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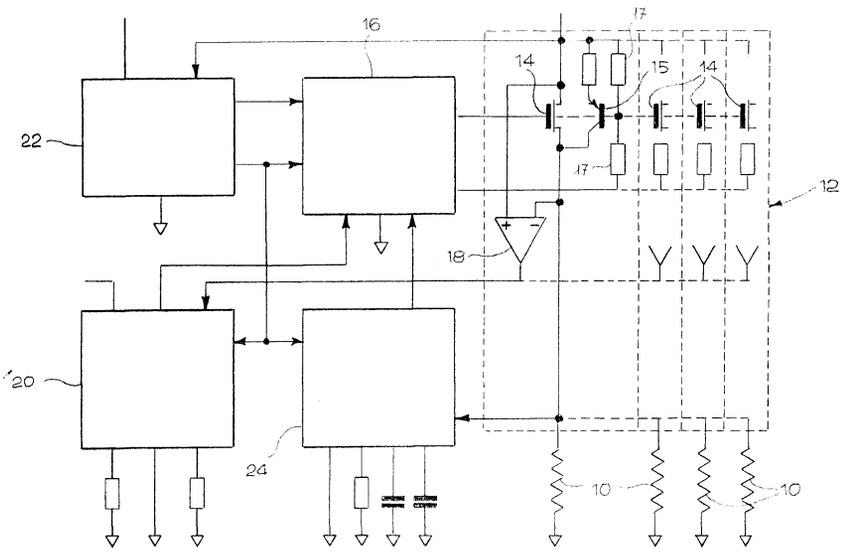
(54) A method for controlling the temperature in the combustion chambers of an engine

(57) A method for controlling temperature in the combustion chambers of an internal combustion engine, comprising:

- a plurality of glow plugs (10),
- a circuit (12) for supplying said glow plugs (10), and
- a circuit (24) for measuring the temperature in the combustion chambers, which measures the resistance of said glow plugs (10) during intervals in which said supply circuit (12) is turned off.

The method comprises a heating phase which is operative for a short time interval immediately preceding the start of the engine, in which a supply circuit is periodically turned-off and during the periods of inactivity of the supply circuit the temperature into the combustion chambers is measured.

The method further comprises a maintaining phase which is continuously operative during the whole running period of the engine, in which the temperature in the combustion chambers is measured at predetermined time interval and said supply circuit (12) is turned-on if the measured temperature falls below a predetermined threshold.



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Description

[0001] The present invention relates to a method for controlling the temperature in the combustion chambers of an internal combustion engine, comprising:

- a plurality of glow plugs,
- a circuit for supplying said glow plugs, and
- a circuit for measuring the temperature in the combustion chambers, which measures resistance values of said glow plugs in time intervals during which said supply circuit is inactive.

[0002] From EP-A-0315934 a method for regulating the temperature of heating plugs of diesel engines is known, comprising a heating step which is operative for a short time interval immediately preceding the engine ignition. In this heating step, the supply circuit provides a voltage with short interruptions during which the temperature into the combustion chambers is measured. The supply circuit is turned off after reaching a predetermined temperature in the combustion chambers and remains inactive when the engine is operating.

[0003] The object of the present invention is to provide a method for controlling operating conditions of an internal combustion engine, which improves the engine general operative conditions, with particular reference to the reduction of polluting exhaust emissions (EOBD) and to optimizing fuel consumption.

[0004] According to the present invention, this object is achieved by a method having the features forming the subject of the claims.

[0005] The present invention now will be disclosed in detail with reference to the attached drawing which shows a block diagram of a glow plug control unit for an internal combustion engine, adapted to carry out a method according to the invention.

[0006] With reference to the figure, a plurality of glow plugs schematically indicated 10 are associated, in a conventional way, to respective combustion chambers (not shown) of a diesel internal combustion engine. The glow plugs 10 are associated with a supply circuit 12 comprising a plurality of power switches 14 which are preferably mosfet each of which is connected to a respective glow plug 10. The power of the mosfets 14 is selected depending on the type of glow plug. The switches 14 have the purpose of closing and opening the glow plugs supply circuit depending on signals originating from a control unit 16.

[0007] The supply circuit 12 further comprises a current sensor for each supply branch (one for each glow plug 10), which may be constituted by an internal resistance of each mosfet and may be used also as sensors for diagnosing the supply circuit operative state, that is for detecting interruptions or short circuit on the glow plug supply branches. Any possible irregularity is detected by comparators 18 which send to an alarm module 20 signals indicative of such irregularities.

[0008] The glow plugs control system which is disclosed in the following controls the glow plug temperature during the phases currently known as pre-heating and post-heating (before starting the engine) and in addition carries out a continuous monitoring of the temperature in the combustion chambers during engine operation. Therefore the system minimizes polluting effects due to low operating temperatures and can issue a signal indicating engine overheating conditions. The system for monitoring and controlling the glow plugs 10 comprises, in addition to the control module 16 and the alarm module 20, a supply module 22 and a measure and regulating module 24.

[0009] The supply module 22 is a functional block which generates all the voltages necessary for the correct operation of the system. The input voltage of the supply module 22 is provided by the dashboard key switch. The supply module 22 provides an internal supply voltage preferably obtained by a series regulating circuit which provides an output of about 7.5 V, which can support wide variations of the system supply voltage (the battery voltage) and at the same time ensure a very reduced variation of the supply voltage of the various blocks of the system.

[0010] For driving the power devices, the supply module 22 provides a bootstrap voltage which is a variable voltage whose value is about 12 V higher than the system supply voltage.

[0011] Preferably, the supply module 22 provides also a steady and precise reference voltage independent of the variations of the system supply voltage. The reference voltage is used for defining various reference thresholds for temperature readings and for the alarms. The supply module 22 can also be provided with UV and OV alarms respectively for signalling undervoltage and overvoltage conditions. These alarms represent the operative limits of the system and the system is switched-off when the input voltage falls outside these limits.

[0012] The measure and regulating block 24 detects the temperature in the combustion chambers by measuring the resistance of the glow plugs 10, by virtue of the variation of this parameter with the temperature. The measure system is based on the detection potential difference on individual glow plugs when a current with known and constant value flows through them. Preferably, the measure current is provided by a PNP transistor 15 which carries out the function of a current generator calibrated for emitting a measure current of 0.5 A. The measure of temperature is carried out during time intervals in which the supply circuit 12 is inactive and no supply current flows through the glow plugs 10. In these conditions, a calibrated measurement current produced by said current generator passes through the glow plugs 10 and the potential difference on each glow plug 10 is directly related to the temperature in the respective combustion chamber. A unitary temperature value is obtained by calculating an average of the temperature values relating to the various combustion chambers. As an

alternative, the temperature of each combustion chamber could be detected separately. The measure of temperature is controlled by a signal generated by an oscillator having a clock rate which can vary preferably from a few milliseconds to a few hundreds of milliseconds during the step of pre-heating (condition in which the engine is not running) and which is slowed-down to a suitable frequency during the maintaining phase (engine running). During the pre-heating and post-heating phases, the measurement and regulation block 24 sends a signal to the control block 16 which temporaneously switches-off the glow plugs 10 for a time interval sufficient for carrying out the measure. In maintaining conditions, if the supply circuit 12 is turned-off the system measures directly the resistance of the glow plugs 10 at the predetermined intervals whereas if the supply circuit 12 is turned-on even when the engine is running, before carrying out the measure of temperature, the supply of the glow plugs is temporaneously switched-off for enabling the passage of the measure current.

[0013] The measure and regulating block compares the values indicative of the temperature in the combustion chamber with minimum and maximum temperature thresholds. If the detected value is lower than the minimum temperature threshold, the control block 16 turns-on the supply circuit 12, both during pre-heating and running conditions of the engine. If the detected temperature is higher than the maximum temperature threshold, the alarm block 20 generates suitable alarm signals to the driver or to an upper lever control system. In order to avoid possible alarm conditions which are transient or caused by disturbances, which could distract the driver, the alarm condition is enabled only when an anomalous condition permains for a predetermined time.

[0014] Preferably, the control block 16 during the maintaining phase turns-on the supply circuit 12 only if the respective control signal remains continuously on for a predetermined time. An heating cycle, which consists in switching to a conductive condition the power switches 14 controlling the glow plugs 10, is started at the same time as a control signal is validated. At the same time as the power switches 14 are turned on, a verification phase of the state of the glow plugs 10 is carried out and when a condition of open circuit or short circuit is detected a signal is generated indicating an anomalous condition. In this case, the faulty branch is immediately turned-off and an alarm signal is generated.

[0015] A maintaining cycle is started at the end of the heating cycle, each time a temperature in the combustion chamber is detected which is lower than said minimum threshold. In fact, the system continues to read the glow plug temperatures at predetermined intervals during the whole running period of the engine and activates a heating condition for re-establishing the correct operative temperature when the detected value is lower than the intervention limit.

[0016] The system according to the present invention enables therefore the temperature in the engine combustion chambers to be constantly maintained into a predetermined interval, which can be chosen for instance so as to minimize the content of polluting agents in the exhaust gas (EOBD) and for optimizing fuel consumption.

Claims

1. A method for controlling the temperature in the combustion chambers of an internal combustion engine, comprising:

   - a plurality of glow plugs (10),
   - a circuit (12) for supplying said glow plugs (10), and
   - a circuit (24) for measuring the temperature in the combustion chambers, which measures the resistance of said glow plugs (10) during time intervals in which said supply circuit (12) is turned off,

   the method comprising a heating phase which is operative for a short time interval immediately preceding the start of the engine, in which the supply circuit is periodically turned-off and during inactivity phases of the supply circuit the temperature in the combustion chamber is measured, and wherein the supply circuit (12) is turned-off after reaching a predetermined temperature in the combustion chamber,
   the method being characterized in that it comprises a maintaining phase which is operative continuously during the whole engine running period in the course of which the temperature in the combustion chamber is measured at predetermined time intervals and said supply circuit (12) is turned-on if the measured temperature falls below a predetermined threshold.

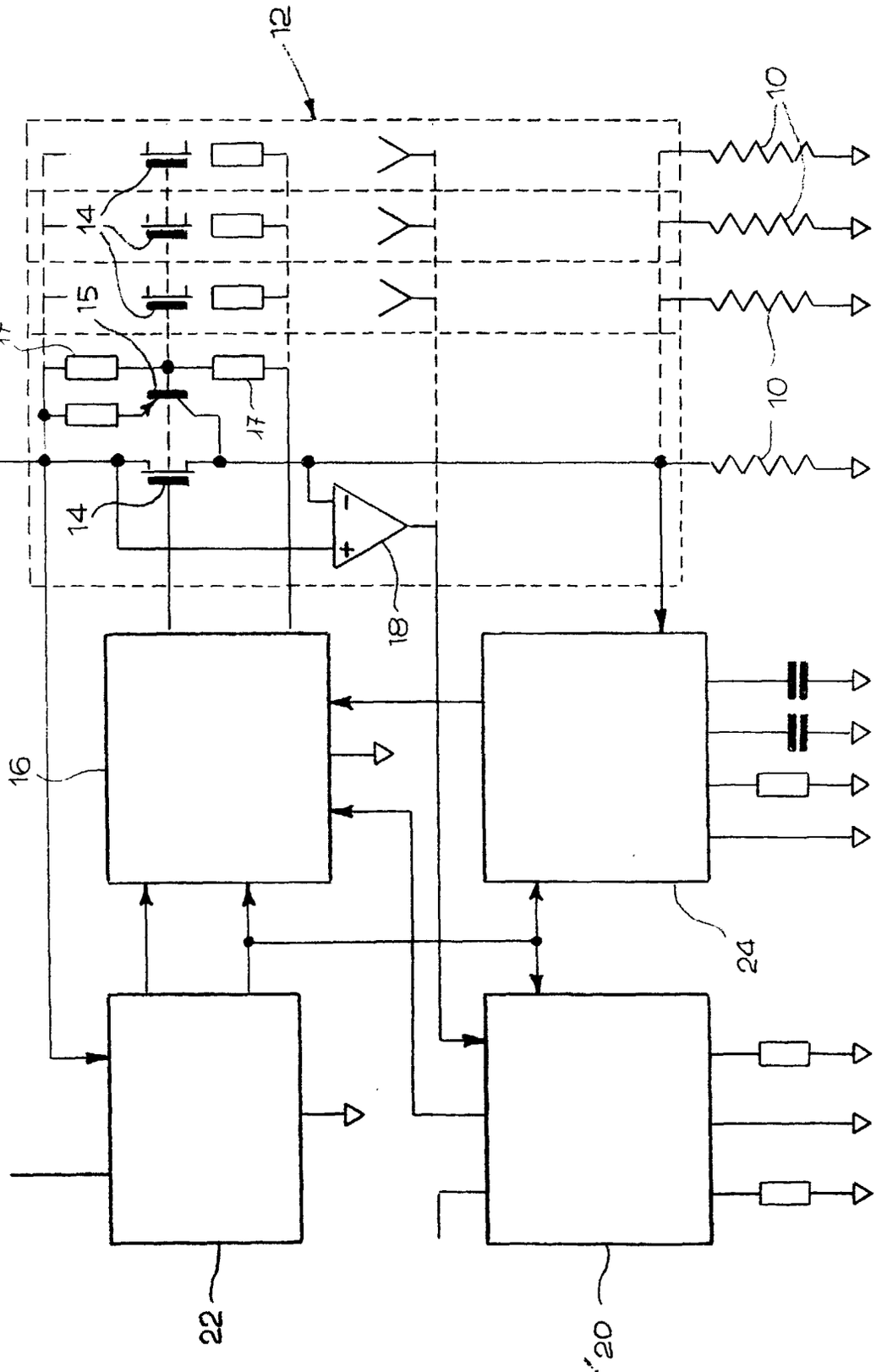
2. A method according to claim 1, characterized in that the temperature measurement is carried out by generating a measurement current by means of a current generator, passing said measure current through each of said glow plugs and measuring the potential difference on each glow plug.

3. A method according to claim 1, characterized in that a reference temperature is determined as an average value of the temperature in the various combustion chambers.

4. A method according to claim 1, characterized in that said average temperature value is compared with a maximum and minimum temperature threshold.

5. A method according to claim 1, characterized in that a reference temperature is determined for each

glow plug, which is indicative of the temperature into the respective combustion chamber.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EUROPEAN SEARCH REPORT

Application Number
EP 98 83 0590

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A	EP 0 565 431 A (RENAULT) 13 October 1993 * column 2, line 51 - column 3, line 41 * * column 4, line 21 - line 55 * * column 8, line 15 - column 9, line 40 * * figures 1,3 *	1,3	TECHNICAL FIELDS SEARCHED (Int.Cl.6) F02D F02P

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	9 March 1999	Lapeyronnie, P

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 98 83 0590

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82