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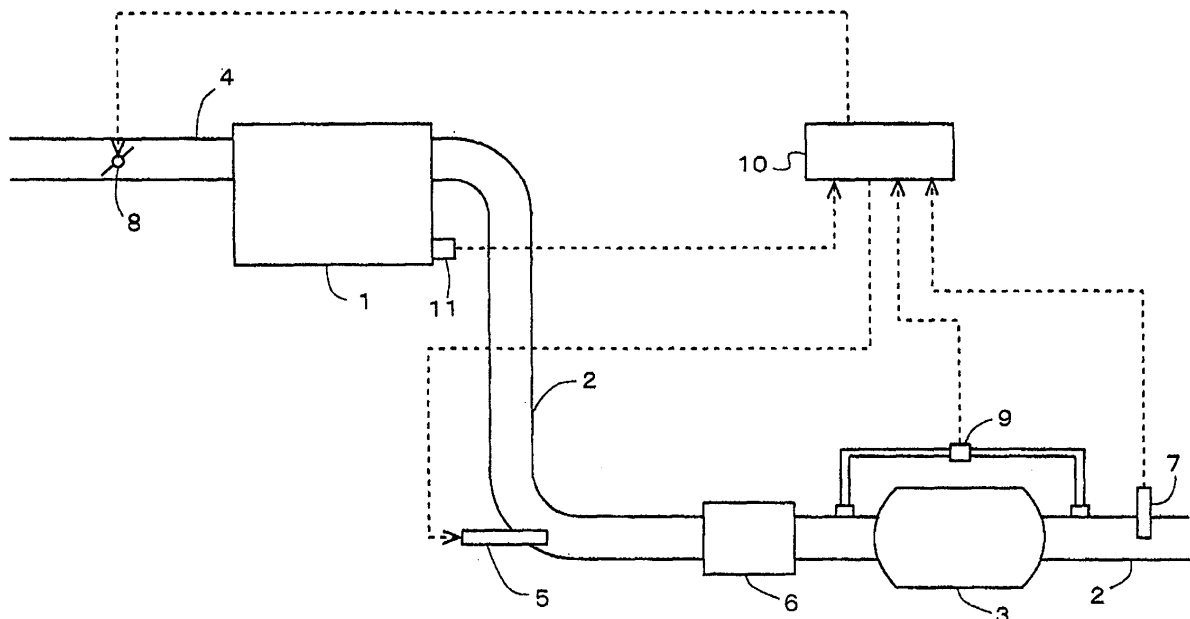
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(54) Exhaust gas purifying system of internal combustion engine

(57) In an exhaust gas purifying system of an internal combustion engine (1) having a filter (3) provided in an exhaust passage (2) of the internal combustion engine, the present invention enables to prevent excessive temperature rise of the filter (3) while filter regeneration control is performed. When the temperature of the filter (3) is rising after filter regeneration process in which the temperature of the filter is raised to a target temperature to

oxidize and remove particulate matter collected on the filter has been started, the temperature of the filter that will be attained if the number of engine revolutions of the internal combustion engine (1) has become equal to or lower than a specified number of engine revolutions is estimated (S105). The temperature rise rate of the filter while the temperature of the filter is rising is controlled in such a way that the estimated filter temperature to be attained is kept within an allowable range (S106).

Fig. 1



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to an exhaust gas purifying system of an internal combustion engine equipped with a particulate filter provided in an exhaust passage of the internal combustion engine for collecting particulate matter contained in the exhaust gas.

Description of Related Art

[0002] Japanese Patent Application Laid-Open No. 2004-68804 discloses a technology applied to a particulate filter (which will be simply referred to as a filter hereinafter) for collecting particulate matter contained in the exhaust gas provided in an exhaust passage of an internal combustion engine in which the flow rate of the exhaust gas (which will be simply referred to as the exhaust gas flow rate) flowing into the filter is increased when the rate of increase in the temperature of the filter becomes equal to or higher than a specified value while a filter regeneration control is performed. Japanese Patent Application Laid-Open No. 2002-38930 and Japanese Patent Publication No. 6-21552 also disclose technologies concerning a filter regeneration control process.

[0003] In the exhaust gas purifying systems of internal combustion engines having a filter provided in an exhaust passage of the internal combustion engine, when the amount of the particulate matter collected or depositing on the filter (Which will be referred to as the PM collection amount) becomes equal to or larger than a specified PM collection amount, a filter regeneration control for oxidizing and removing particulate matter collected on the filter is performed by increasing the temperature of the filter to a target temperature.

[0004] If the number of engine revolutions of the internal combustion engine decreases while such a filter regeneration control process is performed, the quantity of heat carried away from the filter decreases with a decrease in the exhaust gas flow rate. In such cases accordingly, the temperature of the filter sometimes rises steeply. Thus, there is a risk that the temperature of the filter can rise to temperatures that might cause melting or serious deterioration of the filter, namely excessive temperature rise of the filter can occur.

SUMMARY OF THE INVENTION

[0005] The present invention has been made in view of the above-described problem and has as an object to provide, in an exhaust gas purifying system of an internal combustion engine equipped a filter provided in an exhaust passage of the internal combustion engine, a technology that can prevent excessive temperature rise of the filter from occurring during filter regeneration control

process.

[0006] In the present invention, the temperature of the filter that will be attained if the number of engine revolutions of the internal combustion engine becomes lower than or equal to a specified number of engine revolutions is estimated while the filter temperature is rising due to execution of the filter regeneration control. In addition, the temperature rise rate of the filter while the temperature of the filter is rising is controlled in such a way that the estimated filter temperature to be attained falls within an allowable range.

[0007] More specifically, an exhaust gas purifying system of an internal combustion engine according to the present invention comprising: a particulate filter provided in an exhaust passage of the internal combustion engine, for collecting particulate matter contained in exhaust gas; filter regeneration control execution means for executing filter regeneration control in which the temperature of the particulate filter is raised to a target temperature to oxidize and remove particulate matter collected on said particulate filter;

PM collection amount detection means for detecting the amount of the particulate matter collected on said particulate filter;

temperature rise rate detection means for detecting the temperature rise rate of said particulate filter while the temperature of said particulate filter is rising due to execution of the filter regeneration control by said filter regeneration control execution means;

attained temperature estimation means for estimating the temperature of said particulate filter that will be attained if the number of engine revolutions of said internal combustion engine becomes lower than or equal to a specified number of engine revolutions, based on the amount of the particulate matter detected by said PM collection amount detection means and the temperature rise rate detected by said temperature rise rate detection means While the temperature of the particulate filter is rising due to execution of the filter regeneration control by said filter regeneration control execution means; and temperature rise rate control means for controlling the temperature rise rate of said particulate filter, while the temperature of said particulate filter is rising due to execution of the filter regeneration control by said filter regeneration control execution means, in such a way that the temperature of said particulate filter to be attained estimated by said attained temperature estimation means is kept lower than or equal to an upper allowable temperature limit.

[0008] In the present invention, the filter regeneration control is executed by raising the temperature of the filter to a target temperature. The target temperature is such a temperature that enables oxidation and removal of the particulate matter collected on the filter, and prevention of melting and serious deterioration of the filter.

[0009] When execution of the filter regeneration control is started, the temperature of the filter starts to rise. In the present invention, the temperature rise rate of the

filter while the filter regeneration control is executed is detected by the temperature rise rate detection means. Here, the temperature rise rate means the temperature rise per unit time. Hereinafter, the temperature rise rate of the filter at that time will be simply referred to as the filter temperature rise rate.

[0010] If the number of engine revolutions (or the rotation speed) of the internal combustion engine decreases while the filter temperature is rising due to execution of the filter regeneration control, the temperature of the filter sometimes rises steeply since the quantity of heat carried away from the filter decreases with an decrease in the exhaust gas flow rate. Therefore, if the number of engine revolutions of the internal combustion engine decreases excessively while the filter regeneration control is executed, there is a risk that the temperature of the filter can rise beyond the target temperature and excessive temperature rise of the filter may eventually occur.

[0011] In such cases, the larger the PM collection amount at the time when the number of engine revolutions of the internal combustion engine decreases is, and the higher the filter temperature rise rate at the time when the number of engine revolutions of the internal combustion engine decreases is, the higher the filter temperature that will be attained by the steep rise in the temperature of the filter becomes. This is because the larger the PM collection amount is, and the higher the filter temperature rise rate is, the more expeditiously oxidation of particulate matter is promoted when the number of engine revolutions of the internal combustion engine decreases.

[0012] In view of the above, according to the present invention, the temperature of the filter that will be attained if the number of engine revolution of the internal combustion engine becomes lower than or equal to the specified number of engine revolutions while the temperature of the filter is rising due to execution of the filter regeneration control is estimated based on the PM collection amount and the filter temperature rise rate at that time. In other words, while the temperature of the filter is rising due to execution of the filter regeneration control, the assumption is made that the number of engine revolutions of the internal combustion engine becomes lower than or equal to the specified number of engine revolutions, and the temperature of the filter that will be attained in that case is estimated. In the following, the temperature of the filter attained in that case will be simply referred to as the filter temperature to be attained.

[0013] Here, the specified number of engine revolutions may be such a threshold value of the number of engine revolutions that if the number of engine revolutions of the internal combustion engine becomes lower than or equal to that specified number of engine revolutions while the filter temperature is rising due to execution of the filter regeneration control, it may be considered that there is a risk of excessive temperature rise of the filter. Alternatively, it may be such a threshold value of the number of engine revolutions with which it may be considered that the running state of the internal combustion

engine has shifted to idling.

[0014] The filter temperature rise rate while the temperature of the filter is rising is controlled in such a way that the estimated filter temperature to be attained becomes smaller than or equal to an upper allowable temperature limit. Here, the upper allowable temperature limit is an upper limit value of allowable temperatures determined by, for example, experiments. The upper allowable temperature limit is higher than or equal to the target temperature in the filter regeneration control and lower than or equal to the upper limit value of the temperatures at which melting or serious deterioration of the filter can be prevented.

[0015] According to the present invention, if the number of engine revolutions of the internal combustion engine decreases while the temperature of the filter is rising due to execution of the filter regeneration control, it is possible to keep the temperature of the filter lower than the upper allowable temperature limit. Therefore, it is possible to prevent excessive temperature rise of the filter while the filter regeneration control is executed. In other words, it is possible to promote regeneration of the filter while preventing excessive temperature rise of the filter, even when the number of engine revolutions of the internal combustion engine decreases.

[0016] In the present invention, the temperature rise rate of the filter may be controlled only when the temperature of the filter is rising due to execution of the filter regeneration control and the temperature of the filter is higher than a specified temperature.

[0017] Even while the temperature of the filter is rising due to execution of the filter regeneration control, excessive temperature rise of the filter can be prevented even if the number of engine revolutions of the internal combustion engine becomes lower than or equal to the specified number of engine revolutions, as long as the temperature of the filter is not as high as a certain temperature.

[0018] In view of this, the specified temperature is set as such a temperature at which it can be considered that the possibility of excessive temperature rise of the filter is low even if the number of engine revolutions of the internal combustion engine becomes lower than or equal to the specified number of engine revolutions while the temperature of the filter is rising due to execution of the filter regeneration control. The specified temperature is lower than the target temperature.

[0019] In the above-described control, even after the filter regeneration control has been started, the filter temperature rise rate is not controlled as long as the temperature of the filter is lower than or equal to the specified temperature. Consequently, it is possible to raise the temperature of the filter to the target temperature more quickly after the filter regeneration control has been started, while preventing excessive temperature rise of the filter. Thus, it is possible to reduce the execution time of the filter regeneration control as much as possible.

[0020] In the filter temperature rise rate control process

in the present invention, the filter temperature rise rate may be controlled to the maximum value within the range with which the filter temperature to be attained estimated by the attained temperature estimation means is kept lower than or equal to the upper allowable temperature limit.

[0021] According to this control process, it is possible to raise the temperature of the filter to the target temperature more quickly after the filter regeneration control has been started, while preventing excessive temperature rise of the filter. Thus, it is possible to reduce the execution time of the filter regeneration control as much as possible.

[0022] The above and other objects, features and advantages of the present invention will become more readily apparent to those skilled in the art from the following detailed description of preferred embodiments of the present invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023]

Fig. 1 is a diagram schematically showing the basic structure of the internal combustion engine and its air-intake and exhaust systems according to an embodiment.

Fig. 2 is a flow chart of a control routine of a filter temperature rise rate control according to a first embodiment of the present invention.

Fig. 3 is a flow chart of a control routine of a filter temperature rise rate control according to a second embodiment of the present invention.

DESCRIPTION OF THE EMBODIMENTS

[0024] In the following, specific embodiments of the exhaust gas purifying system of an internal combustion engine according to the present invention will be described with reference to the drawings.

(First Embodiment)

(Basic Structure of Internal Combustion Engine and its Air-Intake and Exhaust Systems)

[0025] Here, a diesel engine for driving a vehicle to which the present invention is applied will be described by way of example. Fig. 1 is a diagram schematically showing the basic structure of the internal combustion engine and its air-intake and exhaust systems according to this embodiment.

[0026] The internal combustion engine 1 is a diesel engine for driving a vehicle. The internal combustion engine 1 is connected with an intake passage 4 and an exhaust passage 2. A throttle valve 8 is provided in the intake passage 4. On the other hand, a particulate filter

3 (which will be simply referred to as a filter 3 hereinafter) for collecting particulate matter contained in the exhaust gas is provided in the exhaust passage 2. An oxidizing catalyst 6 is provided in the exhaust passage 2 upstream of the filter 3. Alternatively, an oxidizing catalyst may be supported on the filter 3 instead of providing the oxidizing catalyst 6 in the exhaust passage 2 upstream of the filter 3.

[0027] An exhaust gas pressure difference sensor 9 that outputs an electric signal indicative of the difference in the pressure of the exhaust gas between the upstream and the downstream of the filter 3 is provided in the exhaust gas passage 2. An exhaust gas temperature sensor 7 that outputs an electric signal indicative of the temperature of the exhaust gas flowing through the exhaust passage 2 is provided in the exhaust passage 2 downstream of the filter 3. In addition, a fuel addition valve 5 for adding fuel to the exhaust gas is provided in the exhaust passage 2 upstream of the filter 3.

[0028] To the internal combustion engine 1 having the above-described structure, an electronic control unit (ECU) 10 for controlling the internal combustion engine 1 is annexed. The ECU 10 is a unit for controlling the running state of the internal combustion engine 1 in accordance with running conditions of the internal combustion engine 1 or driver's demands. The ECU 10 is electrically connected with the exhaust gas pressure difference sensor 9, the exhaust gas temperature sensor 7 and a crank position sensor 11 that outputs an electric signal indicative of the crank angle of the internal combustion engine 1 etc., and output signals of these sensors are input to the ECU 10. The ECU 10 estimates the particulate matter collection amount on the filter 3 based on the output value of the exhaust gas pressure difference sensor 9. In this embodiment, the exhaust gas pressure difference sensor 9 constitutes the PM collection amount detection means according to the present invention. The ECU 10 estimates the temperature of the filter 3 based on the output value of the exhaust gas temperature sensor 7. In addition, the ECU 10 is electrically connected with the throttle valve 8 and the fuel addition valve 5, which are controlled by the ECU 10. ,

(Filter Regeneration Control)

[0029] In this embodiment, when the amount of the particulate matter collected on the filter 3 becomes equal to or larger than a specified PM collection amount, the ECU 10 performs a filter regeneration control for oxidizing and removing the particulate matter collected on the filter 3, wherein the ECU controls to reduce the degree of opening of the throttle valve 8 and to add fuel to the exhaust gas through the fuel addition valve 5 to raise the temperature of the filter 3 to a target temperature T_t . In this embodiment, the throttle valve 8 and the fuel addition valve 5 constitute the filter regeneration control execution means according to the present invention.

[0030] The target temperature T_t is such a temperature

that if the temperature of the filter 3 is the target temperature T_t , it is possible to oxidize and remove the particulate matter collected on the filter 3 and to prevent melting and serious deterioration of the filter 3. The target temperature T_t is determined in advance by, for example, experiments.

[0031] The fuel added through the fuel addition valve 5 is oxidized in the oxidizing catalyst 6, whereby the temperature of the exhaust gas flowing into the filter 3 is increased by the heat generated by oxidation. The temperature of the filter 3 rises with the rise in the temperature of the exhaust gas. By reducing the degree of opening of the throttle valve 8, it is possible to reduce the flow rate of the exhaust gas. This makes it possible to raise the temperature of the exhaust gas flowing into the filter 3 more expeditiously. In view of this, in this embodiment, the temperature of the filter 3 is adjusted to the target temperature by controlling the quantity of the fuel added through the fuel addition valve 5 and the degree of opening of the throttle valve 8.

[0032] When execution of the filter regeneration control is started, the temperature of the filter 3 starts to rise gradually. If the running state of the internal combustion engine 1 shifts to idling while the filter regeneration control is performed, the temperature rise of the filter 3 is sometimes promoted steeply, since the quantity of heat carried away from the filter 3 decreases due to a decrease in the exhaust gas flow rate. Therefore, there is a risk that the temperature of the filter 3 can rise beyond the target temperature T_t to eventually cause excessive temperature rise of the filter 3.

[0033] In such cases, the larger the PM collection amount at the time when the running state of the internal combustion engine 1 shifts to idling is, and the higher the filter temperature rise rate at the time when the running state of the internal combustion engine 1 shifts to idling is, the higher the filter temperature T_a that will be attained by the steep rise in the temperature of the filter 3 becomes.

(Filter Temperature Rise Rate Control)

[0034] In view of the above, in this embodiment, filter temperature rise rate control for controlling the filter temperature rise rate R_{up} while the temperature of the filter 3 is rising during execution of the filter regeneration control is performed to suppress excessive temperature rise of the filter 3.

[0035] In the following, the control routine of the filter temperature rise rate control according to this embodiment will be described with reference to a flow chart shown in Fig. 2. This routine is stored in advance in the ECU 10 and executed every time the crankshaft rotates by a specified angle while the internal combustion engine 1 is running.

[0036] In this routine, firstly in step S101, a determination is made by the ECU 10 as to whether or not the filter regeneration control is in operation. If step S101 is an-

swered in the affirmative, the process of the ECU 10 proceeds to step S102, and if answered in the negative, the ECU 10 stops executing this routine.

[0037] In step S102, a determination is made by the ECU 10 as to whether or not the temperature of the filter 3 is lower than the target temperature T_t . If step S102 is answered in the affirmative, which is considered to mean that the temperature of the filter 3 is rising, the process of the ECU 10 proceeds to step S103. On the other hand, if step S102 is answered in the negative, which is considered to mean that the temperature of the filter 3 has reached the target temperature T_t , namely, that the temperature of the filter 3 is not rising, the ECU 10 stops executing this routine.

[0038] In step S103, the ECU 10 detects the current PM collection amount Q_{pm} .

[0039] Next, the process of the ECU 10 proceeds to step S104, where the ECU 10 detects the current filter temperature rise rate R_{up} . In this embodiment, the ECU 10 that executes the process of detecting the filter temperature rise rate R_{up} constitutes the temperature rise rate detection means according to the present invention.

[0040] Next, the process of the ECU 10 proceeds to step S105, where the ECU 10 estimates, by computation, the filter temperature T_a that will be attained if the running state of the internal combustion engine 1 shifts to idling at that time based on the PM collection amount Q_{pm} and the filter temperature rise rate R_{up} . Here, the relationship between the PM collection amount Q_{pm} , the filter temperature rise rate R_{up} and the filter temperature to be attained T_a may be determined in advance by, for example, experiments and stored in the ECU 10 as a map. In this map, the larger the PM collection amount Q_{pm} is, and the higher the filter temperature rise rate R_{up} is, the higher the filter temperature to be attained T_a is. In this embodiment, the ECU 10 that executes the process of computing the filter temperature to be attained T_a based on the PM collection amount Q_{pm} and the filter temperature rise rate R_{up} constitutes the attained temperature estimation means according to the present invention.

[0041] At that time, the temperature of the filter 3 has not reached the target temperature T_t , and accordingly, oxidation and removal of particulate matter has been effected little during the period after filter regeneration control was started until that time. Therefore, the filter temperature to be attained T_a may be computed with the assumption that the current PM collection amount Q_{pm} is the specified PM collection amount set as the threshold value for starting the filter regeneration control.

[0042] Next, the process of the ECU 10 proceeds to step S106, where the ECU 10 controls the filter temperature rise rate R_{up} in such a way that the filter temperature to be attained T_a is kept lower than or equal to an upper allowable temperature limit T_{limit} . Here, the upper allowable temperature limit T_{limit} is an upper limit of the allowable temperature that is determined by, for example, experiments. It is equal to or higher than the target temperature T_t and equal to or lower than the upper limit

of temperatures at which melting and serious deterioration of the filter 3 can be prevented.

[0043] A method of controlling the filter temperature rise rate R_{up} may be, for example, to control the quantity of fuel added through the fuel addition valve 5 and/or to control the exhaust gas flow rate by adjusting the degree of opening of the throttle valve 8. In this embodiment, the ECU 10 that executes the process of controlling the filter temperature rise rate R_{up} by controlling the fuel addition valve 5 and/or the throttle valve 8 constitutes the temperature rise rate control means according to the present invention. After controlling the filter temperature rise rate R_{up} in step S106, the ECU 10 terminates execution of this routine.

[0044] By the above-described control routine, it is possible to keep the temperature of the filter 3 equal to or lower than the upper allowable temperature limit T_{limit} even if the running state of the internal combustion engine 1 shifts to idling while the temperature of the filter 3 is rising due to execution of filter regeneration control. Therefore, it is possible to prevent excessive temperature rise of the filter 3 while the filter regeneration control is performed. In other words, even if the number of revolutions (or rotation speed) of the internal combustion engine decreases, it is possible to promote filter regeneration while preventing excessive temperature rise of the filter.

[0045] When the filter temperature rise rate R_{up} is controlled in the above-described control routine, the filter temperature rise rate R_{up} may be controlled to the maximum value within the range with which the filter temperature to be attained T_a does not exceed the upper allowable temperature limit T_{limit} .

[0046] By this control, it is possible to raise the temperature of the filter 3 to the target temperature T_t more quickly after execution of the filter regeneration control has been started, while preventing excessive temperature rise of the filter 3. Thus, it is possible to reduce the execution time of the filter regeneration control as much as possible.

[0047] In this embodiment, the filter temperature to be attained T_a is defined as the temperature of the filter that will be attained if the running state of the internal combustion engine 1 shifts to idling while the temperature of the filter 3 is rising due to execution of the filter regeneration control. However, the filter temperature to be attained T_a may be defined as the temperature of the filter that will be attained if the number of revolutions of the internal combustion engine 1 becomes lower than or equal to a specified number of engine revolutions that is determined in advance. In this case, the specified number of engine revolutions is not limited to the threshold value of the number of engine revolutions with which it can be considered that the running state of the internal combustion engine has shifted to idling, but it may be a threshold value of the number of engine revolutions with which it can be considered that there is a risk of excessive temperature rise of the filter 3.

[0048] By defining the filter temperature to be attained T_a in this way, it is possible to keep the temperature of the filter 3 lower than or equal to the upper allowable temperature limit T_{limit} not only in the case where the running state of the internal combustion engine 1 has shifted to idling while the temperature of the filter 3 is rising due to execution of the filter regeneration process, but also in the case where the number of engine revolutions of the internal combustion engine 1 has become lower than or equal to the specified number of engine revolutions.

[0049] As the altitude (or height) of the land on which the vehicle is running becomes higher, the decrease in the quantity of the carried-away heat caused by an decrease in the number of engine revolutions of the internal combustion engine 1 becomes smaller, since the density of the atmospheric air is lower. Accordingly, the temperature of the filter that will be attained when the number of engine revolutions of the internal combustion engine 1 decreases increases with an increase in the altitude of the land on which the vehicle is running, even if the filter temperature rise rate R_{up} at the time when the number of engine revolutions of the internal combustion engine 1 decreases is the same. In view of this, the target value set in controlling the filter temperature rise rate R_{up} in the above-described control routine may be adjusted in accordance with the altitude of the land on which the vehicle is running.

(Second Embodiment)

[0050] The basic structure of the internal combustion engine and its air-intake and exhaust systems according to the second embodiment are the same as those of the first embodiment, and descriptions thereof will be omitted. In this embodiment also, the filter regeneration control is performed in the same way as in the first embodiment.

(Filter Temperature Rise Rate Control)

[0051] In the following, the control routine of the filter temperature rise rate control according to this embodiment will be described with reference to a flow chart shown in Fig. 3. This routine is stored in advance in the ECU 10 and executed every time the crankshaft rotates by a specified angle while the internal combustion engine 1 is running. This routine differs from the filter temperature rise control routine in the first embodiment only in that step S102 is replaced by step S202, and the other steps are the same. Accordingly, only step S202 will be described here.

[0052] In this routine, in step S202, a determination is made by the ECU 10 as to whether or not the temperature of the filter 3 is higher than a specified temperature T_0 and is lower than the target temperature T_t . If step S202 is answered in the affirmative, the process of the ECU 10 proceeds to step S103, and if answered in the nega-

tive, the ECU 10 terminates execution of this routine.

[0053] Here, the specified temperature T0 is a temperature lower than the target temperature Tt. The specified temperature T0 is such a temperature that when the temperature of the filter 3 is lower than or equal to the specified temperature T0, it can be considered that the possibility of occurrence of excessive temperature rise of the filter 3 is low if the running state of the internal combustion engine 1 shifts to idling even while the temperature of the filter 3 is rising due to execution of the filter regeneration control.

[0054] According to the this embodiment, even while the temperature of the filter 3 is rising after the filter regeneration control has been started, the filter temperature rise rate Rup is not regulated as long as the temperature of the filter 3 is lower than or equal to the specified temperature T0. Consequently, it is possible to raise the temperature of the filter 3 to the target temperature Tt more quickly after execution of the filter regeneration control has been started, while preventing excessive temperature rise of the filter 3. Thus, it is possible to shorten the execution time of the filter regeneration control as much as possible.

[0055] According to the exhaust gas purifying system of an internal combustion engine according to the present invention, it is possible to prevent, in an exhaust gas purifying system of an internal combustion engine having a filter provided in an exhaust passage of the internal combustion engine, excessive temperature rise of the filter while the filter regeneration control is performed.

[0056] While the invention has been described in terms of preferred embodiments, those skilled in the art will recognize that the invention can be practiced with modifications within the spirit and scope of the appended claims.

[0057] In an exhaust gas purifying system of an internal combustion engine having a filter provided in an exhaust passage of the internal combustion engine, the present invention enables to prevent excessive temperature rise of the filter while filter regeneration control is performed. When the temperature of the filter is rising after filter regeneration process in which the temperature of the filter is raised to a target temperature to oxidize and remove particulate matter collected on the filter has been started, the temperature of the filter that will be attained if the number of engine revolutions of the internal combustion engine has become equal to or lower than a specified number of engine revolutions is estimated (S105). The temperature rise rate of the filter while the temperature of the filter is rising is controlled in such a way that the estimated filter temperature to be attained is kept within an allowable range (S106).

Claims

1. An exhaust gas purifying system of an internal combustion engine, comprising:

a particulate filter (3) provided in an exhaust passage (2) of the internal combustion engine (1), for collecting particulate matter contained in exhaust gas;

filter regeneration control execution means (5, 8) for executing filter regeneration control in which the temperature of the particulate filter (3) is raised to a target temperature to oxidize and remove particulate matter collected on said particulate filter (3);

PM collection amount detection means (9) for detecting the amount of the particulate matter collected on said particulate filter (3);

temperature rise rate detection means (10) for detecting the temperature rise rate of said particulate filter (3) while the temperature of said particulate filter (3) is rising due to execution of the filter regeneration control by said filter regeneration control execution means (5, 8);

attained temperature estimation means (10) for estimating the temperature of said particulate filter (3) that will be attained if the number of engine revolutions of said internal combustion engine (1) becomes lower than or equal to a specified number of engine revolutions, based on the amount of the particulate matter detected by said PM collection amount detection means (9) and the temperature rise rate detected by said temperature rise rate detection means (10) while the temperature of the particulate filter (3) is rising due to execution of the filter regeneration control by said filter regeneration control execution means (5, 8); and

temperature rise rate control means (10) for controlling the temperature rise rate of said particulate filter (3), while the temperature of said particulate filter (3) is rising due to execution of the filter regeneration control by said filter regeneration control execution means (5, 8), in such a way that the temperature of said particulate filter (3) to be attained estimated by said attained temperature estimation means (10) is kept lower than or equal to an upper allowable temperature limit.

2. An exhaust gas purifying system of an internal combustion engine according to claim 1, wherein said specified number of engine revolutions is a threshold value of the number of engine revolutions with which it can be considered that the running state of said internal combustion engine (1) has shifted to idling.
3. An exhaust gas purifying system of an internal combustion engine according to claim 1, wherein a target value in controlling the temperature rise rate of said particulate filter (3) by said temperature rise rate control means (10) while the temperature of said particulate filter (3) is rising is adjusted in accordance with

the altitude of a land on which a vehicle equipped with said internal combustion engine (1) is running.

4. An exhaust gas purifying system of an internal combustion engine according to claim 1, wherein the temperature rise rate of said particulate filter (3) is controlled by said temperature rise rate control means (10) only when the temperature of said particulate filter (3) is higher than a specified temperature that is lower than said target temperature. 5
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5. An exhaust gas purifying system of an internal combustion engine according to claim 1 or 4, wherein said temperature rise rate control means (10) controls the temperature rise rate of said particulate filter (3) to the maximum value within the range with which the temperature of said particulate filter (3) to be attained estimated by said attained temperature estimation means (10) is kept lower than or equal to said upper allowable temperature limit. 15
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Fig. 1

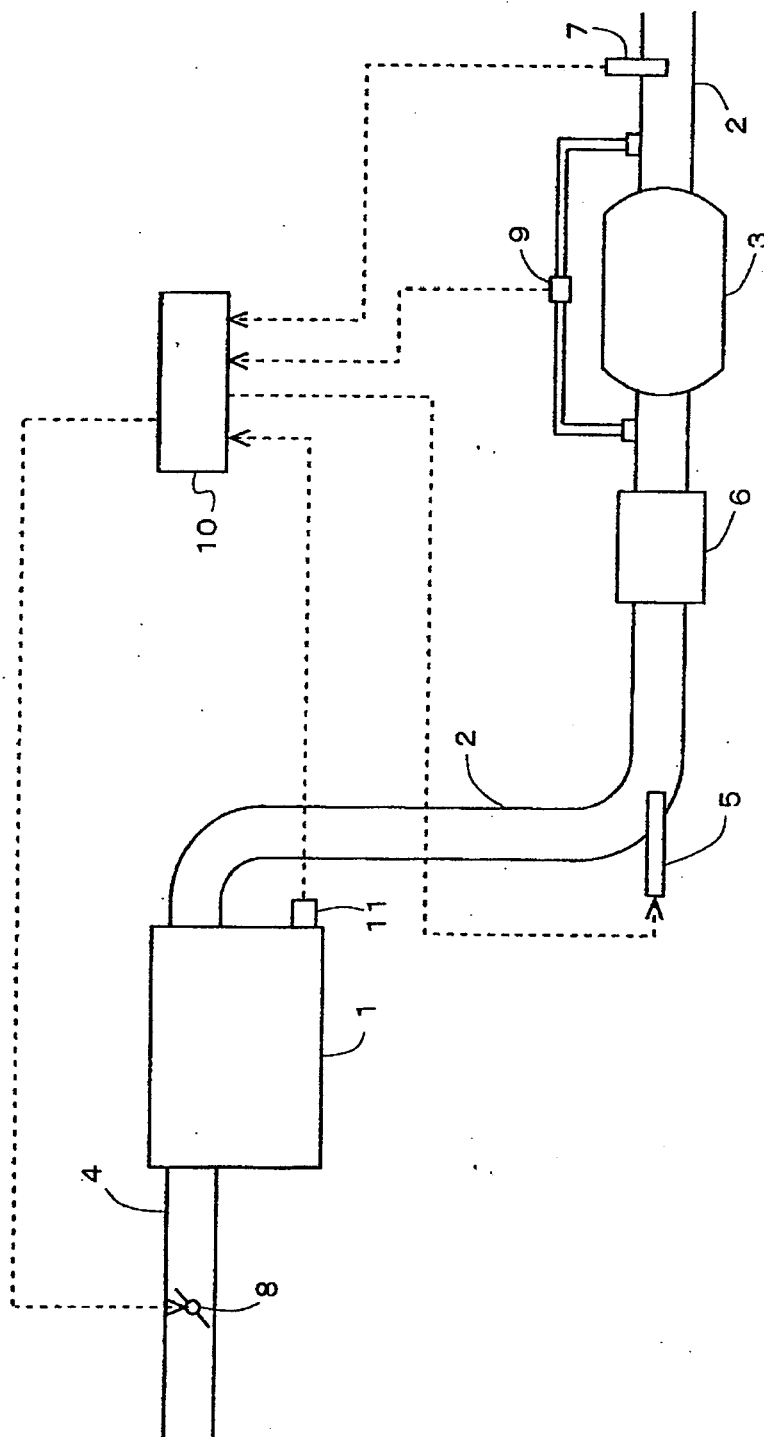


Fig. 2

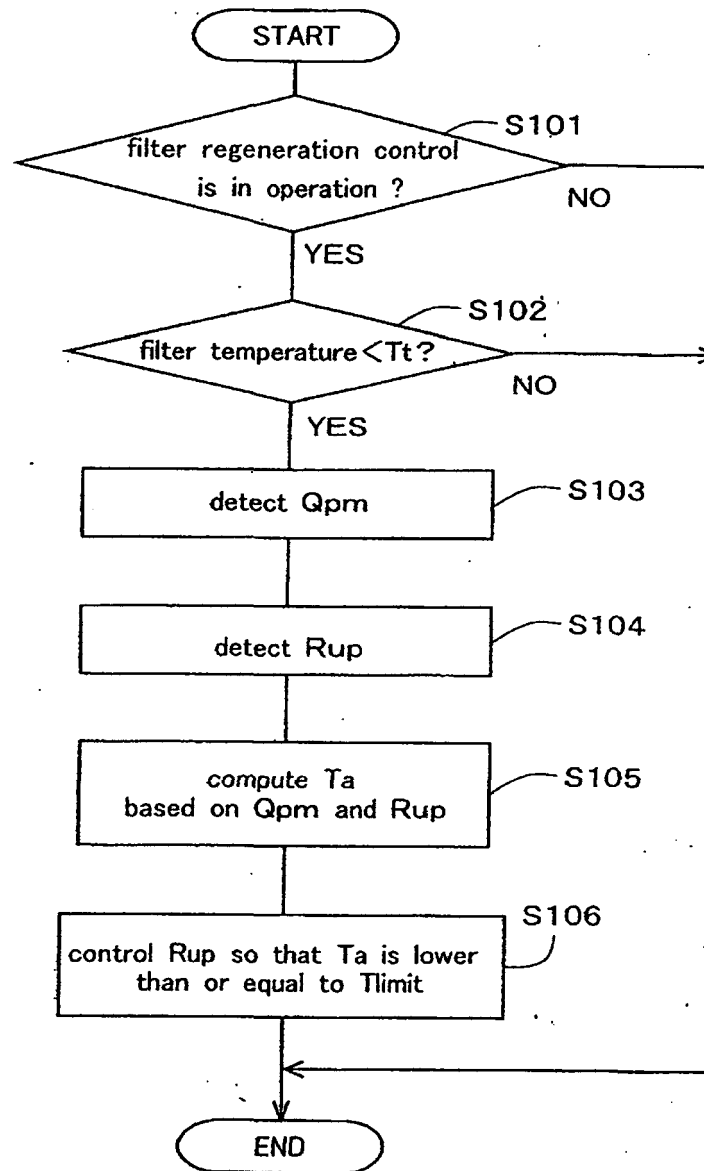
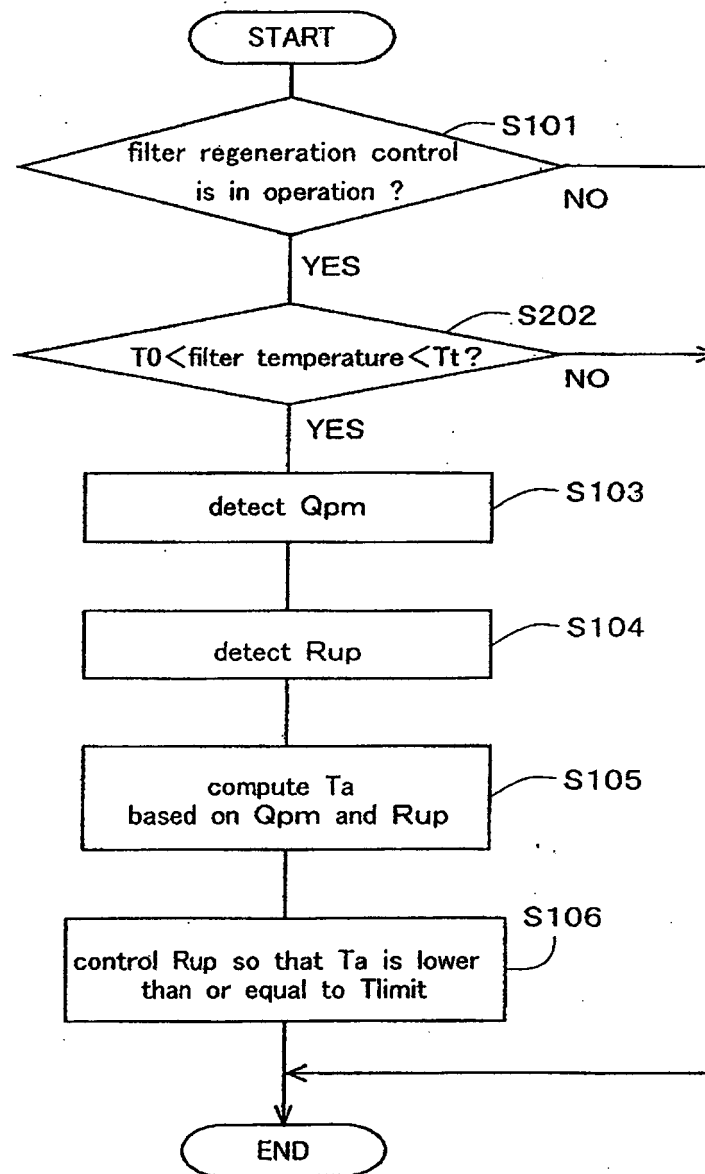


Fig. 3





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 02 1106

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	PATENT ABSTRACTS OF JAPAN vol. 016, no. 299 (M-1274), 2 July 1992 (1992-07-02) & JP 04 081513 A (NISSAN DIESEL MOTOR CO LTD), 16 March 1992 (1992-03-16) * abstract * -----	1	F01N3/023 F02D41/02
			TECHNICAL FIELDS SEARCHED (IPC)
			F01N F02D
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 23 December 2005	Examiner Tatus, W
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EPO FORM 1503 03.82 (P04C01)

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

EP 05 02 1106

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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23-12-2005

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 04081513 A	16-03-1992	JP 3024780 B2	21-03-2000

EPO FORM P0459

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