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(54) METHOD AND DEVICE FOR REGULATING THE TEMPERATURE OF AN INTERNAL COMBUSTION ENGINE

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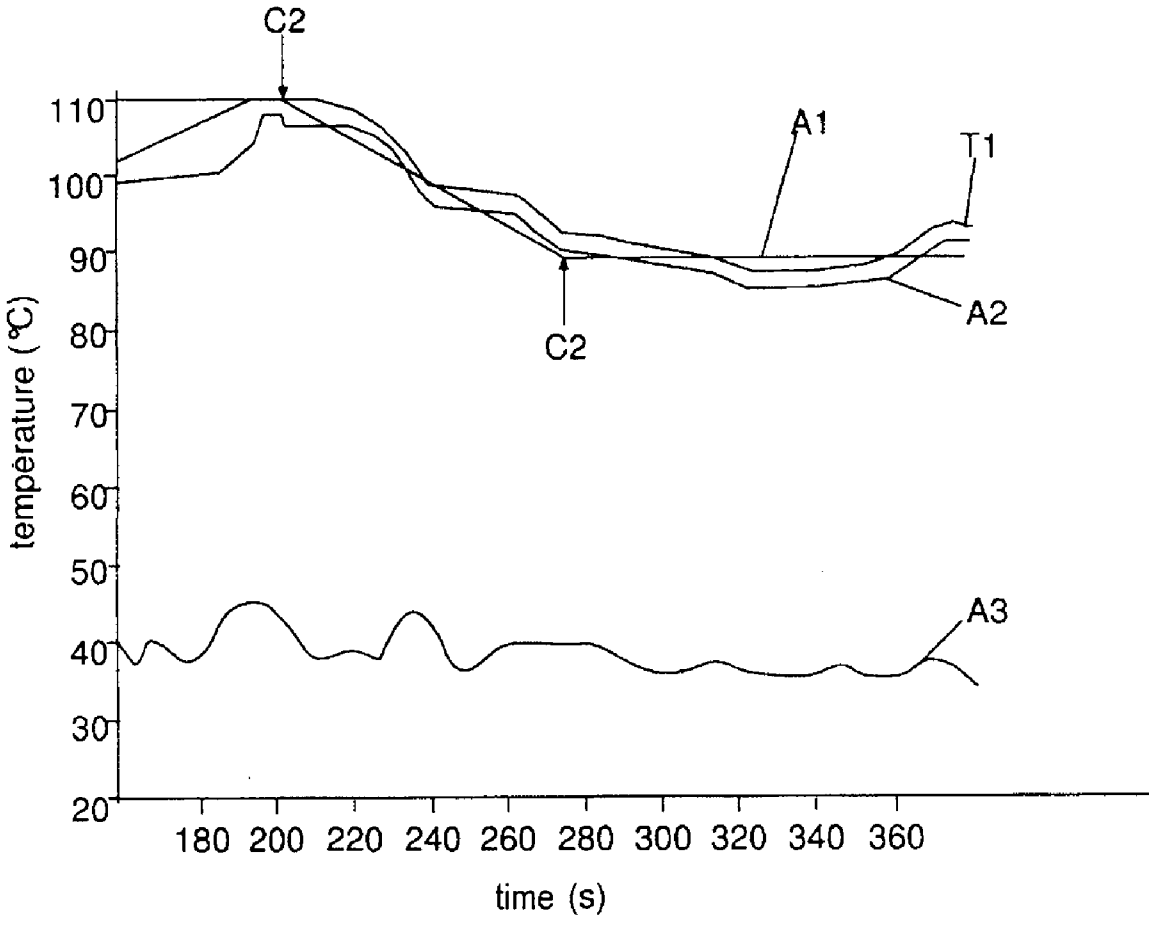
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(57) **ABSTRACT**

A method and device for regulating engine temperature. The device includes a valve control system arranged on a pipe of a cooling circuit of an internal combustion engine connecting the engine to a radiator. The pipe includes a temperature sensor arranged at the engine output and upstream of the valve control system that is automatically opened under effect of a cooling liquid being heated to a set temperature in accordance with a predetermined setpoint profile, ranging between a minimum stored temperature setpoint and a maximum stored temperature setpoint, so that the temperature of the engine gradually reaches the minimum or maximum setpoint by maintaining the control valve system more or less wide open. A controller controls the initial opening of the control valve system enabling the opening of the control valve system to be controlled when the control valve system has already been initially opened.



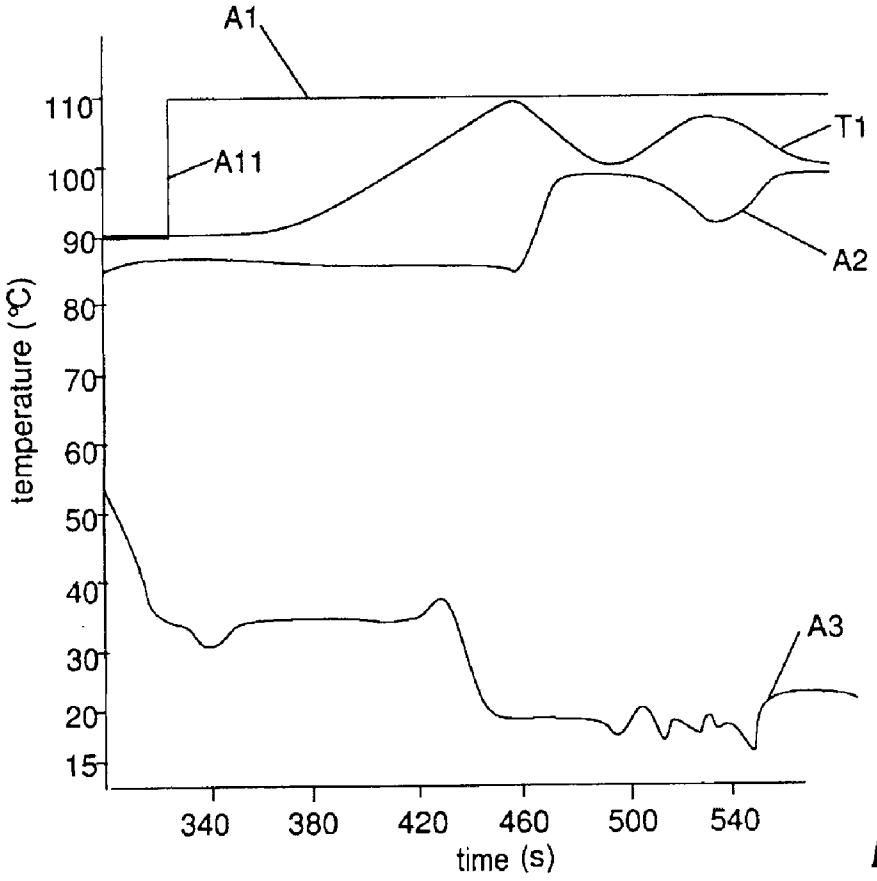

A1
A11
T1
A2
A3
110
100
90
80
70
60
50
40
30
20
15
temperature (°C)
340
380
420
460
500
540
time (s)

Fig. 1

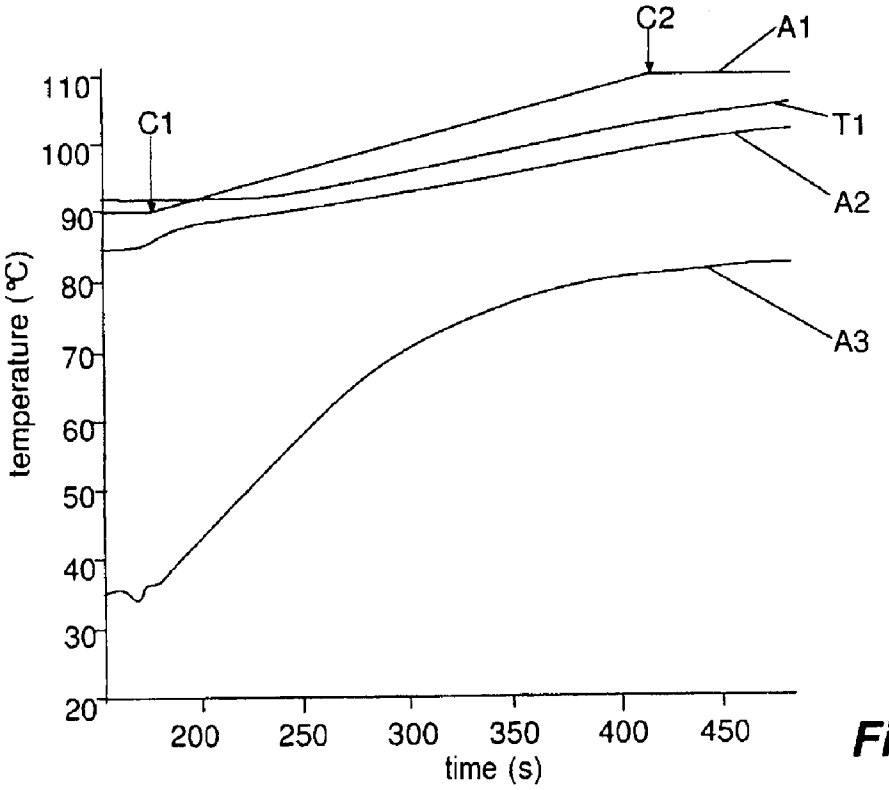

C2
A1
C1
T1
A2
A3
110
100
90
80
70
60
50
40
30
20
temperature (°C)
200
250
300
350
400
450
time (s)

Fig. 2

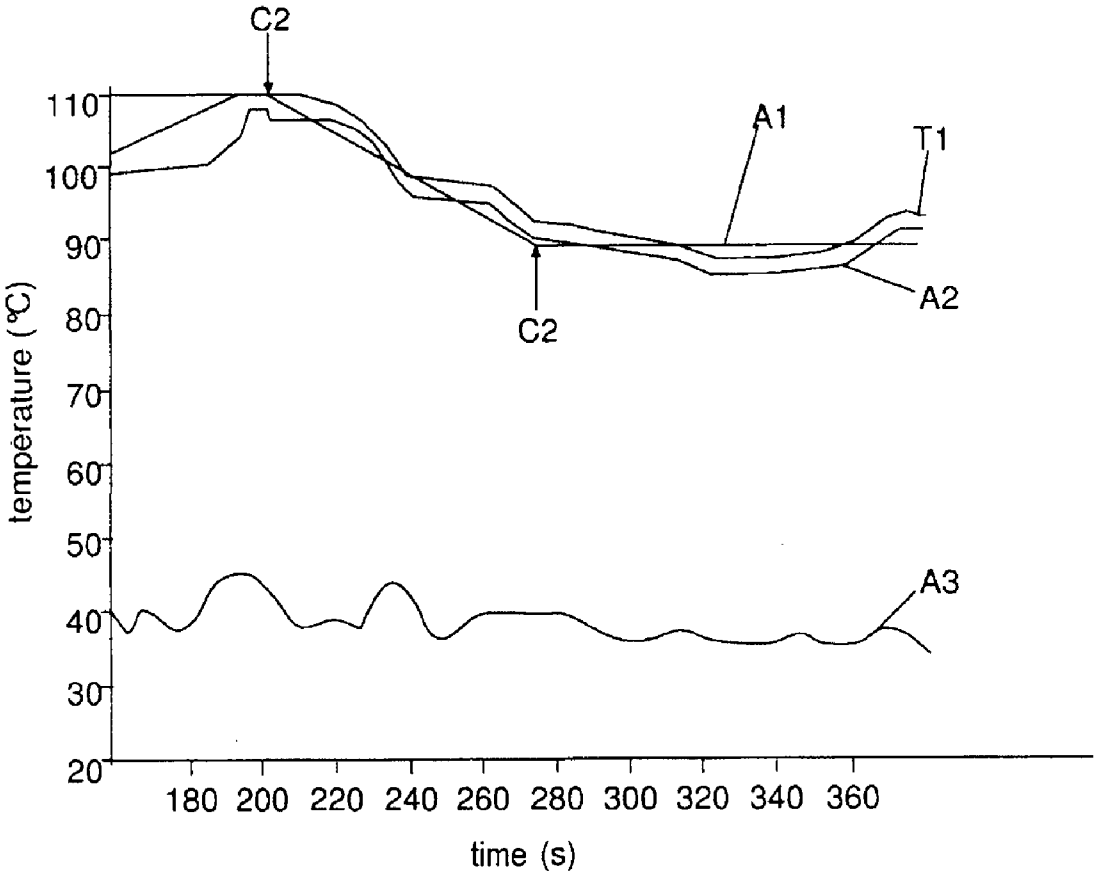

C2
A1
T1
A2
C2
A3
110
100
90
80
70
60
50
40
30
20
température (°C)
180 200 220 240 260 280 300 320 340 360
time (s)

Fig. 3

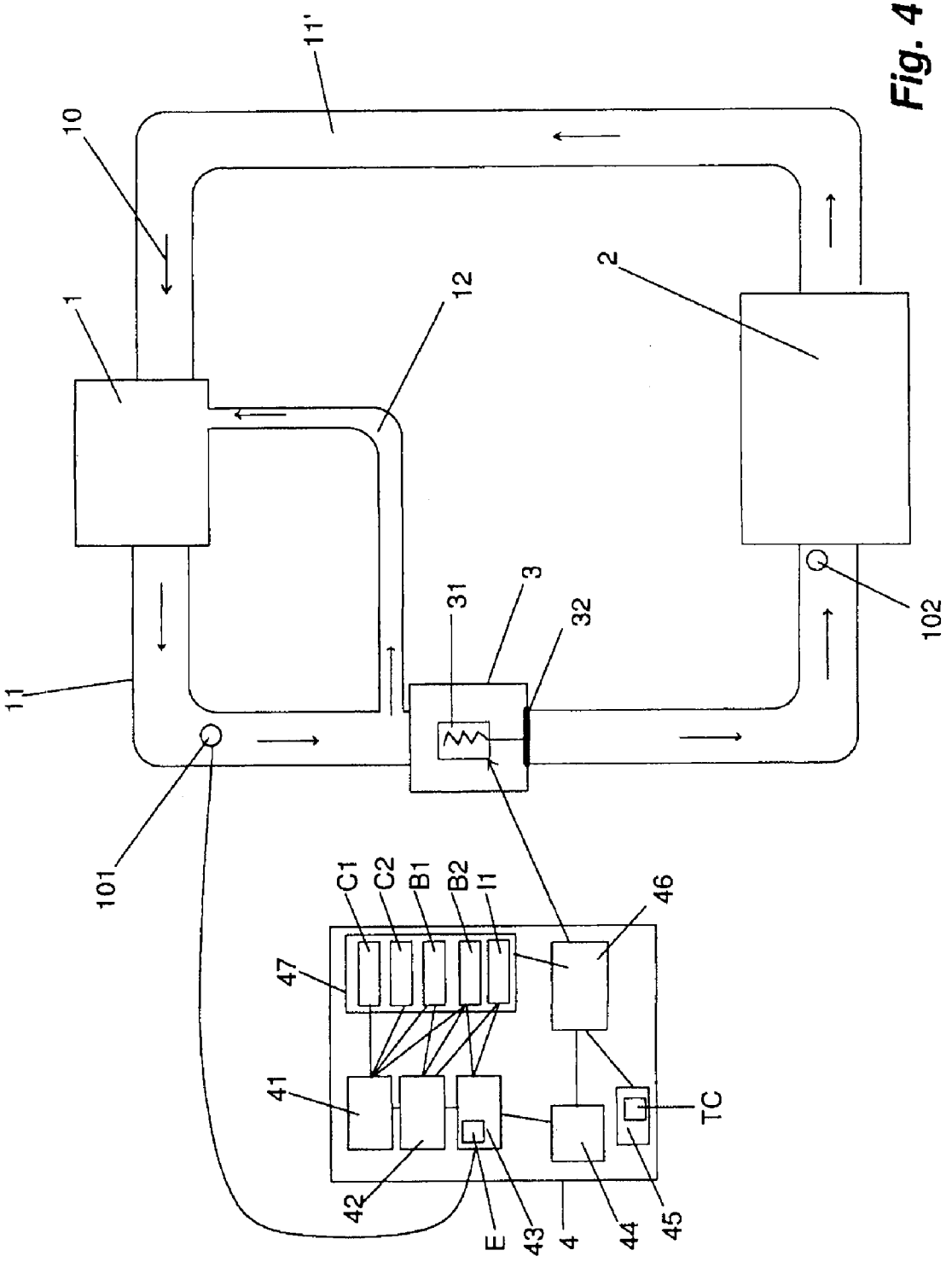


Fig. 4

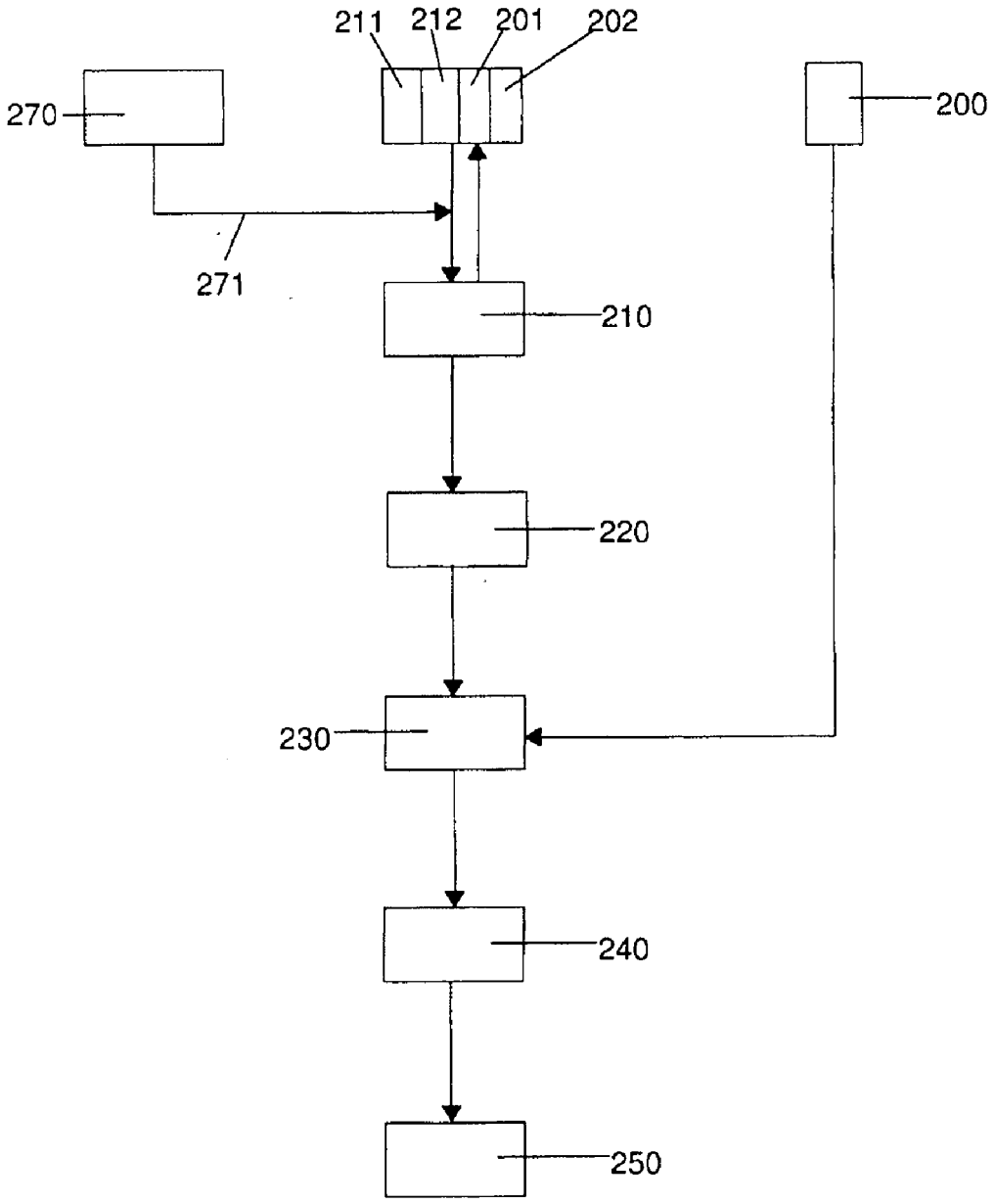


Fig. 5

METHOD AND DEVICE FOR REGULATING THE TEMPERATURE OF AN INTERNAL COMBUSTION ENGINE

[0001] The present invention relates to the field of engine control and more particularly to a method and a device for regulating the temperature of an internal combustion engine by controlling the opening of the cooling circuit valve control system (e.g. thermostat).

[0002] Engine control is the technique of managing an internal combustion engine with all its sensors, actuators and inter-system links (ISL). All the monitoring and control laws (the software strategies) and characterization parameters (calibrations) of an engine are contained in a computer called an electronic control unit (ECU).

[0003] Internal combustion engines (with a carburetor or with fuel injection), require cooling that is generally obtained by circulating water or air. This is because an internal combustion engine generates heat. This heat is due to the combustion of the gases and to the various frictions of the moving parts.

[0004] In order to confine the expansion between permissible temperature ranges and to preserve the characteristics of the lubricating oil, the engine must therefore be cooled. This cooling is achieved by means of three fluids present in the environment:

[0005] Air is essentially used for the heat exchangers (radiator, air—air heat exchangers), and for the natural cooling of the heat generated by conduction on the outside of the engine and of the exhaust.

[0006] Water cools the cylinders and the cylinder head.

[0007] Oil removes the heat from the pistons, the camshaft, the big ends, the crankshaft bearings, the valves.

[0008] When water is circulated, the water generally flows in a closed circuit and is cooled in a radiator, which is itself cooled by air whereof the flow may be assisted by a fan. Since the heat to be removed depends on the speed and load of the internal combustion engine and since the temperature thereof must be kept within a relatively narrow range to obtain optimal efficiency, the cooling system must be regulated. For this purpose, it is necessary to determine a regulation temperature with a setpoint to guarantee an optimal operating temperature for the engine.

[0009] One objective of this regulation is to decrease the fuel consumption and thereby obtain a commensurate decrease in the formation of pollutants such as nitrogen oxides.

[0010] In fact, at low temperature, the lubricating oil of the internal combustion engine has a high viscosity, which causes additional friction in the engine and consequently extra fuel consumption. This occurs in particular upon starting the vehicle when the internal combustion engine and the oil are cold.

[0011] The production of nitrogen oxides (NOX) depends in particular on the temperature of the gas mixture introduced into the cylinders of the vehicle internal combustion engine. The higher the mixture temperature, the greater the production of nitrogen oxides.

[0012] Thus by increasing the temperature of the engine cooling water, the oil temperature is thereby increased and the friction losses are reduced, whereas a lower temperature will limit the production of nitrogen oxide in particular. It is therefore important to maintain the engine at an optimal temperature, hence the advantage of the cooling circuit. Thus, most vehicles today are equipped with a conventional thermostat operating on the principle of the expansion of a volume of wax. This thermostat may be placed at the outlet or inlet of the engine. Under the effect of the water temperature, a wax plug, through its thermal expansion calibrated against a temperature point, controls the opening of one or two check valves via a working piston. The one or two valves will open or close or regulate the coolant circulation, and optionally a bypass circuit.

[0013] Thus, depending on the engine operating phase (acceleration, deceleration, etc.), it is necessary to regulate the temperature either by increasing the temperature setpoint or by decreasing it. At present, the temperature is varied with a stepped temperature setpoint profile. This means that when the temperature should be raised for example from 90° C. to 110° C. or lowered from 110° C. to 90° C., the setpoint changes sharply from 90° C. to 110° C. or from 110° C. to 90° C. without an intermediate step. Thus the opening of the valve control system is not gradual.

[0014] Thus, whenever the temperature setpoint is changed, before the valve opens, the temperature difference on either side of the thermostat is amplified as the engine temperature rises. When the valve opens, a thermal shock is thereby produced.

[0015] This thermal shock has negative effects on the auxiliary components surrounding the engine and, in particular, the cooling systems for the engine itself and other cooling systems (passenger compartment unit heater, EGR heat exchangers, water/oil heat exchangers, air conditioning radiator and its condenser, turbocharging air, BVA radiator, etc.) which are vulnerable to changes or passages from one temperature to another engine operating temperature setpoint. Similarly, the position at the various elements with regard to each other has an influence on the quality of the temperature regulation and the associated stresses. For example, if the cooling circuit valve control system is located at the inlet or outlet of the engine.

[0016] These additional stresses cause deformations of the auxiliary components of the engine generated by temperature variations and result in additional mechanical forces.

[0017] Patent US 2002/0053325 proposes a solution to limit the thermal shocks with a device for regulating the engine temperature by controlling the coolant circulation between the engine and a heat exchanger such as a radiator. This device comprises a first conventional thermostat as described previously, of which the activation temperature is around 102° C., and a thermostat comprising a central resistor and of which the activation temperature is 25° C. higher than that of the first thermostat, and is therefore around 127° C. These two thermostats each control a different opening of a valve enabling the coolant to enter the radiator to be cooled. Thus when the coolant temperature reaches the first activation temperature, the expansible material contained in the first thermostat activates a piston which is itself opens a valve thereby enabling the coolant to flow via the radiator at a certain flow rate. If the liquid temperature is higher and is about 127° C., the expansible material contained in the second thermostat activates a second piston which allows a wider opening of the valve. The liquid thus flows with a higher flow rate to the radiator, so that within the same time interval, a larger quantity of liquid will be cooled. This device therefore serves to prevent the engine from remaining at an excessively high temperature too long.

[0018] However, one drawback of the device is that it only acts when the temperature of the engine is higher than an ideal operating temperature, which is about 90° C. It therefore does not serve to completely avoid the thermal shocks and does not process changes in temperature setpoint. The various parts of the engine concerned by this overheating are therefore subject to the stresses and deformations mentioned above.

[0019] It is therefore the object of the present invention to reduce these drawbacks by an appropriate control of the valve control system (a thermostat here) serves to reduce the amplitude of the thermal shock on the components by performing a control according to a criterion selected with regard to the coolant temperature and by monitoring the effective opening of the valve control system, also with regard to the temperature.

[0020] For this purpose, the invention proposes a device for regulating the engine temperature, the device comprising a valve control system placed on a line of a cooling circuit of an internal combustion engine connecting the engine to a radiator, the line comprising a temperature sensor placed at the outlet of the engine and upstream of the valve control system, which is automatically opened under the effect of a coolant being heated to a temperature setpoint, characterized in that it comprises means for varying the temperature setpoint in accordance with a predefined setpoint profile, ranging between a minimum stored temperature setpoint and a maximum stored temperature setpoint, so that the temperature of the engine gradually reaches the minimum or maximum setpoint to attenuate the thermal shock by maintaining the control valve system more or less wide open, and means for controlling the first opening of the control valve system and for checking that the first opening of the control valve system has already taken place.

[0021] According to another feature of the invention, the means for effecting a more or less wide opening of the valve control system in accordance with the predefined setpoint profile, consists of a heating resistor used to prematurely increase or decrease the temperature of a wax plug of the valve control system, respectively causing the opening or the closing of a check valve, and are controlled by computation means placed in a computer.

[0022] According to another feature of the invention, the computation means placed in the computer consists of at least one first computation module for determining the lowest minimum and maximum temperature limits in accordance mutually with the minimum and maximum temperature setpoints stored in storage means in the computer, a second computation module for calculating several intermediate temperatures of the setpoint profile between the minimum temperature limit and the maximum temperature limit, a comparison module for comparing the temperature measured continuously at the engine outlet by the temperature sensor during the driving, with the intermediate temperatures calculated with the second computation module in order to determine the difference between the two temperatures, and a module for correcting the difference and serving to define the necessary opening of the thermostat to reach the desired temperature setpoint according to the measured difference.

[0023] According to another feature of the invention, the computation placed in the computer comprises a thermostat control module associated with the correction module.

[0024] A further object of the invention is to propose a method for regulating the engine temperature implementing the device as claimed in claim **1**, characterized in that it consists in varying the temperature setpoint so that the engine temperature gradually reaches a maximum temperature when the first opening of the valve control system has already taken place.

[0025] According to another feature of the invention, the method comprises the following steps:

[0026] determination of a minimum temperature setpoint and a maximum temperature setpoint and storage of these two temperature setpoints in storage means of a computer,

[0027] determination by a first computation module of a minimum temperature limit from the minimum temperature setpoint and a maximum temperature limit from the maximum temperature setpoint and storage of these two temperature setpoints in storage means of a computer.

[0028] determination by a second computation module of intermediate temperatures as a function of the minimum and maximum temperature limits,

[0029] measurement continuously during the driving time, of the temperature of the coolant contained in the circuit at the outlet of the engine and downstream of the valve control system with a sensor,

[0030] comparison of the temperature at the engine of the various intermediate temperatures in order to determine a difference,

[0031] correction of the difference in temperature by opening or closing the valve control system.

[0032] According to another feature of the invention, the minimum temperature setpoint is between 80° C. and 85° C. and the maximum temperature setpoint is between 100° C. and 120° C.

[0033] According to another feature of the invention, the minimum temperature setpoint is 90° C. and the maximum temperature setpoint is 110° C.

[0034] According to another feature of the invention, the minimum temperature limit is 92° C. when the minimum temperature setpoint is 90° C., and the maximum temperature limit is 108° C. when the maximum temperature setpoint is 110° C.

[0035] According to another feature of the invention, the opening and closing of the valve control system are carried out by turning on heating means located in the valve control system which prematurely reaches the temperature setpoint allowing the opening or closing of the valve control system.

[0036] The invention, with its features and advantages, will appear more clearly from a reading of the description, provided with reference to the appended drawings given as non limiting examples, in which:

[0037] FIG. **1** is a schematic representation of the change in temperature as a function of time for a standard temperature regulation,

[0038] FIG. **2** is a schematic representation of the change in temperature as a function of time for a progressive regulation with setpoint increase according to the invention,

[0039] FIG. **3** is a schematic representation of the change in temperature as a function of time for a progressive regulation with setpoint decrease according to the invention,

[0040] FIG. **4** is a schematic representation of the device according to the invention,

[0041] FIG. **5** is a schematic representation of the method according to the invention.

[0042] FIG. **1** illustrates a conventional engine temperature regulation. In this type of opening, the device for opening the valve control system comprises a conventional thermostat, as

shown previously, of which the expansible liquid serves to open a check valve at a given temperature. In the graph shown in FIG. **1**, the curve A**1** represents the temperature setpoint and the curve T**1** the coolant temperature that is the engine temperature. In the example presented here, the setpoint rises suddenly from 90° C. to 110° C. to form a plateau or a step (A**11**). As may be observed, the coolant temperature does not immediately follow this setpoint and undergoes a number of fluctuations before converging toward a thermostat regulation temperature. These fluctuations are explained by the sudden change in the temperature at the radiator inlet (curve A**2**) and the radiator outlet (curve A**3**). When the coolant proceeds to flow, this also occurs suddenly, like a setpoint, causing considerable fatigue of the cooling system.

[0043] These sudden temperature changes in this operating mode generate loads of the radiator and accentuate its aging.

[0044] FIGS. **2** and **3** illustrate an engine temperature regulation, but controlled this time with the method and the device according to the invention.

[0045] FIG. **2** shows a temperature setpoint change profile (curve A**1**) going from a low temperature (C**1**) of 90° C. to a high temperature (C**2**) of 110° C. The engine temperature (curve T**1**) rises in the same way as the setpoint (more slowly) and without any temperature fluctuations. For the radiator inlet temperature (curve A**2**), the same ramp-shaped temperature profile is observable, and the stresses on the radiator are commensurately diminished. In this case, the temperature setpoint is reached by a gradual closure of the valve control system, and the resistor heats less and less. This explains why the radiator inlet temperature continues to rise. In fact, the gradual closure of the valve control system causes a heating of the coolant, and the little liquid that continues to flow through the radiator is increasingly hot, hence the increase in temperature observed in curve A**2**.

[0046] FIG. **3** shows a temperature setpoint change profile (curve A**1**) going from a high temperature (C**2**) to a low temperature (C**1**). The resistor heats more and more. The engine cooling and radiator inlet temperature also follow this ramp, but more chaotically, and the presence of a temperature mini-plateaux, is observed, due to the variation in engine operation (change in engine speed and load).

[0047] FIG. **4** shows an embodiment of the device according to the invention for obtaining the results shown in FIGS. **2** and **3**. This device comprises an internal combustion engine (**1**) and a radiator (**2**) connected together by a line (**11**, **11'**) serving for the flow (**10**) of the coolant, in order to form a loop circuit. This circuit enables the coolant to flow from the engine (**1**) to the radiator (**2**) and then to leave the radiator toward the engine via a different path (**11'**). A second line forms a bypass (**12**) enabling the coolant to return directly to the engine (**1**) without passing through the radiator (**2**). On the route of the first line (**11**) between the engine (**1**) and the radiator (**2**), and after the bypass (**12**), a thermostat type valve control system (**3**) is placed. This valve control system (**3**) shown in the form of a box, comprises a passage (not shown) for the coolant between the engine (**1**) and the radiator (**2**), closable by a valve, and an element for thermostatic control of this valve. This thermostatic control element (**3**) only allows coolant to flow from the engine (**1**) to the radiator (**2**) when the latter has reached a certain temperature.

[0048] The thermostatic control element is of the same type as previously described. It operates on the principle of the expansion of a volume of wax contained in a plug. Under the effect of the coolant temperature, the wax plug, by its thermal expansion calibrated to a temperature point, commands the opening of a check valve (**32**) via a working piston. The check valve (**32**) then opens or closes to regulate the flow of coolant and, optionally, of the bypass circuit (**12**). In the context of the invention, the thermostat (**3**) used opens when the coolant temperature reaches a standard temperature setpoint of 110° C. This thermostat (**3**) comprises heating means (**31**), of the resistor type (**31**), which serves to artificially raise the temperature of the wax and thereby change its temperature setpoint. This means that the thermostat (**3**), which normally causes an opening of the check valve (**32**) when the coolant is at 110° C., will now open when the coolant is at 90° C., thanks to the resistor (**31**) which artificially raises the thermostat to 110° C. The purpose of this resistor (**31**) is to serve to change the temperature setpoint according to a predefined setpoint profile for controlling the opening or closing of the valve control system (**3**). This resistor (**31**) is connected to the computer (**4**) of the vehicle, which produces the commands required by the method.

[0049] The cooling circuit also comprises at least one temperature sensor (**101**) placed in the line (**11**) of the cooling circuit at the outlet of the engine (**1**) and upstream of the valve control system (**3**). A second sensor (**102**) may be placed in the line (**11**) of the cooling circuit downstream of the valve control system (**3**) and at the inlet of the radiator (**2**). These two temperature sensors are also connected to the computer (**4**). The first sensor (**101**) serves to measure the temperature (T**1**) of the coolant at the engine outlet. The second sensor (**102**) serves to measure the coolant temperature at the inlet of the radiator (**2**). Due to its high cost, conventional motor vehicles are not equipped with this second sensor (**102**) which is only used for the engine test. All the measurements necessary to regulate the engine temperature during the operation of an engine vehicle are therefore taken with the first temperature sensor (**101**).

[0050] The device also comprises a control module (**45**) for determining whether the first opening of the valve control system has taken place, because it is only used after this first opening. In fact, during the first opening of the valve control system, the temperature difference between the engine temperature and the temperature setpoint is too wide to use a progressive setpoint.

[0051] The first opening which takes place upon starting can be effected by using means which serve to prevent the thermal shock from being too high. For this purpose, the first opening of the valve control system, of which the standard setpoint is 110° C., occurs early. This means that the device has means for enabling the valve control system to be open when the coolant temperature is at 90° C. instead of 110° C. This is effected by using the heating resistor (**31**) of the thermostat. When the opening is effected, the control module (**45**) assumes a value (TC) indicating that the first opening has taken place. It is this control module (**45**) that is used as means for controlling the first opening in the regulation device according to the invention.

[0052] The first sensor (**101**) is therefore used to measure this temperature (T**1**) of the coolant at the engine outlet continuously during driving, in order to monitor the engine temperature and check that the temperature setpoint is reached.

[0053] For this purpose, the device comprises at least one first computation module (**41**) calibrated by identification on the vehicle or engine test bench for determining the minimum (B**1**) and maximum (B**2**) temperature limits in accordance with the minimum (C**1**) and maximum (C**2**) temperature setpoints stored in storage means (**47**) in the computer (**4**). These minimum (B**1**) and maximum (B**2**) temperature limits are located in the interval formed by the minimum (C**1**) and maximum (C**2**) temperature setpoints. This means that the first computation module (**41**) determines a minimum temperature limit (B**1**) that is higher than the minimum tempera-

ture setpoint (C1) and a maximum temperature limit (B2) that is lower than the maximum temperature setpoint (C2). For example, if the minimum temperature setpoint (C1) is 90° C. and if the maximum temperature setpoint (C2) is 110° C., the minimum temperature limit (B1) may be 92° C. and the maximum temperature limit (B2) may be 108° C. This temperature difference plays the role of a safety margin.

[0054] The device comprises a second computation module calibrated by identification on the vehicle or engine test bench for determining the temperature setpoint profile. For this purpose, this module will calculate several intermediate temperatures (I1) between the minimum temperature limit (B1) and the maximum temperature limit (B2). These intermediate temperatures (I1) serve to reach the minimum (C1) or maximum (C2) temperature setpoint gradually.

[0055] In an alternative, the profile is prestored in the computer (**4**).

[0056] The device also comprises a comparison module (**43**) for comparing the temperature (T1) measured continuously at the engine outlet by the temperature sensor (**101**) during the driving, with the intermediate temperatures (I1) calculated with the second computation module (**42**). This comparison serves to determine a difference (E) between the two temperatures. This difference (E) is transferred into a module (**44**) for correcting the difference serving to define the more or less wide opening necessary for the valve control system to reach the desired temperature setpoint according to the measured difference (E).

[0057] This correction module (**44**) of the computer is associated with a control module (**46**) of the thermostat in order to turn on the heating resistor.

[0058] In an alternative device, the computation and correction modules may be associated with a PID controller (Proportion, Integral, Derivative). This controller acts on a regulation value, which, in the case here, is the temperature regulation value, to control a heating resistor, a valve, etc.

[0059] This type of controller combines three actions:

[0060] A proportional action (P): the controller output value is directly proportional to the difference between the measured value and the setpoint. With this type of regulation, the measured value never reaches the setpoint: the role of the controller is to minimize this difference.

[0061] an integral action (I): the integral action serves to cancel the difference between the measurement and the setpoint and thereby to improve the regulation accuracy. It consists in performing an integration (in the mathematical sense of the term) of the difference. This integral action is practically always associated with a proportional action.

[0062] A derivative action (D): this consists in deriving (in the mathematical sense of the term) the difference between the measurement and the setpoint. The derivative action serves to shorten the regulation response time and to stabilize the regulation (when the variations in the controlled values are rapid). The derivative action is complementary to the proportional action.

[0063] The operation of this device, illustrated in FIG. **5**, will now be described in detail.

[0064] Before starting the regulation of the engine, the minimum and maximum temperature setpoints are determined and stored (**201**, **202**) in the storage module (**47**) of the computer (**4**).

[0065] During driving, the coolant temperature (T1) at the engine outlet is measured continuously (**200**) by the temperature sensor (**101**). This temperature (T1) is sent to the computer (**4**).

[0066] If the control module (**45**) has a temperature (TC) indicating that the first opening has taken place, the engine temperature regulation according to the invention is initiated.

[0067] Thanks to a first computation module (**41**), the computer (**4**) uses the minimum (C1) and maximum (C2) temperature setpoints to determine (**210**) the minimum (B1) and maximum (B2) temperature limits. In general, the minimum (C1) and maximum (C2) temperature setpoints are 90° C. and 110° C. respectively and the minimum (B1) and maximum (B2) temperature limits determined by the first computation module (**41**) may then be 92° C. and 102° C. respectively.

[0068] These temperature limits (C1, C2) are stored (**211**, **212**) in the storage module (**47**) of the computer (**4**).

[0069] The second module (**42**) of the computer (**4**) then calculates (**220**) the intermediate temperature setpoints (I1) of the temperature profile determined from the minimum (B1) and maximum (B2) temperature limits in order to reach the temperature setpoint (C1, C2) gradually.

[0070] The temperature (T1) at the engine outlet measured continuously (**200**) is compared (**230**) to the various intermediate temperatures (I1) in order to determine a difference (E) by means of the comparison module (**43**). The values of the differences (E) are sent as they are determined to a module (**44**) for correcting the difference which serves to determine (**240**) the more or less wide opening or closing (**250**) of the valve control system that is necessary to correct the difference (E) and thereby reach the desired setpoint by following the setpoint profile.

[0071] The correction is effected thanks to the control module (**46**) by controlling the heating resistor (**31**) so as to heat it or not. When the resistor (**31**) is turned on, the valve control system is progressively opened, and when the resistor (**31**) is turned off, the valve control system is progressively closed.

[0072] The operation of the device according to the invention thus comprises the following steps:

[0073] determination of a minimum temperature setpoint (C1) and a maximum temperature setpoint (C2) and storage (**201**, **202**) of these two temperature setpoints in storage means (**47**) of a computer (**4**),

[0074] determination (**210**) by a first computation module (**41**) of a minimum temperature limit (B1) from the minimum temperature setpoint (C1) and a maximum temperature limit (B2) from the maximum temperature setpoint (C2) and storage (**212**, **212**) of these two temperature setpoints in storage means (**47**) of a computer (**4**).

[0075] determination (**220**) by a second computation module (**42**) of intermediate temperatures (I1) as a function of the minimum (B1) and maximum (B2) temperature limits,

[0076] measurement (**200**) continuously during the driving time, of the temperature (T1) of the coolant contained in the circuit at the outlet of the engine (**1**) and downstream of the valve control system (**3**) with a sensor (**101**),

[0077] comparison (**230**) of the temperature at the engine of the various intermediate temperatures (I1) in order to determine a difference (E),

[0078] correction (**240**) of the difference (E) in temperature by opening or closing the valve control system (**250**).

[0079] In the case presented here, the valve control system (**3**) is of the thermostat type, but another type of coolant valve control system can be used, for example, an electrically controlled valve, thereby serving to regulate other criteria in addition the temperature.

[0080] Similarly, the example of a radiated progression has been described. However, any other heat exchanger could have been used as an example, or even components not involved in engine heat transfer but not subjected to a certain thermal shock level.

[0081] Also in this sense, this protection mode may be applied to other types of engine comprising auxiliary components which may benefit from thermal protection: electric engine or hybrid systems for example.

[0082] Furthermore, in the example mentioned, a high temperature and a low temperature have been selected by various compromises. Depending on the changes in the conditions, other values may be adopted (lower or higher).

[0083] It must be obvious to a person skilled in the art that the present invention is suitable for embodiments in many other specific forms without departing from the field of application of the invention as claimed. In consequence, the present embodiments must be considered as illustrations, but can be modified in the field defined by the scope of the appended claims, and the invention must not be limited to the details given above.

1-10. (canceled)

11: A device for regulating engine temperature, comprising:

a valve control system placed on a line of a cooling circuit of an internal combustion engine connecting the engine to a radiator, the line including a temperature sensor placed at an outlet of the engine and upstream of the valve control system, which is automatically opened under effect of a coolant being heated to a temperature setpoint;

means for varying the temperature setpoint in accordance with a predefined setpoint profile, ranging between a minimum stored temperature setpoint and a maximum stored temperature setpoint, so that the temperature of the engine gradually reaches the minimum or maximum setpoint to attenuate thermal shock by maintaining the control valve system more or less wide open; and

means for controlling the first opening of the control valve system and for checking that the first opening of the control valve system has already taken place.

12: The device for regulating engine temperature as claimed in claim **11**, wherein the means for effecting a more or less wide opening of the valve control system in accordance with the predefined setpoint profile includes a heating resistor used to prematurely increase or decrease the temperature of a wax plug of the valve control system, respectively causing the opening or the closing of a check valve, and are controlled by computation device placed in a computer.

13: The device for regulating engine temperature as claimed in claim **12**, wherein the computation device placed in a computer includes at least one first computation module that determines the lowest minimum and maximum temperature limits in accordance mutually with the minimum and maximum temperature setpoints stored in a storage in the computer, a second computation module that calculates plural intermediate temperatures of the setpoint profile between the minimum temperature limit and the maximum temperature limit, a comparison module that compares the temperature measured continuously at the engine outlet by the temperature sensor during the driving, with the intermediate temperatures calculated with the second computation module to determine the difference between the two temperatures, and a correction module that corrects the difference and serves to define the necessary opening of the thermostat to reach the desired temperature setpoint according to the measured difference.

14: The device for regulating engine temperature as claimed in claim **13**, wherein the computation device further includes a thermostat control module associated with the correction module.

15: A method for regulating engine temperature implementing the device as claimed in claim **11**, comprising:

varying the temperature setpoint so that the engine temperature gradually reaches a maximum temperature when the first opening of the valve control system has already taken place.

16: The method for regulating engine temperature as claimed in claim **15**, further comprising:

determining a minimum temperature setpoint and a maximum temperature setpoint and storing these two temperature setpoints in a storage of a computer;

determining by a first computation module a minimum temperature limit from the minimum temperature setpoint and a maximum temperature limit from the maximum temperature setpoint and storing these two temperature setpoints in the storage of the computer;

determining by a second computation module intermediate temperatures as a function of the minimum and maximum temperature limits;

measuring continuously, during the driving time, the temperature of the coolant contained in the circuit at the outlet of the engine and downstream of the valve control system with a sensor;

comparing the temperature at the engine of the various intermediate temperatures to determine a difference; and

correcting the difference in temperature by opening or closing the valve control system.

17: The method for regulating engine temperature as claimed in claim **16**, wherein the minimum temperature setpoint is between 80° C. and 85° C. and the maximum temperature setpoint is between 100° C. and 120° C.

18: The method for regulating engine temperature as claimed in claim **17**, wherein the minimum temperature setpoint is 90° C. and the maximum temperature setpoint is 110° C.

19: The method for regulating engine temperature as claimed in claim **18**, wherein the minimum temperature limit is 92° C. when the minimum temperature setpoint is 90° C., and the maximum temperature limit is 108° C. when the maximum temperature setpoint is 110° C.

20: The method for regulating engine temperature as claimed in claim **16**, wherein the opening and closing of the valve control system are carried out by turning on a heating mechanism located in the valve control system that prematurely reaches the temperature setpoint allowing the opening or closing of the valve control system.

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