a value set as a fixed value or a variable value according to physical quantity or some parameter in advance.

[0039] The height threshold value is typically expressed as a sum of the detected oil-level height and a predetermined height. Here, the "predetermined height" may be set as the upper limit value of an increment of the oil-level height which can maintain the appropriate state of the engine oil, or as a value which is smaller than the upper limit value by a predetermined value, on the basis of a relation between the increment of the oil-level height and the amount of fuel or the like mixed into the engine oil, wherein the relation is obtained experimentally, or experientially, or by simulations.

[0040] Therefore, according to this aspect, it is possible to maintain the appropriate state of the engine oil while inhibiting the oxidation and thermal degradation of the engine oil.

[0041] Alternatively, in another aspect of the oil dilution inhibiting apparatus of the present invention, it is further provided with: a high oil temperature time integrating device for integrating a time in which the detected oil temperature is an oil temperature greater than a third temperature threshold value, thereby calculating an integrated high oil temperature time; and a duration detecting time for detecting a time in which the vehicle continues to be in the oil heating mode, the controlling device controlling the vehicle to continue the oil heating mode in such conditions that the calculated integrated high oil temperature time is less than an integrated time threshold value, that the detected oil temperature is less than a second temperature threshold value, and that the detected time is less than a duration threshold value.

[0042] According to this aspect, the high oil temperature time integrating device, which is provided with, for example, a memory, a processor, and the like, integrates the time in which the detected oil temperature is the oil temperature greater than the third temperature threshold value, thereby calculating the integrated high oil temperature time. Here, the "third temperature threshold value" is set as a temperature at which thermal degradation occurs in an additive added to the base oil of the engine oil, or a temperature which is lower than the temperature by a predetermined value, such as the heatproof temperature of antioxidant included in the engine oil.

[0043] Incidentally, the integrated high oil temperature time calculated by the high oil temperature time integrating device may be calculated in each period from when the oil temperature becomes greater than the third temperature threshold value and to when the oil temperature becomes less than the third temperature threshold value (i.e. if the oil temperature becomes less than the third temperature threshold value after becoming higher than the third temperature threshold value, the integrated high oil temperature time may be reset after the calculated integrated high oil temperature time is stored into a memory or the like), or it may be calculated as a total time of the whole period in which the oil temperature is greater than the third temperature threshold value.

[0044] For example, the duration detecting time, which is provided with, for example, a memory, a processor, and the like, detects the time in which the vehicle contin-

ues to be in the oil heating mode. The controlling device controls the vehicle to continue the oil heating mode in such conditions that the calculated integrated high oil temperature time is less than the integrated time threshold value, that the detected oil temperature is less than the second temperature threshold value, and that the detected time is less than the duration threshold value.

[0045] Here, the "integrated time threshold value" of the present invention is one of the values for determining whether or not to maintain the oil heating mode, and it is a value as a fixed value or a variable value according to physical quantity or some parameter in advance. The "integrated time threshold value" may be set as a time corresponding to the upper limit of an acceptable range of the extent of the thermal degradation of the engine oil, or as a value which is smaller than the time by a predetermined value, on the basis of a relation between the time in which the oil temperature is the oil temperature greater than the third temperature threshold value and the extent of the thermal degradation of the engine oil, wherein the relation is obtained experimentally, or experientially, or by simulations. In other words, the integrated time threshold value may be set as a time in which an influence due to the thermal degradation of the engine oil would be more significant than an influence, such as a reduction in lubricating ability, due to the fuel or the like mixed into the engine oil), or as a time less than the aforementioned time by a predetermined value.

[0046] Therefore, according to this aspect, the oxidation and thermal degradation of the engine oil can be inhibited, so that it is extremely useful in practice.

[0047] In another aspect of the oil dilution inhibiting apparatus of the present invention, the engine includes a heating device capable of heating the engine oil, and the oil heating mode is a mode in which the engine oil is heated by the heating device to increase the oil temperature.

[0048] According to this aspect, it is possible to increase the oil temperature by heating the engine oil, relatively easily, so that it is extremely useful in practice.

[0049] The heating device, such as a heater, is provided for the engine. The heating device may be placed, for example, in an oil pan or in the vicinity of the entrance of an oil filter.

[0050] Alternatively, in another aspect of the oil dilution inhibiting apparatus of the present invention, the oil heating mode is a mode in which the engine is continuously operated to increase the oil temperature.

[0051] According to this aspect, it is possible to increase the oil temperature by heating the engine oil. Moreover, for example, if the vehicle on which the oil dilution inhibiting apparatus is mounted is a hybrid vehicle, a battery can be charged by rotating a motor with the engine (i.e. by making the motor function as a generator).

[0052] Here, "the engine is continuously operated" means that the engine can be forcibly operated even if such a condition that the engine can be automatically stopped is satisfied, such as a condition that the temperature of cooling water of the engine is greater than a predetermined temperature and a condition that the vehicle is stopped. In other words, "the engine is continuously operated" means that intermittent operation is forbidden.

[0053] The above object of the present invention can be also achieved by an oil dilution inhibiting method in an oil dilution inhibiting apparatus mounted on a vehicle comprising an engine in which alcohol fuel can be used, the oil dilution inhibiting method provided with: an intake amount integrating process of integrating amount of an air sucked into the engine while the engine is in operation, thereby calculating an integrated intake amount; a temperature detecting process of detecting oil temperature of engine oil of the engine; and a controlling process of controlling the vehicle to move into an oil heating mode in which the oil temperature is increased in such conditions that the calculated integrated intake amount is greater than an integrated intake amount threshold value and that the detected oil temperature is less than a first temperature threshold value.

[0054] According to the oil dilution inhibiting method of the present invention, the dilution of the engine oil can be inhibited, as in the oil dilution inhibiting apparatus of the present invention described above.

[0055] Incidentally, even the oil dilution inhibiting method of the present invention can also adopt the various aspects of the oil dilution inhibiting apparatus of the present invention described above.

[0056] The operation and other advantages of the present invention will become more apparent from the best mode for carrying out the invention explained below.

Brief Description of Drawings

[0057]

[FIG. 1] FIG. 1 is a block diagram showing the structure of an oil dilution inhibiting apparatus in a first embodiment.

[FIG. 2] FIG. 2 is a flowchart showing an oil dilution inhibiting process performed by an ECU in the first embodiment.

[FIG. 3] FIG. 3 is a block diagram showing the structure of an oil dilution inhibiting apparatus in a first modified example in the first embodiment.

[FIG. 4] FIG. 4 is a flowchart showing an oil dilution inhibiting process performed by the ECU in a second modified example in the first embodiment.

[FIG. 5] FIG. 5 is a flowchart showing an oil dilution inhibiting process performed by the ECU in a second embodiment.

[FIG. 6] FIG. 6 is a flowchart showing an oil dilution inhibiting process performed by the ECU in a third embodiment.

Description of Reference Codes

[0058]

1, 2	engine
11	cylinder
12	intake valve
13	exhaust valve
14	intake passage
15	exhaust passage
16	oil pan
17	piston
21	ignition plug
22	fuel injection valve
23	oil filter
26	oil heater
31	ECU
32	airflow meter
33	water temperature sensor
34	oil temperature sensor
35	oil-level height sensor

Best Mode for Carrying Out the Invention

[0059] Hereinafter, embodiments of the oil dilution inhibiting apparatus of the present invention will be explained with reference to the drawings.

<First Embodiment>

[0060] A first embodiment of the oil dilution inhibiting apparatus of the present invention will be explained with reference to FIG. 1 and FIG. 2. FIG. 1 is a block diagram showing the structure of an oil dilution inhibiting apparatus in the first embodiment.

[0061] In FIG. 1, an engine 1 provided for a vehicle (not illustrated) on which an oil dilution inhibiting apparatus 100 is mounted is provided with: a cylinder 11; an intake valve 12; an exhaust valve 13; an intake passage 14; an exhaust passage 15; an oil pan 16; a piston 17; an ignition plug 21; a fuel injection valve 22; an oil filter 23; and an oil heater 26.

[0062] Engine oil EO accumulated in the oil pan 16 flows into the oil filter 23 via an oil inflow passage 24. The engine oil EO which has passed through the oil filter 23 is pumped by the oil pump 25 and is supplied to a main gallery not illustrated. The fuel injection valve 22 is controlled by an ECU (Electronic Control Unit) 31 to inject alcohol fuel accumulated in a not-illustrated fuel tank, by a predetermined amount in predetermined timing.

[0063] Incidentally, the vehicle in the first embodiment is typically a vehicle provided with a so-called economy run system, or a hybrid vehicle provided with a motor for driving.

[0064] The oil dilution inhibiting apparatus 100 is provided with: the ECU 31 for detecting an air amount sucked into the engine 1 via the airflow meter 32 disposed in the intake passage 14 in the operation of the engine 1 and for integrating the detected air amount to calculate an integrated intake amount; a water temperature sensor 33 for detecting the temperature of cooling water LLC of the engine 1; an oil temperature sensor 34 for detecting the oil temperature of the engine oil EO; and an oil-level height sensor 35 capable of detecting the oil-level height of the engine oil EO accumulated in the oil pan 16.

[0065] Here, each of the "ECU 31", the "oil temperature sensor 34" and the "oil-level height sensor 35" in the first embodiment is one example of respective one of the "intake amount integrating device", the "temperature detecting device", and the "oil-level height detecting device" of the present invention. In the first embodiment, one portion of the ECU 31 for various electronic control is used as one portion of the oil dilution inhibiting apparatus 100.

[0066] The ECU 31 as one portion of the oil dilution inhibiting apparatus 100 judges whether or not the calculated integrated intake amount is greater than an integrated intake amount threshold value, and whether or not the detected oil temperature is less than a first temperature threshold value. If it is judged that the calculated integrated intake amount is greater than the integrated intake amount threshold value and that the detected oil temperature is less than the first temperature threshold value, the ECU 31 as one portion of the oil dilution inhibiting apparatus 100 controls the oil heater 26 to heat the engine oil EO and increase the oil temperature.

[0067] Here, the "ECU 31" in the first embodiment is one example of the "judging device" and the "controlling device" of the present invention. Moreover, the "heating of the engine oil EO by the oil heater 26" in the first embodiment is one example of the "oil heating mode" of the present invention.

[0068] Next, an explanation will be given on an oil dilution inhibiting process performed by the ECU 31 in the vehicle on which the oil dilution inhibiting apparatus 100 as constructed above is mounted. The oil dilution inhibiting process is performed, for example, regularly or irregularly, in cycles of several tenths seconds to several seconds, during the run of the vehicle or at the start of the run.

(In Case Where Oil Heater Is OFF)

[0069] In FIG. 2, if the oil heater 26 is OFF (i.e. if it is not in the oil heating mode), firstly, the ECU 31 judges whether or not the engine 1 is in operation (step S101). Incidentally, the ECU 31 judges whether or not the engine 1 is in operation by judging whether or not the ECU 31 has sent a signal indicating an engine start command, whether or not the ECU 31 has not sent a signal indicating an engine stop command, whether or not the number of revolutions of the engine 1 is not zero, or the like.

[0070] If it is judged that the engine 1 is in operation (the step S101: Yes), the ECU 31 calculates the integrated intake amount by detecting the amount of air sucked into the engine 1 via the airflow meter 32 disposed in the

intake passage 14 and by integrating the detected air amount (step S102). On the other hand, if it is judged that the engine 1 is not in operation (the step S101: No), the ECU 31 obtains the integrated intake amount calculated in the previous trip from a memory (not illustrated) or the like (step S103).

[0071] Then, the ECU 31 judges whether or not the integrated intake amount calculated in the step S102 or the integrated intake amount obtained in the step S103 is greater than the integrated intake amount threshold value (step S104). If it is judged that the calculated or obtained integrated intake amount is greater than the integrated intake amount threshold value (the step S104: Yes), the ECU 31 obtains the oil temperature of the engine oil EO via the oil temperature sensor 34 (step S105).

[0072] Then, the ECU 31 judges whether or not the obtained oil temperature is less than the first temperature threshold value (step S106). If it is judged that the obtained oil temperature is less than the first temperature threshold value (the step S106: Yes), the ECU 31 controls the oil heater 26 to heat the engine oil EO (step S109). The ECU 31 further integrates the continuous operating time of the oil heater 26 in tandem with the process in the step S109 (step S110). Then, the ECU 31 temporarily ends the process.

[0073] Here, in the process in the step S106, the case where it is judged that the obtained oil temperature is less than the first temperature threshold value is typically a case where although the gross heating value of the engine 1 in one trip, the temperature of the engine 1 is reduced due to the passage of time after the stop of the engine 1 and the oil temperature of the engine oil EO becomes lower than an oil temperature which can maintain the appropriate state of the engine oil EO. Thus, in the process in the step S106, if it is judged that the obtained oil temperature is less than the first temperature threshold value (the step S106: Yes), the ECU 31 controls the oil heater 26 to evaporate the fuel mixed into the engine oil EO or the like.

[0074] In the process in the step S104, if it is judged that the integrated intake amount calculated in the step S102 or the integrated intake amount obtained in the step S103 is less than the integrated intake amount threshold value (the step S104: No), the ECU 31 controls the oil heater 26 not to heat the engine oil EO (i.e. to make the oil heater 26 maintain the OFF state) (step S111) and temporarily ends the process.

[0075] In the process in the step S106, if it is judged that the oil temperature obtained in the step S105 is greater than the first temperature threshold value (the step S106: No), the ECU 31 judges whether or not the obtained oil temperature is greater than the second temperature threshold value (step S107). If it is judged that the obtained oil temperature is greater than the second temperature threshold value (the step S107: Yes), the ECU 31 controls the oil heater 26 not to heat the engine oil EO (i.e. to make the oil heater 26 maintain the OFF state) (the step S111) and temporarily ends the process.

[0076] On the other hand, in the process in the step S107, if it is judged that the obtained oil temperature is less than the second temperature threshold value (the step S107: No), the ECU 31 judges whether or not the continuous operating time of the oil heater 26 is greater than a duration threshold value (step S108). Here, since the oil heater 26 is in the OFF state (i.e. the continuous operating time is zero), the ECU 31 judges that the continuous operating time of the oil heater 26 is less than the duration threshold value (the step S108: No).

[0077] Then, the ECU 31 controls the oil heater 26t to heat the engine oil EO (step S109) and integrates the continuous operating time of the oil heater 26 in tandem with the process in the step S109 (step S110). Then, the ECU 31 temporarily ends the process. This is because the obtained oil temperature is less than the second temperature threshold value, i.e. the obtained oil temperature is a temperature at which the extent of the oxidation and thermal degradation of the engine oil EO is in an acceptable range, and because the continuous operating time of the oil heater 26 is less than the duration threshold value, i.e. the continuous operating time of the oil heater 26 is a time in which the extent of the oxidation and thermal degradation of the engine oil EO is in an acceptable range. Therefore, even if the oil heater 26 is controlled to heat the engine oil EO, for example, there is a little or almost no influence of the extent of the oxidation and thermal degradation of the engine oil EO on the lubricating ability of the engine oil EO.

(In Case Where Oil Heater Is ON)

[0078] In FIG. 2, if the oil heater 26 is ON (i.e. if it is in the oil heating mode), firstly, the ECU 31 judges whether or not the engine 1 is in operation (the step S101). If it is judged that the engine 1 is in operation (the step S101: Yes), the ECU 31 calculates the integrated intake amount by detecting the amount of air sucked into the engine 1 and by integrating the detected air amount (the step S102). On the other hand, if it is judged that the engine 1 is not in operation (the step S101: No), the ECU 31 obtains the integrated intake amount calculated in the previous trip (the step S103).

[0079] Then, the ECU 31 judges whether or not the integrated intake amount calculated in the step S102 or the integrated intake amount obtained in the step S103 is greater than the integrated intake amount threshold value (the step S104). If it is judged that the calculated or obtained integrated intake amount is greater than the integrated intake amount threshold value (the step S104: Yes), the ECU 31 obtains the oil temperature of the engine oil EO (the step S105).

[0080] Then, the ECU 31 judges whether or not the obtained oil temperature is less than the first temperature threshold value (the step S106). If it is judged that the obtained oil temperature is less than the first temperature threshold value (the step S106: Yes), the ECU 31 controls the oil heater 26 to heat the engine oil EO (i.e. to make

the oil heater 26 maintain the ON state) (the step S109). The ECU 31 further integrates the continuous operating time of the oil heater 26 in tandem with the process in the step S109 (the step S110). Then, the ECU 31 temporarily ends the process.

[0081] In the process in the step S104, if it is judged that the integrated intake amount calculated in the step S102 or the integrated intake amount obtained in the step S103 is less than the integrated intake amount threshold value (the step S104: No), the ECU 31 controls the oil heater 26 not to heat the engine oil EO (the step S111) and temporarily ends the process.

[0082] In the process in the step S106, if it is judged that the oil temperature obtained in the step S105 is greater than the first temperature threshold value (the step S106: No),the ECU 31 judges whether or not the obtained oil temperature is greater than the second temperature threshold value (the step S107). If it is judged that the obtained oil temperature is greater than the second temperature threshold value (the step S107: Yes), the ECU 31 controls the oil heater 26 not to heat the engine oil EO (the step S111) and temporarily ends the process.

[0083] On the other hand, in the process in the step S107, if it is judged that the obtained oil temperature is less than the second temperature threshold value (the step S107: No), the ECU 31 judges whether or not the continuous operating time of the oil heater 26 is greater than the duration threshold value (the step S108). If it is judged that continuous operating time of the oil heater 26 is greater than the duration threshold value (the step S108: Yes), the ECU 31 controls the oil heater 26 not to heat the engine oil EO (the step S111) and temporarily ends the process.

[0084] In the process in the step S108, if it is judged that continuous operating time of the oil heater 26 is less than the duration threshold value (the step S108: No), the ECU 31 controls the oil heater 26 to heat the engine oil EO (i.e. to make the oil heater 26 maintain the ON state) (the step S109). The ECU 31 further integrates the continuous operating time of the oil heater 26 in tandem with the process in the step S109 (the step S110). Then, the ECU 31 temporarily ends the process.

[0085] Particularly in the first embodiment, as described above, if it is judged that the obtained oil temperature is less than the first temperature threshold value (i.e. if the oil temperature of the engine oil EO becomes lower than the oil temperature which can maintain the appropriate state of the engine oil EO) in the process in the step S106, the oil heater 26 is controlled by the ECU 31 to heat the engine oil EO. Thus, it is possible to keep the appropriate state of the engine oil EO.

[0086] In particular, if the temperature of the engine 1 is relatively low, relatively-much alcohol fuel is likely injected from the fuel injection valve 22 at the start of the engine 1 due to a difficulty in volatilization of the alcohol fuel (i.e. relatively-much relatively-cold unburnt fuel is likely mixed into the engine oil EO). Then, even if it is judged that the gross heating value of the engine 1 in one trip is greater than a gross heating value which can maintain the appropriate state of the engine oil EO on the basis of the integrated intake amount, the oil temperature of the engine oil EO likely becomes lower than the oil temperature which can maintain the appropriate state of the engine oil EO. This has been found by the present inventors' study.

<First Modified Example>

[0087] Next, a first modified operation in the first embodiment will be explained with reference to FIG. 3. FIG. 3 is a block diagram showing the structure of an oil dilution inhibiting apparatus in the first modified example in the first embodiment, to the same effect as in FIG. 1.

[0088] In FIG. 3, in an engine 2 in the first modified example the oil heater 26 is disposed in the vicinity of the oil inflow passage 24 of the oil filter 23. In other words, the oil heater 26 is disposed in the vicinity of ht entrance of the oil filter 23.

<Second Modified Example>

[0089] Next, a second modified operation in the first embodiment will be explained with reference to FIG. 4. FIG. 4 is a flowchart showing an oil dilution inhibiting process performed by the ECU in the second modified example in the first embodiment, to the same effect as in FIG. 2. Except that an intermittent operation is forbidden (i.e. the engine 1 is continuously operated) instead of heating the engine oil EO with the oil heater 26, the second modified example has the same configuration as in the first embodiment. Thus, the overlap explanation with the first embodiment will be omitted in the second modified example. Incidentally, the "forbiddance of the intermittent operation" in the second modified example is another example of the "oil heating mode" of the present invention.

(If Intermittent Operation Is Allowed>

[0090] In FIG. 4, if the intermittent operation is allowed (i.e. if it is not in the oil heating mode), firstly, the ECU 31 judges whether or not the engine 1 is in operation (step S201). If it is judged that the engine 1 is in operation (the step S201: Yes), the ECU 31 calculates the integrated intake amount by detecting the amount of air sucked into the engine 1 and by integrating the detected air amount (step S202). On the other hand, if it is judged that the engine 1 is not in operation (the step S201: No), the ECU 31 obtains the integrated intake amount calculated in the previous trip (step S203).

[0091] Then, the ECU 31 judges whether or not the integrated intake amount calculated in the step S202 or the integrated intake amount obtained in the step S203 is greater than the integrated intake amount threshold value (step S204). If it is judged that the calculated or obtained integrated intake amount is greater than the in-

tegrated intake amount threshold value (the step S204: Yes), the ECU 31 obtains the oil temperature of the engine oil EO (step S205).

[0092] Then, the ECU 31 judges whether or not the obtained oil temperature is less than the first temperature threshold value (step S206). If it is judged that the obtained oil temperature is less than the first temperature threshold value (the step S206: Yes), the ECU 31 controls the engine 1 such that the engine 1 continuously operates (i.e. to forbid the intermittent operation) (step S209). The ECU 31 further integrates a time in which the intermittent operation is forbidden (step S210). Then, the ECU 31 temporarily ends the process.

[0093] In the process in the step S204, if it is judged that the integrated intake amount calculated in the step S202 or the integrated intake amount obtained in the step S203 is less than the integrated intake amount threshold value (the step S204: No), the ECU 31 allows the intermittent operation (i.e. maintains the state in which the intermittent operation is allowed) (step S211) and temporarily ends the process.

[0094] In the process in the step S206, if it is judged that the oil temperature obtained in the step S205 is greater than the first temperature threshold value (the step S206: No), the ECU 31 judges whether or not the obtained oil temperature is greater than the second temperature threshold value (step S207). If it is judged that the obtained oil temperature is greater than the second temperature threshold value (the step S207: Yes), the ECU 31 allows the intermittent operation (i.e. maintains the state in which the intermittent operation is allowed) (the step S211) and temporarily ends the process.

[0095] On the other hand, in the process in the step S207, if it is judged that the obtained oil temperature is less than the second temperature threshold value (the step S207: No), the ECU 31 judges whether or not the time in which the intermittent operation is forbidden is greater than a duration threshold value (step S208). Here, since it is in the state that the intermittent operation is allowed (i.e. the time in which the intermittent operation is forbidden is zero), the ECU 31 judges that the time in which the intermittent operation is forbidden is less than the duration threshold value (the step S208: No).

[0096] Then, the ECU 31 controls the engine 1 such that the engine 1 continuously operates (i.e. to forbid the intermittent operation) (the step S209). The ECU 31 further integrates the time in which the intermittent operation is forbidden in tandem with the process in the step S209 (the step S210). Then, the ECU 31 temporarily ends the process.

(If Intermittent Operation Is Forbidden>

[0097] In FIG. 4, if the intermittent operation is forbidden (i.e. if it is in the oil heating mode), firstly, the ECU 31 judges whether or not the engine 1 is in operation (the step S201). If it is judged that the engine 1 is in operation (the step S201: Yes), the ECU 31 calculates the integrated intake amount by detecting the amount of air sucked into the engine 1 and by integrating the detected air amount (the step S202). On the other hand, if it is judged that the engine 1 is not in operation (the step S201: No), the ECU 31 obtains the integrated intake amount calculated in the previous trip (the step S203).

[0098] Then, the ECU 31 judges whether or not the integrated intake amount calculated in the step S202 or the integrated intake amount obtained in the step S203 is greater than the integrated intake amount threshold value (the step S204). If it is judged that the calculated or obtained integrated intake amount is greater than the integrated intake amount threshold value (the step S204: Yes), the ECU 31 obtains the oil temperature of the engine oil EO (the step S205).

[0099] Then, the ECU 31 judges whether or not the obtained oil temperature is less than the first temperature threshold value (the step S206). If it is judged that the obtained oil temperature is less than the first temperature threshold value (the step S206: Yes), the ECU 31 controls the engine 1 such that the engine 1 continuously operates (i.e. maintains the state that the intermittent operation is forbidden) (the step S209). The ECU 31 further integrates the time in which the intermittent operation is forbidden in tandem with the process in the step S209 (the step S210). Then, the ECU 31 temporarily ends the process.

[0100] In the process in the step S204, if it is judged that the integrated intake amount calculated in the step S202 or the integrated intake amount obtained in the step S203 is less than the integrated intake amount threshold value (the step S204: No), the ECU 31 allows the intermittent operation (the step S211) and temporarily ends the process.

[0101] In the process in the step S206, if it is judged that the oil temperature obtained in the step S205 is greater than the first temperature threshold value (the step S206: No), the ECU 31 judges whether or not the obtained oil temperature is greater than the second temperature threshold value (the step S207). If it is judged that the obtained oil temperature is greater than the second temperature threshold value (the step S207: Yes), the ECU 31 allows the intermittent operation (the step S211) and temporarily ends the process.

[0102] On the other hand, in the process in the step S207, if it is judged that the obtained oil temperature is less than the second temperature threshold value (the step S207: No), the ECU 31 judges whether or not the time in which the intermittent operation is forbidden is greater than the duration threshold value (the step S208). If it is judged that the time in which the intermittent operation is forbidden is greater than the duration threshold value (the step S208: Yes), the ECU 31 allows the intermittent operation (the step S211) and temporarily ends the process.

[0103] In the process in the step S208, if it is judged that the time in which the intermittent operation is forbidden is less than the duration threshold value (the step S208: No), the ECU 31 controls the engine 1 such that

the engine 1 continuously operates (i.e. maintains the state that the intermittent operation is forbidden) (the step S209). The ECU 31 further integrates the time in which the intermittent operation is forbidden in tandem with the process in the step S209 (the step S210). Then, the ECU 31 temporarily ends the process.

<Second Embodiment>

[0104] A second embodiment of the oil dilution inhibiting apparatus of the present invention will be explained with reference to FIG. 5. Except that the second embodiment has a different oil dilution inhibiting process performed by the ECU, the second embodiment has the same configuration as in the first embodiment. Thus, in the second embodiment, the overlap explanation with the first embodiment will be omitted. The common point will carry the same reference numeral in the drawing, and basically only a different point will be explained with reference to FIG. 5. FIG. 5 is a flowchart showing the oil dilution inhibiting process performed by the ECU in the second embodiment, to the same effect as in FIG. 2.

(If Oil Heater Is OFF)

[0105] In FIG. 5, if the oil heater 26 is OFF (i.e. if it is not in the oil heating mode), firstly, the ECU 31 detects the state of the vehicle (step S301). Specifically, for example, the ECU 31 detects a vehicle speed, vehicle inclination, the number of revolutions of the engine 1, and the like. Incidentally, the "ECU 31" in the second embodiment is one example of the "vehicle state detecting device" of the present invention.

[0106] Then, the ECU 31 judges whether or not the vehicle is stopped, for example, on the basis of the detected vehicle speed (step S302). If it is judged that the vehicle is stopped (the step S302: Yes), the ECU 31 judges whether or not the vehicle is horizontal, for example, on the basis of the detected vehicle inclination (step S303).

[0107] If it is judged that the vehicle is horizontal (the step S303: Yes), the ECU 31 judges whether or not the engine 1 is stopped, for example, on the basis of the detected number of revolutions of the engine 1 (step S304). If it is judged that the engine 1 is stopped (the step S304: Yes), the ECU 31 obtains the oil-level height of the engine oil EO in the oil pan 16 via the oil-level height sensor 35 (step S305). This is because if all the judgment results are "Yes" in the processes from the step S302 to the step S304, it is predicted that the vehicle state is reproducible.

[0108] On the other hand, if it is judged that the vehicle is not stopped in the process in the step S302 (the step S302: No), if it is judged that the vehicle is not horizontal in the process in the step S303 (the step S303: No), or if it is judged that the engine 1 is not stopped in the process in the step S304 (the step S304: No), the ECU 31 temporarily ends the process. This is because it is predicted that the vehicle state is not reproducible. Incidentally, in this case, the OFF state of the oil heater 26 is maintained.

[0109] Incidentally, each of the expressions that "the vehicle is stopped", that "the vehicle is horizontal", and that "the engine 1 is stopped" in the second embodiment is one example of the "predetermined state" of the present invention. Moreover, the processes from the step S302 to the step S304 descried above may be performed in tandem with each other.

[0110] After obtaining the oil-level height in the process in the step S305, the ECU 31 judges whether or not the obtained oil-level height is greater than a height threshold value (step S306). Here, the "height threshold value" is expressed by a sum of the oil-level height obtained in the process in the previous step S305 and a predetermined height set as a fixed value or as a variable value according to physical quantity or some parameter in advance.

[0111] If it is judged that the obtained oil-level height is greater than the height threshold value, i.e. if the oil-level height of the engine oil EO becomes higher due to the fuel mixed into the engine oil EO or the like (the step S306: Yes), the ECU 31 obtains the oil temperature of the engine oil EO via the oil temperature sensor 34 (step S307).

[0112] Then, the ECU 31 judges whether or not the obtained oil temperature is greater than the second temperature threshold value (step S308). If it is judged that the obtained oil temperature is less than the second temperature threshold value (the step S308: No), the ECU 31 judges whether or not the continuous operating time of the oil heater 26 is greater than the duration threshold value (step S309). Here, since the oil heater 26 is in the OFF state (i.e. the continuous operating time is zero), the ECU 31 judges that the continuous operating time of the oil heater 26 is less than the duration threshold value (the step S309: No).

[0113] Then, the ECU 31 controls the oil heater 26 to heat the engine oil EO (step S310). The ECU 31 further integrates the continuous operating time of the oil heater 26 in tandem with the process in the step S310 (step S311). Then, the ECU 31 temporarily ends the process.

[0114] On the other hand, if it is judged that obtained oil-level height is less than the height threshold value in the process in the step S306 (the step S306: No), or if it is judged that the obtained oil temperature is greater than the second temperature threshold value (the step S308: Yes), the ECU 31 controls the oil heater 26 not to heat the engine oil EO (i.e. to make the oil heater 26 maintain the OFF state) (step S312).

(If Oil Heater Is ON)

[0115] In FIG. 5, if the oil heater 26 is ON (i.e. if it is in the oil heating mode), firstly, the ECU 31 detects the state of the vehicle (the step S301). Then, the ECU 31 judges whether or not the vehicle is stopped, for example, on the basis of the detected vehicle speed (the step S302).

If it is judged that the vehicle is stopped (the step S302: Yes), the ECU 31 judges whether or not the vehicle is horizontal, for example, on the basis of the detected vehicle inclination (the step S303).

[0116] If it is judged that the vehicle is horizontal (the step S303: Yes), the ECU 31 judges whether or not the engine 1 is stopped (the step S304). If it is judged that the engine 1 is stopped (the step S304: Yes), the ECU 31 obtains the oil-level height of the engine oil EO in the oil pan 16 (the step S305).

[0117] On the other hand, if it is judged that the vehicle is not stopped in the process in the step S302 (the step S302: No), if it is judged that the vehicle is not horizontal in the process in the step S303 (the step S303: No), or if it is judged that the engine 1 is not stopped in the process in the step S304 (the step S304: No), the ECU 31 temporarily ends the process. Incidentally, in this case, the ON state of the oil heater 26 is maintained.

[0118] After obtaining the oil-level height in the process in the step S305, the ECU 31 judges whether or not the obtained oil-level height is greater than the height threshold value (the step S306). If it is judged that the obtained oil-level height is greater than the height threshold value (the step S306: Yes), the ECU 31 obtains the oil temperature of the engine oil EO (the step S307).

[0119] Then, the ECU 31 judges whether or not the obtained oil temperature is greater than the second temperature threshold value (the step S308). If it is judged that the obtained oil temperature is less than the second temperature threshold value (the step S308: No), the ECU 31 judges whether or not the continuous operating time of the oil heater 26 is greater than the duration threshold value (the step S309).

[0120] If it is judged that the continuous operating time of the oil heater 26 is less than the duration threshold value (the step S309: No), the ECU 31 controls the oil heater 26 to heat the engine oil EO (i.e. to make the oil heater 26 maintain the ON state) (the step S310). The ECU 31 further integrates the continuous operating time of the oil heater 26 in tandem with the process in the step S310 (the step S311). Then, the ECU 31 temporarily ends the process.

[0121] On the other hand, if it is judged that obtained oil-level height is less than the height threshold value in the process in the step S306 (the step S306: No), if it is judged that the obtained oil temperature is greater than the second temperature threshold value (the step S308: Yes), or if it is judged that continuous operating time of the oil heater 26 is greater than the duration threshold value in the process in the step S309 (the step S309: Yes), the ECU 31 controls the oil heater 26 not to heat the engine oil EO (the step S312).

[0122] Particularly in the second embodiment, as described above, if it is judged that the obtained oil-level height is less than the height threshold value (i.e. if the fuel included in the engine oil EO or the like is less enough to keep the appropriate state of the engine oil EO) in the process in the step S306, the oil heater 26 is controlled by the ECU 31 not to heat the engine oil EO. Thus, it is possible to inhibit the thermal degradation of the engine oil EO due to the excessive heating of the engine oil EO if the fuel included in the engine oil EO or the like is less enough to keep the appropriate state of the engine oil EO.

[0123] Incidentally, even the second embodiment can adopt the various modified examples of the first embodiment described above. Moreover, for example, if the oil heater 26 is in the OFF state, the oil dilution inhibiting process in the first embodiment may be performed, and if the oil heater 26 is in the ON state, the oil dilution inhibiting process in the second embodiment may be performed,

<Third Embodiment>

[0124] A third embodiment of the oil dilution inhibiting apparatus of the present invention will be explained with reference to FIG. 6. Except that the third embodiment has a different oil dilution inhibiting process performed by the ECU, the third embodiment has the same configuration as in the first embodiment. Thus, in the third embodiment, the overlap explanation with the first embodiment will be omitted. The common point will carry the same reference numeral in the drawing, and basically only a different point will be explained with reference to FIG. 6. FIG. 6 is a flowchart showing the oil dilution inhibiting process performed by the ECU in the third embodiment, to the same effect as in FIG. 2.

(If Oil Heater Is OFF)

[0125] In FIG. 6, if the oil heater 26 is OFF (i.e. if it is not in the oil heating mode), firstly, the ECU 31 obtains the oil temperature of the engine oil EO via the oil temperature sensor 34 (step S401). Then, the ECU 31 judges whether or not the obtained oil temperature is greater than a third temperature threshold value (step S402).

[0126] If it is judged that the obtained oil temperature is greater than the third temperature threshold value (the step S402: Yes), the ECU 31 detects a high oil temperature time indicating the length of a period in which the oil temperature is greater than the third temperature threshold value, and the ECU 31 updates an integrated high oil temperature time on the basis of the detected high oil temperature time (step S403). Here, the "integrated high oil temperature time" is stored in a memory or the like in advance, and its initial value is typically zero.

[0127] On the other hand, in the process in the step S402, if it is judged that the obtained oil temperature is less than the third temperature threshold value (the step S402: No), the ECU 31 obtains the integrated high oil temperature time stored in the memory or the like.

[0128] Then, the ECU 31 judges whether or not the integrated high oil temperature time updated in the process in the step S403 or the integrated high oil temperature time stored in the memory or the like is greater than an integrated time threshold value (step S404). If it is judged

that the integrated high oil temperature time is less than the integrated time threshold value (the step S404: No), the ECU 31 obtains the oil temperature of the engine oil EO via the oil temperature sensor 34 (step S405).

[0129] Then, the ECU 31 judges whether or not the obtained oil temperature is greater than the second temperature threshold value (step S406). If it is judged that the obtained oil temperature is less than the second temperature threshold value (the step S406: No), the ECU 31 judges whether or not the continuous operating time of the oil heater 26 is greater than the duration threshold value (step S407).

[0130] Here, since the oil heater 26 is in the OFF state (i.e. the continuous operating time is zero), the ECU 31 judges that the continuous operating time of the oil heater 26 is less than the duration threshold value (the step S407: No). Then, the ECU 31 controls the oil heater 26 to heat the engine oil EO (step S408). The ECU 31 further integrates the continuous operating time of the oil heater 26 in tandem with the process in the step S408 (step S409). Then, the ECU 31 temporarily ends the process.

[0131] On the other hand, if it is judged that the integrated high oil temperature time is greater than the integrated time threshold value in the process in the step S404 (the step S404: Yes), or if it is judged that the obtained oil temperature is greater than the second temperature threshold value in the process in the step S406 (the step S406: Yes), the ECU 31 controls the oil heater 26 not to heat the engine oil EO (i.e. to make the oil heater 26 maintain the OFF state) (the step S410) and temporarily ends the process.

(If Oil Heater Is ON)

[0132] In FIG. 6, if the oil heater 26 is OFF (i.e. if it is in the oil heating mode), firstly, the ECU 31 obtains the oil temperature of the engine oil EO via the oil temperature sensor 34 (the step S401). Then, the ECU 31 judges whether or not the obtained oil temperature is greater than the third temperature threshold value (the step S402).

[0133] If it is judged that the obtained oil temperature is greater than the third temperature threshold value (the step S402: Yes), the ECU 31 detects the high oil temperature time indicating the length of the period in which the oil temperature is greater than the third temperature threshold value, and the ECU 31 updates the integrated high oil temperature time on the basis of the detected high oil temperature time (the step S403). On the other hand, if it is judged that the obtained oil temperature is less than the third temperature threshold value (the step S402: No), the ECU 31 obtains the integrated high oil temperature time stored in the memory or the like.

[0134] Then, the ECU 31 judges whether or not the integrated high oil temperature time updated in the process in the step S403 or the integrated high oil temperature time stored in the memory or the like is greater than the integrated time threshold value (the step S404). If it is judged that the integrated high oil temperature time is less than the integrated time threshold value (the step S404: No), the ECU 31 obtains the oil temperature of the engine oil EO (the step S405).

[0135] Then, the ECU 31 judges whether or not the obtained oil temperature is greater than the second temperature threshold value (the step S406). If it is judged that the obtained oil temperature is less than the second temperature threshold value (the step S406: No), the ECU 31 judges whether or not the continuous operating time of the oil heater 26 is greater than the duration threshold value (the step S407).

[0136] If it is judged that the continuous operating time of the oil heater 26 is less than the duration threshold value (the step S407: No), the ECU 31 controls the oil heater 26 to heat the engine oil EO (i.e. to make the oil heater 26 maintain the ON state (the step S408). The ECU 31 further integrates the continuous operating time of the oil heater 26 in tandem with the process in the step S408 (the step S409). Then, the ECU 31 temporarily ends the process.

[0137] On the other hand, if it is judged that the integrated high oil temperature time is greater than the integrated time threshold value in the process in the step S404 (the step S404: Yes), if it is judged that the obtained oil temperature is greater than the second temperature threshold value in the process in the step S406 (the step S406: Yes), or if it is judged that the continuous operating time of the oil heater 26 is greater than the duration threshold value in the process in the step S407 (the step S407: Yes), the ECU 31 controls the oil heater 26 not to heat the engine oil EO (the step S410) and temporarily ends the process.

[0138] Particularly in the third embodiment, as described above, if it is judged that the integrated high oil temperature time is greater than the integrated time threshold value (i.e. if it is predicted that an influence due to the thermal degradation of the engine oil would be more significant than an influence, such as a reduction in lubricating ability, due to the fuel or the like mixed into the engine oil) in the process in the step S404, the oil heater 26 is controlled by the ECU 31 not to heat the engine oil EO. Thus, it is possible to inhibit the thermal degradation of the engine oil EO from progressing.

[0139] Incidentally, even the third embodiment can adopt the various modified examples of the first embodiment described above. Moreover, for example, if the oil heater 26 is in the OFF state, the oil dilution inhibiting process in the first embodiment may be performed, and if the oil heater 26 is in the ON state, the oil dilution inhibiting process in the third embodiment may be performed,

[0140] The present invention is not limited to the aforementioned embodiments, but various changes may be made, if desired, without departing from the essence or spirit of the invention which can be read from the claims and the entire specification. An oil dilution inhibiting apparatus and method, which involve such changes, are

also intended to be within the technical scope of the present invention.

Claims

1. An oil dilution inhibiting apparatus mounted on a vehicle comprising an engine in which alcohol fuel can be used, said oil dilution inhibiting apparatus comprising:

   an intake amount integrating device for integrating amount of an air sucked into the engine while the engine is in operation, thereby calculating an integrated intake amount;
   a temperature detecting device for detecting oil temperature of engine oil of the engine; and
   a controlling device for controlling the vehicle to move into an oil heating mode in which the oil temperature is increased in such conditions that the calculated integrated intake amount is greater than an integrated intake amount threshold value and that the detected oil temperature is less than a first temperature threshold value.

2. The oil dilution inhibiting apparatus according to claim 1, wherein said controlling device
   includes a judging device for judging whether or not the calculated integrated intake amount is greater than the integrated intake amount threshold value and whether or not the detected oil temperature is less than the first temperature threshold value, and controls the vehicle to move into the oil heating mode if it is judged that the calculated integrated intake amount is greater than the integrated intake amount threshold value and if it is judged that the detected oil temperature is less than the first temperature threshold value.

3. The oil dilution inhibiting apparatus according to claim 1, further comprising a duration detecting device for detecting a time in which the vehicle continues to be in the oil heating mode, and
   said controlling device controlling the vehicle to maintain the oil heating mode in such conditions that the detected oil temperature is less than a second temperature threshold value and that the detected time is less than a duration threshold value.

4. The oil dilution inhibiting apparatus according to claim 1, further comprising:

   a vehicle state detecting device for detecting a vehicle state of the vehicle;
   an oil-level height detecting device capable of detecting oil-level height of the engine oil in an oil pan of the engine; and
   a duration detecting device for detecting a time in which the vehicle continues to be in the oil heating mode,
   said controlling device controlling said oil-level height detecting device to detect the oil-level height in such a condition that the detected vehicle state is a predetermined state, said controlling device controlling the vehicle to continue the oil heating mode in such conditions that the detected oil-level height is greater than a height threshold value, that the detected oil temperature is less than a second temperature threshold value, and that the detected time is less than a duration threshold value.

5. The oil dilution inhibiting apparatus according to claim 1, further comprising:

   a high oil temperature time integrating device for integrating a time in which the detected oil temperature is an oil temperature greater than a third temperature threshold value, thereby calculating an integrated high oil temperature time; and
   a duration detecting time for detecting a time in which the vehicle continues to be in the oil heating mode,
   said controlling device controlling the vehicle to continue the oil heating mode in such conditions that the calculated integrated high oil temperature time is less than an integrated time threshold value, that the detected oil temperature is less than a second temperature threshold value, and that the detected time is less than a duration threshold value.

6. The oil dilution inhibiting apparatus according to claim 1, wherein
   the engine includes a heating device capable of heating the engine oil, and
   the oil heating mode is a mode in which the engine oil is heated by the heating device to increase the oil temperature.

7. The oil dilution inhibiting apparatus according to claim 1, wherein the oil heating mode is a mode in which the engine is continuously operated to increase the oil temperature.

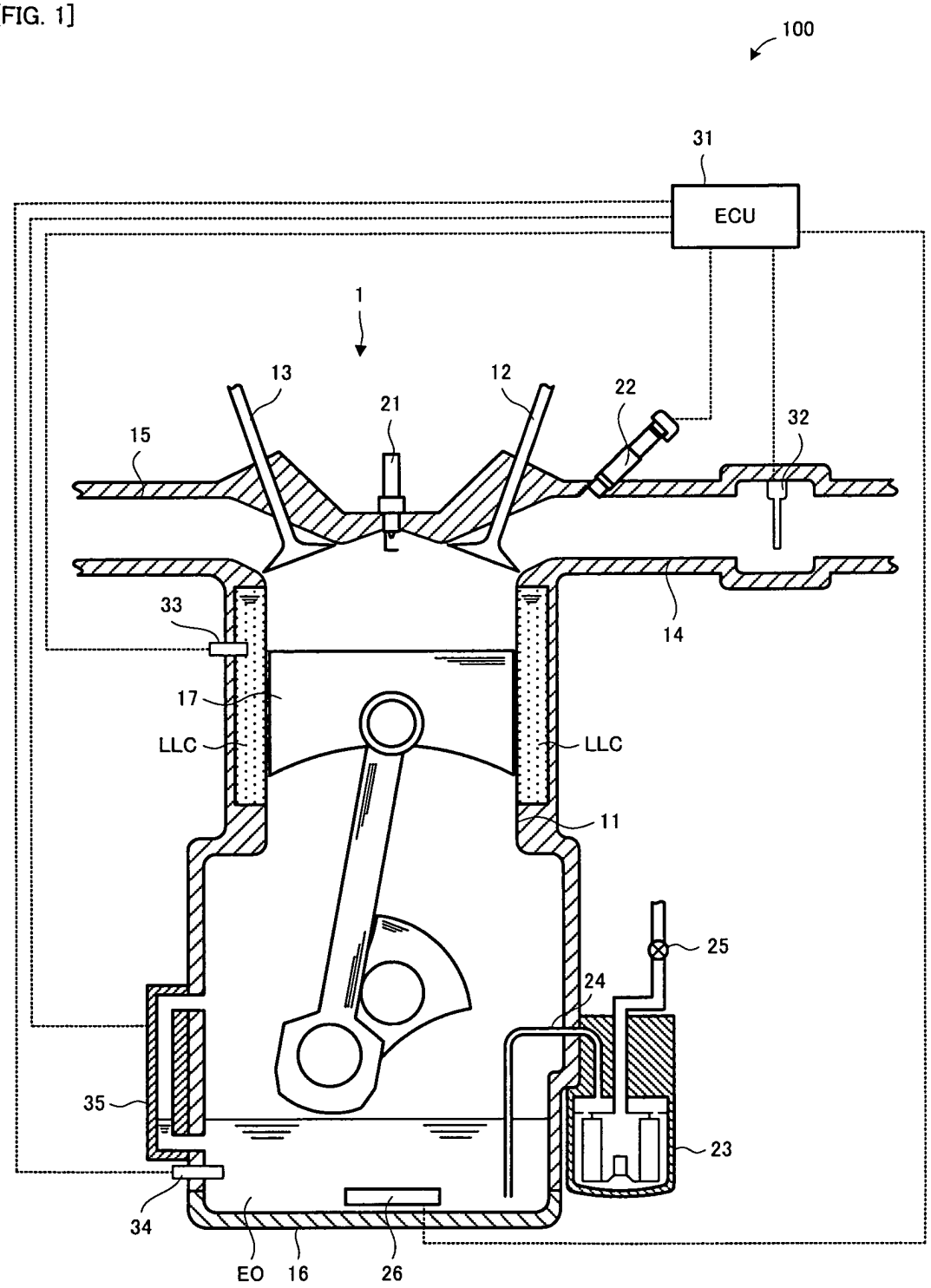
8. An oil dilution inhibiting method in an oil dilution inhibiting apparatus mounted on a vehicle comprising an engine in which alcohol fuel can be used, said oil dilution inhibiting method comprising:

   an intake amount integrating process of integrating amount of an air sucked into the engine while the engine is in operation, thereby calculating an integrated intake amount;
   a temperature detecting process of detecting oil

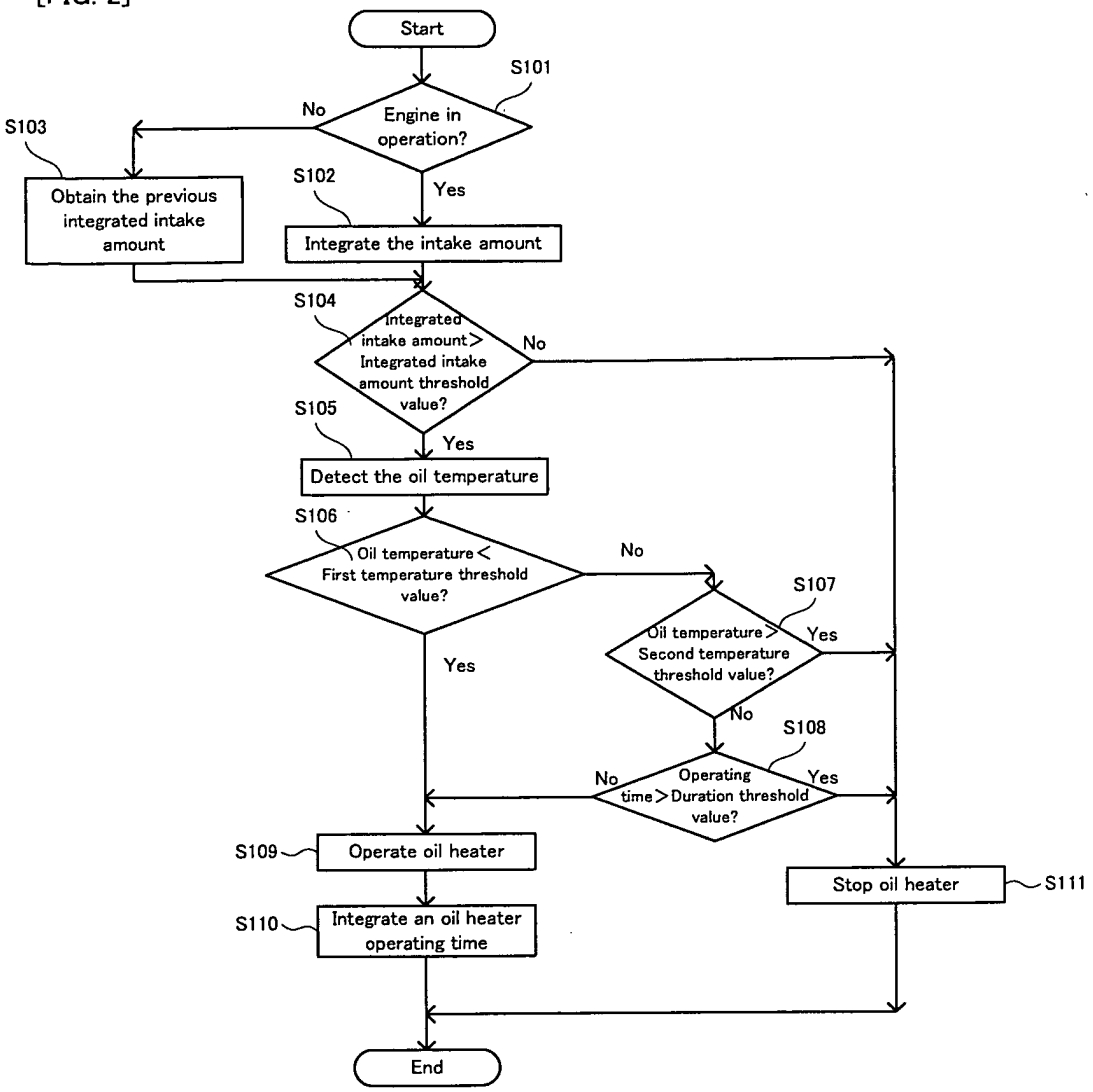
temperature of engine oil of the engine; and

a controlling process of controlling the vehicle to move into an oil heating mode in which the oil temperature is increased in such conditions that the calculated integrated intake amount is greater than an integrated intake amount threshold value and that the detected oil temperature is less than a first temperature threshold value.

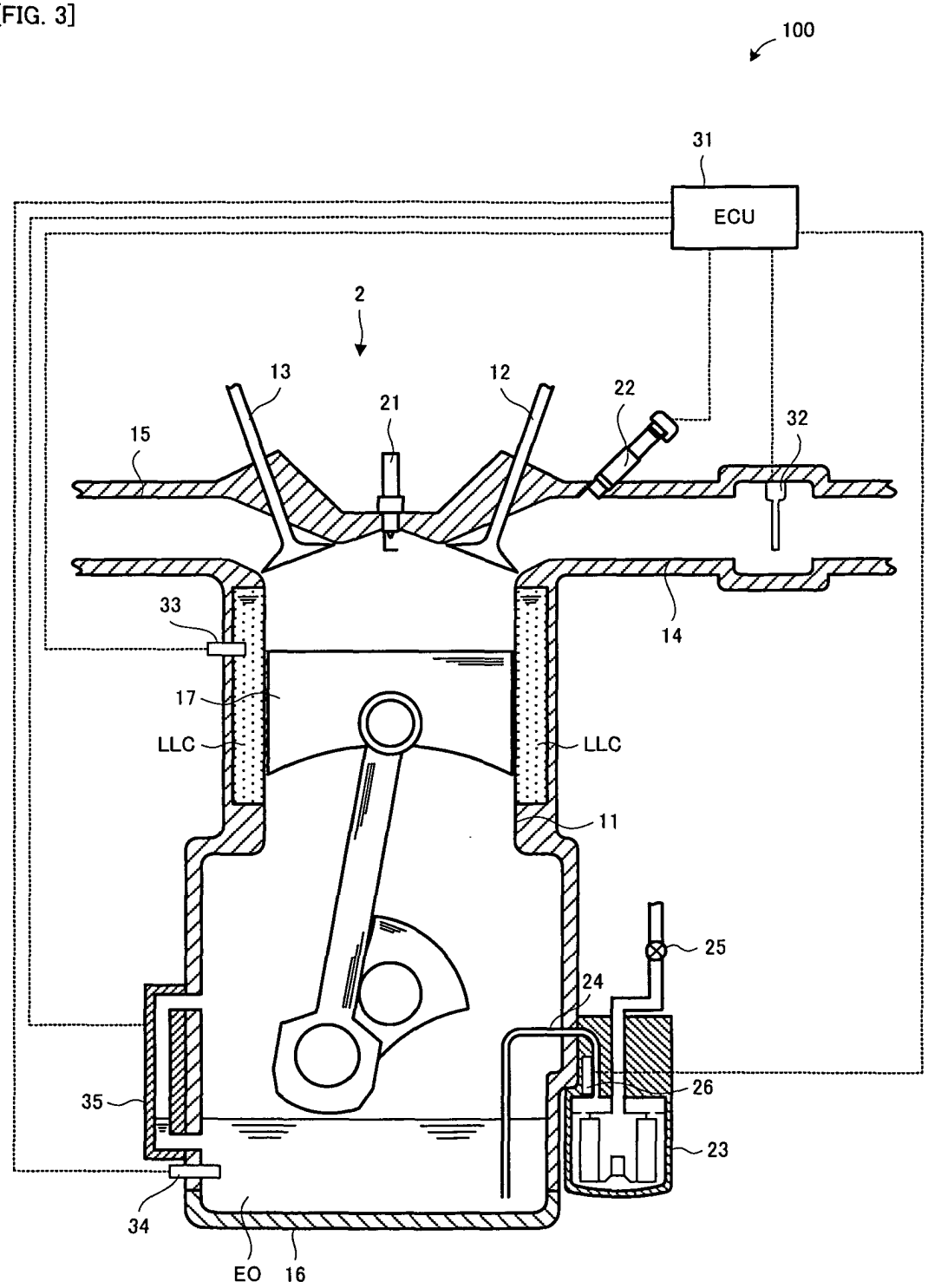
[FIG. 1]


100
31
ECU
1
13
12
22
21
32
15
33
14
17
LLC
LLC
11
25
24
35
23
34
EO
16
26

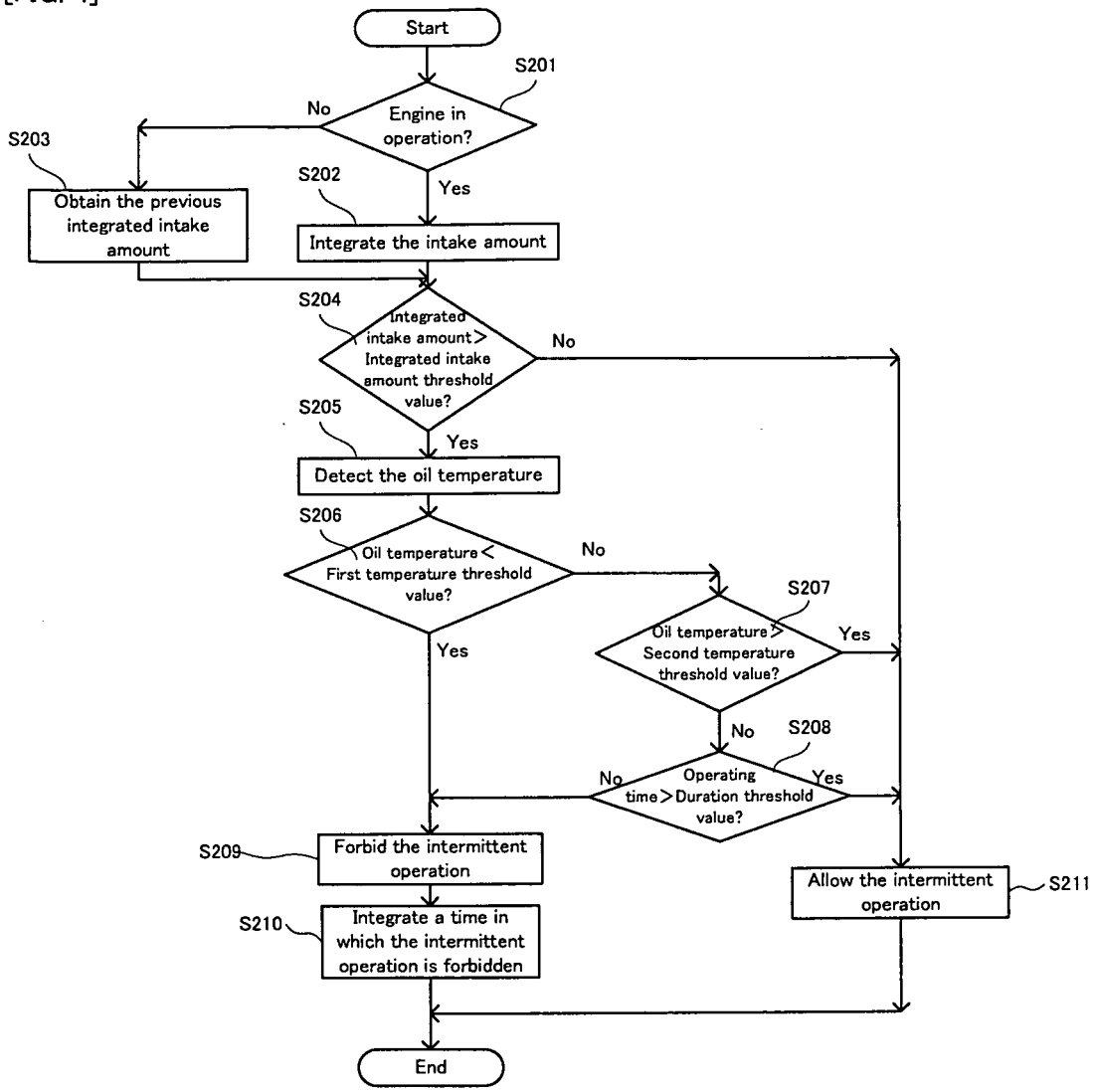
[FIG. 2]


Start
S101
Engine in operation?
No
Yes
S103
Obtain the previous integrated intake amount
S102
Integrate the intake amount
S104
Integrated intake amount > Integrated intake amount threshold value?
No
Yes
S105
Detect the oil temperature
S106
Oil temperature < First temperature threshold value?
No
Yes
S107
Oil temperature > Second temperature threshold value?
Yes
No
S108
Operating time > Duration threshold value?
No
Yes
S109
Operate oil heater
S110
Integrate an oil heater operating time
Stop oil heater
S111
End

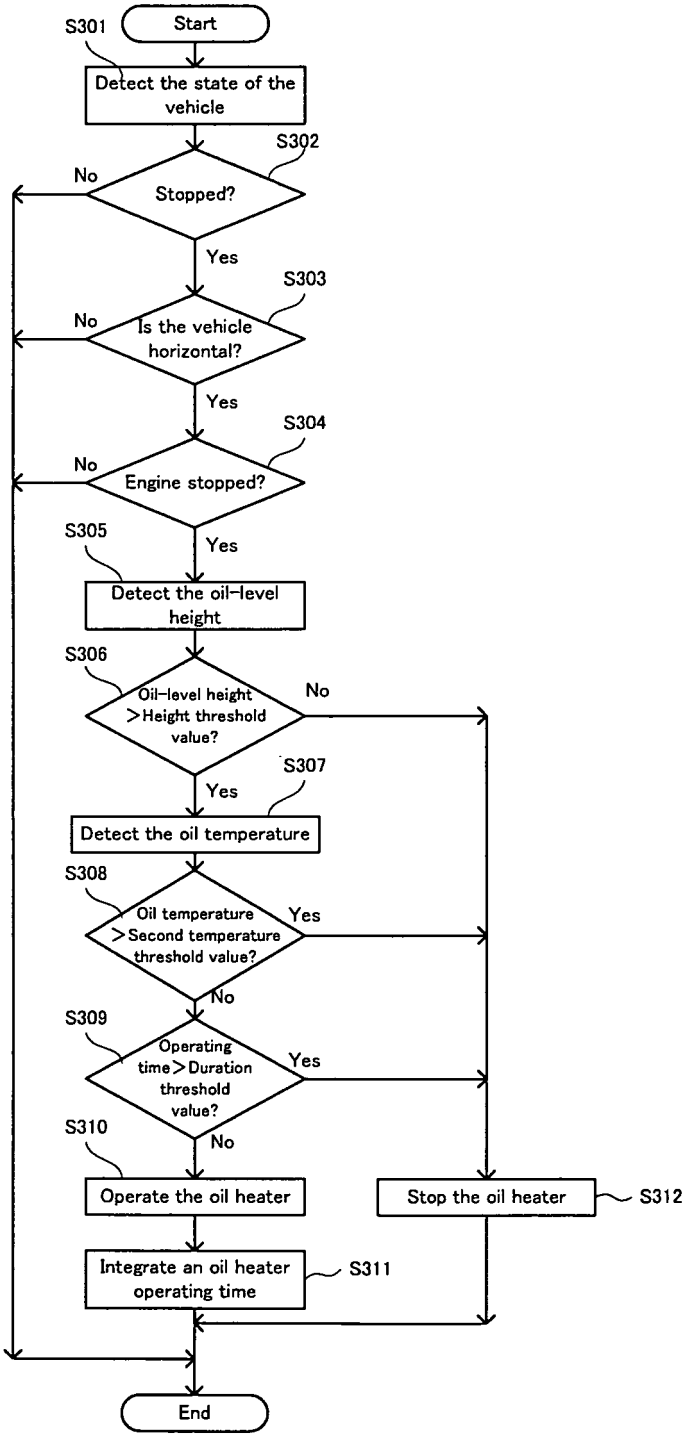
[FIG. 3]


100
31
ECU
2
13
12
21
22
32
15
33
14
17
LLC
LLC
11
25
24
26
35
23
34
EO
16

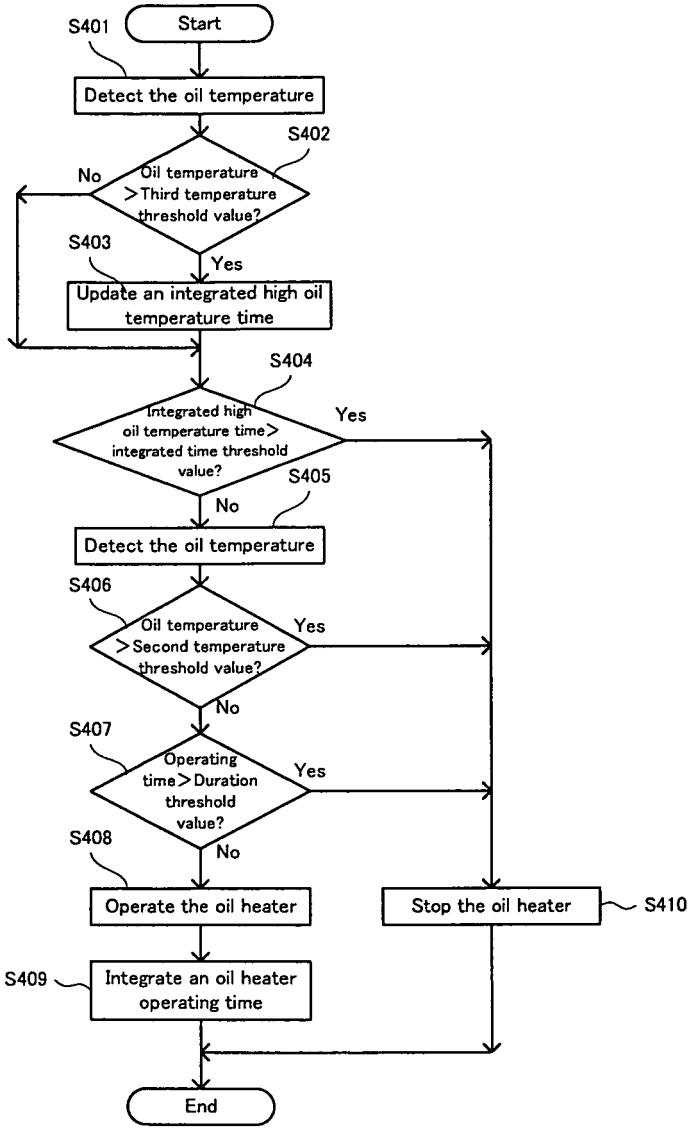
[FIG. 4]


Start
S201
Engine in operation?
No
Yes
S203
Obtain the previous integrated intake amount
S202
Integrate the intake amount
S204
Integrated intake amount > Integrated intake amount threshold value?
No
Yes
S205
Detect the oil temperature
S206
Oil temperature < First temperature threshold value?
No
Yes
S207
Oil temperature > Second temperature threshold value?
Yes
No
S208
Operating time > Duration threshold value?
No
Yes
S209
Forbid the intermittent operation
S210
Integrate a time in which the intermittent operation is forbidden
Allow the intermittent operation
S211
End

[FIG. 5]


Start
S301
Detect the state of the vehicle
S302
Stopped?
No
Yes
S303
Is the vehicle horizontal?
No
Yes
S304
Engine stopped?
No
Yes
S305
Detect the oil-level height
S306
Oil-level height > Height threshold value?
No
Yes
S307
Detect the oil temperature
S308
Oil temperature > Second temperature threshold value?
Yes
No
S309
Operating time > Duration threshold value?
Yes
No
S310
Operate the oil heater
S311
Integrate an oil heater operating time
Stop the oil heater
S312
End

[FIG. 6]


S401
Start
Detect the oil temperature
S402
Oil temperature > Third temperature threshold value?
No
Yes
S403
Update an integrated high oil temperature time
S404
Integrated high oil temperature time > integrated time threshold value?
Yes
No
S405
Detect the oil temperature
S406
Oil temperature > Second temperature threshold value?
Yes
No
S407
Operating time > Duration threshold value?
Yes
No
S408
Operate the oil heater
S409
Integrate an oil heater operating time
Stop the oil heater
S410
End

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2009/052154

A. CLASSIFICATION OF SUBJECT MATTER
F01M5/00(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)
F01M5/00

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 1996-2009
Kokai Jitsuyo Shinan Koho 1971-2009 Toroku Jitsuyo Shinan Koho 1994-2009

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.
A	JP 2008-267227 A (Toyota Motor Corp.), 06 November, 2008 (06.11.08), Full text; all drawings (Family: none)	1-8
A	JP 2008-121592 A (Toyota Motor Corp.), 29 May, 2008 (29.05.08), Full text; all drawings (Family: none)	1-8
A	JP 6-33724 A (Mitsubishi Motors Corp.), 08 February, 1994 (08.02.94), Full text; all drawings (Family: none)	1-8

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

* 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	Date of mailing of the international search report
27 March, 2009 (27.03.09)	07 April, 2009 (07.04.09)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2009/052154

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 35481/1988(Laid-open No. 139199/1989) (Toyota Motor Corp.), 22 September, 1989 (22.09.89), Full text; all drawings (Family: none)	1-8

Form PCT/ISA/210 (continuation of second sheet) (April 2007)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2004190513 A **[0006]**
- JP 2008038779 A **[0006]**
- JP 2003322052 A **[0006]**
- JP 2004293394 A **[0006]**
- JP 2008121592 A **[0006]**