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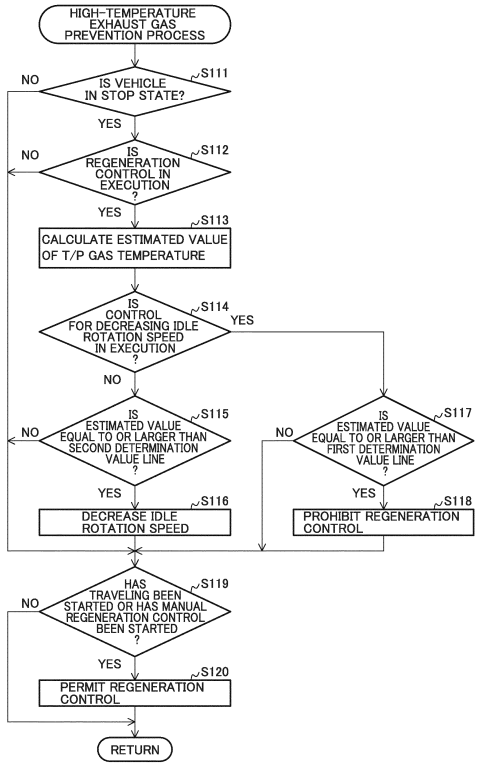
(54) EXHAUST-GAS TREATMENT APPARATUS

(57) An exhaust gas treatment device includes: a filter that collects particulate matter included in exhaust gas flowing through an exhaust passage of an engine mounted on a vehicle; a temperature increasing unit that increases a temperature of the exhaust gas flowing into the filter; and a controller that performs regeneration control for burning the particulate matter accumulated in the filter by the exhaust gas having the temperature increased by the temperature increasing unit. The controller performs control for decreasing an outlet temperature of the exhaust passage (S115 to S118), when the outlet temperature exceeds a determination value as a result of performance of the regeneration control while the vehicle is in a stop state. It is possible to suppress heating of a neighboring object caused by heat for regeneration of a filter, without increasing the manufacturing cost.

FIG.4



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Description

TECHNICAL FIELD

[0001] The present disclosure relates to an exhaust gas treatment device, and particularly to an exhaust gas treatment device including a filter that collects particulate matter (PM) included in exhaust gas flowing through an exhaust passage of an engine.

BACKGROUND ART

[0002] Conventionally, there has been a technique of preventing heating of an obstacle by automatically interrupting forced regeneration of a filter (a PM removal filter, a diesel particulate filter (DPF)) that removes PM, when the obstacle closely faces a tip of an exhaust pipe (refer to, for example, Japanese Patent Laying-Open No. 2005-264774 (hereinafter, referred to as "PTL 1")). PTL 1 discloses that a distance sensor that detects a distance between the tip of the exhaust pipe and the obstacle is provided, and based on an output of the distance sensor, addition of fuel to a diesel oxidation catalyst for supplying reaction heat produced by oxidation of the fuel to the filter is controlled to interrupt regeneration of the filter.

CITATION LIST

PATENT LITERATURE

[0003] PTL 1: Japanese Patent Laying-Open No. 2005-264774

SUMMARY

TECHNICAL PROBLEM

[0004] However, according to the technique in PTL 1, it is necessary to provide the distance sensor, which leads to an increase in manufacturing cost of an exhaust gas treatment device for a vehicle. In addition, when many objects (e.g., vehicles or people) move in the vicinity of the tip of the exhaust pipe, the objects are detected by the distance sensor, which leads to frequent interruption of regeneration of the filter.

[0005] The present disclosure has been made to solve the above-described problem, and an object of the present disclosure is to provide an exhaust gas treatment device that can suppress heating of a neighboring object caused by heat for regeneration of a filter, without increasing the manufacturing cost.

SOLUTION TO PROBLEM

[0006] An exhaust gas treatment device according to the present disclosure includes: a filter that collects particulate matter included in exhaust gas flowing through an exhaust passage of an engine mounted on a vehicle; a temperature increasing unit that increases a temperature of the exhaust gas flowing into the filter; and a controller that performs regeneration control for burning the particulate matter accumulated in the filter by the exhaust gas having the temperature increased by the temperature increasing unit. The controller performs control for decreasing an outlet temperature of the exhaust passage, when the outlet temperature exceeds a determination value as a result of performance of the regeneration control while the vehicle is in a stop state.

[0007] Preferably, the controller suppresses the regeneration control as the control for decreasing the outlet temperature. More preferably, the controller suppresses the regeneration control by prohibiting the regeneration control.

[0008] Preferably, the controller decreases a rotation speed of the engine as the control for decreasing the outlet temperature. More preferably, the controller suppresses the regeneration control as additional control for decreasing the outlet temperature, when the outlet temperature exceeds a determination value higher than the determination value after the rotation speed of the engine is decreased.

[0009] Preferably, the determination value is a value that becomes smaller in accordance with an elapsed time since the vehicle stops. Preferably, the exhaust gas treatment device further includes a temperature sensor provided between the filter in the exhaust passage and an outlet of the exhaust passage and detecting the temperature of the exhaust gas. The controller estimates the outlet temperature from the temperature detected by the temperature sensor.

[0010] Preferably, the temperature increasing unit includes: a fuel addition device provided at a position upstream of the filter in the exhaust passage and adding fuel into the exhaust passage; and a diesel oxidation catalyst provided upstream of the filter and downstream of the fuel addition device in the exhaust passage, and increasing the temperature of the exhaust gas using the fuel added by the fuel addition device.

[0011] Preferably, the controller performs the regeneration control when an amount of accumulation of the particulate matter collected by the filter is larger than a predetermined amount.

[0012] Preferably, when the vehicle moves backward before the vehicle stops, the controller determines whether or not the outlet temperature exceeds the determination value, using a determination value lower than that when the vehicle moves forward before the vehicle stops.

ADVANTAGEOUS EFFECTS

[0013] According to the present disclosure, it is possible to prevent the outlet temperature of the exhaust passage from becoming too high while the vehicle is in a stop state, without providing, for example, a sensor that detects a distance to an object located around the outlet of the exhaust passage. As a result, there can be provid-

ed an exhaust gas treatment device that can suppress heating of a neighboring object caused by heat for regeneration of a filter, without increasing the manufacturing cost.

BRIEF DESCRIPTION OF DRAWINGS

[0014]

Fig. 1 shows a schematic configuration of an engine according to the present embodiment.

Fig. 2 is a flowchart showing a flow of a high-temperature exhaust gas prevention process in a first embodiment.

Fig. 3 is a diagram for illustrating determination of an estimated value of a T/P gas temperature in the first embodiment.

Fig. 4 is a flowchart showing a flow of a high-temperature exhaust gas prevention process in a second embodiment.

Fig. 5 is a diagram for illustrating determination of an estimated value of a T/P gas temperature in the second embodiment.

DESCRIPTION OF EMBODIMENTS

[0015] Embodiments of the present disclosure will be described in detail hereinafter with reference to the drawings, in which the same or corresponding portions are denoted by the same reference characters and description thereof will not be repeated.

[0016] Fig. 1 shows a schematic configuration of an engine 1 according to the present embodiment. In the present embodiment, the engine 1 is described as one example of a diesel engine of common rail type, for example. However, the engine 1 may be another type of diesel engine. The engine 1 is mounted on a vehicle 2, and is coupled to a driving wheel of the vehicle 2 through a transmission and the like (all are not shown) such that an output of the engine 1 can be transmitted to the driving wheel of the vehicle 2.

[0017] The engine 1 includes an engine body 10, an air cleaner 20, an intercooler 26, an intake manifold 28, a diesel throttle valve 29, a turbocharger 30, an exhaust manifold 50, an exhaust gas treatment device 56, an exhaust gas recirculation device (hereinafter, referred to as an EGR device) 60, a controller 200, an engine rotation speed sensor 202, a vehicle speed sensor 204, an accelerator opening degree sensor 205, a water temperature sensor 206, an air flow meter 208, a fuel pump 210, a fuel filter 212, and a fuel tank 214.

[0018] The engine body 10 includes a plurality of cylinders 12, a common rail 14, and a plurality of injectors 16. Although the present embodiment describes an example case in which the engine 1 is an in-line-4 diesel engine, the engine 1 may be an engine having any other cylinder layout (e.g., V-shaped or horizontal layout).

[0019] Each of the plurality of injectors 16 is a fuel injection device provided to a corresponding one of the plurality of cylinders 12 and connected to the common rail 14. Fuel stored in the fuel tank 214 is supplied through the fuel filter 212 to the fuel pump 210 and is pressurized to a predetermined pressure by the fuel pump 210, and subsequently, the pressurized fuel is supplied to the common rail 14. The fuel supplied to the common rail 14 is injected from each of the plurality of injectors 16 at predetermined timing. The plurality of injectors 16 operate based on control signals IJ1 to IJ4 from the controller 200.

[0020] The air cleaner 20 removes foreign matter from the air sucked in from the outside of the engine 1. The air cleaner 20 is connected with one end of a first intake pipe 22.

[0021] The other end of the first intake pipe 22 is connected with an inlet of a compressor 32 of the turbocharger 30. An outlet of the compressor 32 is connected with one end of a second intake pipe 24. The compressor 32 supercharges the air flowing from the first intake pipe 22 and supplies the supercharged air to the second intake pipe 24. A detailed operation of the compressor 32 will be described below.

[0022] The other end of the second intake pipe 24 is connected with one end of the intercooler 26. The intercooler 26 is an air-cooled or water-cooled heat exchanger that cools the air flowing through the second intake pipe 24.

[0023] The other end of the intercooler 26 is connected with one end of a third intake pipe 27. The other end of the third intake pipe 27 is connected with the intake manifold 28. The intake manifold 28 is coupled to an intake port of each of the plurality of cylinders 12 of the engine body 10. The first intake pipe 22, the second intake pipe 24, the third intake pipe 27, the intake manifold 28, and the intake port form "intake passage".

[0024] The diesel throttle valve 29 is provided upstream of the intake manifold 28. The diesel throttle valve 29 is configured such that a degree of opening thereof can be adjusted using a not-shown electrically-powered actuator. The degree of opening of the diesel throttle valve 29 (hereinafter, also referred to as a diesel throttle opening degree) is controlled based on a control signal from the controller 200. In the present embodiment, the diesel throttle opening degree of 100% indicates that the diesel throttle valve 29 is in a fully closed state. Furthermore, in the present embodiment, the diesel throttle opening degree of 0% indicates that the diesel throttle valve 29 is in a fully opened state. After completion of warm-up of the exhaust gas treatment device 56 and during control when the vehicle 2 is not in a deceleration state (hereinafter, referred to as normal control), the diesel throttle opening degree is set to an appropriate degree of opening in accordance with an operation state of the engine 1.

[0025] The exhaust manifold 50 is coupled to an exhaust port of each of the plurality of cylinders 12 of the engine body 10. The exhaust manifold 50 is connected with one end of a first exhaust pipe 52. The other end of

the first exhaust pipe 52 is connected to a turbine 36 of the turbocharger 30. Accordingly, the exhaust gas discharged from the exhaust port of each cylinder is collected in the exhaust manifold 50 and is then supplied through the first exhaust pipe 52 to the turbine 36.

[0026] The turbine 36 is connected with one end of the second exhaust pipe 54. The other end of the second exhaust pipe 54 is connected with an inlet portion of the exhaust gas treatment device 56. The exhaust gas treatment device 56 includes a diesel oxidation catalyst (hereinafter, referred to as DOC) 56a, a PM removal filter 56b, a fuel addition device 56c, a first exhaust gas temperature sensor 56d, a selective catalytic reduction catalyst (SCR catalyst) 56e, a second exhaust gas temperature sensor 56f, an ammonia slip catalyst (ASC) 56g, and a third exhaust gas temperature sensor 56h.

[0027] The PM removal filter 56b is provided on the downstream side of the DOC 56a in a flow path (exhaust passage) of the exhaust gas. The fuel addition device 56c is provided on the upstream side of the DOC 56a in the flow path of the exhaust gas. The first exhaust gas temperature sensor 56d is provided at the PM removal filter 56b. The SCR catalyst 56e is provided on the downstream side of the PM removal filter 56b in the flow path of the exhaust gas. The second exhaust gas temperature sensor 56f is provided between the PM removal filter 56b and the SCR catalyst 56e. The ASC 56g is provided on the downstream side of the SCR catalyst 56e in the flow path of the exhaust gas. The third exhaust gas temperature sensor 56h is provided on the downstream side of the ASC 56g in the flow path of the exhaust gas.

[0028] The PM removal filter 56b collects particulate matter (hereinafter, referred to as PM) included in the circulating exhaust gas. The PM removal filter 56b is made of, for example, ceramic, stainless or the like. The collected PM is accumulated in the PM removal filter 56b.

[0029] The DOC 56a and the fuel addition device 56c function as a regeneration mechanism that burns and removes (regenerates) the PM accumulated in the PM removal filter 56b. When the exhaust gas circulates, the DOC 56a oxidizes nitrogen oxide (NOx), carbon oxide (COx) and the like in the circulating exhaust gas, and oxidizes the fuel when the fuel added by the fuel addition device 56c is included in the exhaust gas. Reaction heat produced by oxidation of the fuel increases a temperature of the exhaust gas passing through the DOC 56a. When the high-temperature exhaust gas passes through the PM removal filter 56b, a temperature of the PM removal filter 56b increases and the PM accumulated in the PM removal filter 56b is oxidized and removed (burned). As a result, the PM removal filter 56b is regenerated. Regeneration control of the PM removal filter 56b is performed when it is determined that an amount of accumulation of the PM becomes larger than a predetermined amount. The determination of the amount of accumulation of the PM can be made using a known method.

[0030] The SCR catalyst 56e is, for example, of monolithic type including multiple through holes (cells) formed in a direction of circulation of the exhaust gas, and is made of cordierite or the like. A wall surface of each cell is provided with a catalytic coating layer and carries, for example, a zeolite-based active component (catalyst). The active component becomes active in response to supply of a reducing agent, and selectively reduces NOx in the exhaust gas.

[0031] A not-shown urea water injection valve is provided on the upstream side of the SCR catalyst 56e. The urea water injection valve injects urea water into the exhaust pipes as a reducing agent. The urea water injected from the urea water injection valve is hydrolyzed by exhaust heat, to thereby produce ammonia. The produced ammonia selectively reacts with NOx in the exhaust gas in the SCR catalyst 56e, to thereby produce nitrogen and water.

[0032] The ASC 56g is a catalyst that oxidizes ammonia escaping from the SCR catalyst and prevents ammonia from being discharged to the atmosphere.

[0033] An outlet portion of the exhaust gas treatment device 56 is connected with one end of the third exhaust pipe 58. The other end of the third exhaust pipe 58 is connected with a muffler or the like. Therefore, the exhaust gas discharged from the turbine 36 is discharged to outside the vehicle 2 through the second exhaust pipe 54, the exhaust gas treatment device 56, the third exhaust pipe 58, and the muffler or the like. The exhaust port, the exhaust manifold 50, the first exhaust pipe 52, the turbine 36, the second exhaust pipe 54, and the third exhaust pipe 58 form "exhaust passage".

[0034] The third intake pipe 27 and exhaust manifold 50 are connected by the EGR device 60, without interposing engine body 10 therebetween. The EGR device 60 includes an EGR valve 62, an EGR cooler 64 and an EGR passage 66. The EGR passage 66 connects the third intake pipe 27 and the exhaust manifold 50. The EGR valve 62 and the EGR cooler 64 are provided partway along the EGR passage 66.

[0035] The EGR valve 62 adjusts a flow rate of the exhaust gas refluxed from the exhaust manifold 50 through the EGR passage 66 of the EGR device 60 to the intake passage (hereinafter, the exhaust gas refluxed to the intake passage will also be referred to as EGR gas), in accordance with a control signal from the controller 200. The EGR cooler 64 is, for example, a water-cooled or air-cooled heat exchanger that cools the EGR gas circulating through the EGR passage 66. The exhaust gas in the exhaust manifold 50 is returned to the intake side through the EGR device 60 as the EGR gas, and thus, a combustion temperature in the cylinders is decreased and an amount of production of NOx is reduced.

[0036] The turbocharger 30 includes the compressor 32 and the turbine 36. A compressor wheel 34 is housed in a housing of the compressor 32, and a turbine wheel 38 is housed in a housing of the turbine 36. The compressor wheel 34 and the turbine wheel 38 are coupled to each other by a connecting shaft 42 and rotate togeth-

er. This allows the compressor wheel 34 to be rotatably driven by the exhaust energy of the exhaust gas supplied to the turbine wheel 38.

[0037] The operation of the engine 1 is controlled by the controller 200. The controller 200 includes a central processing unit (CPU) that performs various processes, a memory including a read only memory (ROM) that stores a program and data, a random access memory (RAM) that stores results of the processes by the CPU, and the like, and input and output ports for exchanging information with the outside (all are not shown). The input port is connected with the above-described sensors (such as, for example, the first exhaust gas temperature sensor 56d, the second exhaust gas temperature sensor 56f, the third exhaust gas temperature sensor 56h, the engine rotation speed sensor 202, the vehicle speed sensor 204, the accelerator opening degree sensor 205, the water temperature sensor 206, and the air flow meter 208). The output port is connected with the devices to be controlled (such as, for example, the plurality of injectors 16, the fuel addition device 56c and the fuel pump 210).

[0038] Based on a signal from each of the sensors and the devices, and a map and a program stored in the memory, the controller 200 controls the devices such that the engine 1 enters a desired operation state. Various types of control can be implemented not only by software but also by dedicated hardware (electronic circuit). In addition, a timer circuit (not shown) for measuring the time is built into the controller 200.

[0039] The first exhaust gas temperature sensor 56d detects a temperature (hereinafter, referred to as a first exhaust gas temperature) Tex1 of the exhaust gas in the PM removal filter 56b. The first exhaust gas temperature sensor 56d transmits a signal indicating the detected first exhaust gas temperature Tex1 to the controller 200.

[0040] The second exhaust gas temperature sensor 56f detects a temperature (hereinafter, referred to as a second exhaust gas temperature) Tex2 of the exhaust gas flowing into the SCR catalyst 56e. The second exhaust gas temperature sensor 56f transmits a signal indicating the detected second exhaust gas temperature Tex2 to the controller 200.

[0041] The third exhaust gas temperature sensor 56h detects a temperature (hereinafter, referred to as a third exhaust gas temperature) Tex3 of the exhaust gas flowing out of the ASC. The third exhaust gas temperature sensor 56h transmits a signal indicating the detected third exhaust gas temperature Tex3 to the controller 200.

[0042] The engine rotation speed sensor 202 detects a rotation speed of a crankshaft of the engine 1 as an engine rotation speed NE. The engine rotation speed sensor 202 transmits a signal indicating the detected engine rotation speed NE to the controller 200.

[0043] The vehicle speed sensor 204 detects a speed (hereinafter, referred to as a vehicle speed) V of the vehicle 2. The vehicle speed sensor 204 transmits a signal indicating the detected vehicle speed V to the controller 200.

[0044] The accelerator opening degree sensor 205 detects a ratio (hereinafter, referred to as an accelerator opening degree) Acc of an amount of pressing an accelerator pedal (not shown) at the present time to an upper limit value of the amount of pressing. The accelerator opening degree sensor 205 transmits a signal indicating the detected accelerator opening degree Acc to the controller 200.

[0045] The water temperature sensor 206 detects a temperature (water temperature) Tw of cooling water circulating through a cooling water passage provided in the engine body 10. The water temperature sensor 206 transmits a signal indicating the detected water temperature Tw to the controller 200.

[0046] The air flow meter 208 detects a flow rate (intake air amount) Qin of new air introduced into the first intake pipe 22. The air flow meter 208 transmits a signal indicating the detected intake air amount Qin to the controller 200.

[0047] The fuel tank 214 stores the fuel to be supplied to the plurality of injectors 16 and the fuel addition device 56c. The fuel pump 210 operates in accordance with a control signal from the controller 200, and transfers the fuel stored in the fuel tank 214 to the common rail 14 and supplies the fuel stored in the fuel tank 214 to the fuel addition device 56c. The fuel filter 212 is provided in a fuel circulating passage between the fuel pump 210 and the fuel tank 214. The fuel filter 212 collects foreign matter included in the circulating fuel.

[Control for Preventing High-Temperature Exhaust Gas]

[0048] In the engine 1 configured as described above, when the regeneration control of the PM removal filter 56b is performed while the vehicle 2 is in a stop state, a neighboring object is heated by the exhaust gas from an exhaust vent.

[0049] Accordingly, in the present embodiment, the controller 200 performs control for decreasing an outlet temperature of the exhaust passage, when the outlet temperature exceeds a determination value as a result of performance of the regeneration control while the vehicle 2 is in a stop state.

[0050] Thus, it is possible to prevent the outlet temperature of the exhaust passage from becoming too high while the vehicle 2 is in a stop state. As a result, heating of a neighboring object by heat for regeneration of the PM removal filter 56b can be suppressed.

(First Embodiment)

[0051] Fig. 2 is a flowchart showing a flow of a high-temperature exhaust gas prevention process in a first embodiment. The high-temperature exhaust gas prevention process is invoked from a main process every predetermined control cycle, and is performed by the controller 200. Referring to Fig. 2, the controller 200 determines whether or not the vehicle 2 is in a stop state,

based on the fact that the vehicle speed V indicated by the signal from the vehicle speed sensor 204 is 0 and the engine rotation speed NE indicated by the signal from the engine rotation speed sensor 202 is not 0 (step (hereinafter, referred to as "S") 101).

[0052] When the controller 200 determines that the vehicle 2 is in a stop state (YES in S101), the controller 200 determines whether or not the regeneration control of the PM removal filter is in execution (S102). During execution of the regeneration control, the controller 200 performs control such that the fuel is added by the fuel addition device 56c of the exhaust gas treatment device 56. Therefore, when the controller 200 performs control such that the fuel is added by the fuel addition device 56c, the controller 200 determines that the regeneration control is in execution.

[0053] When the controller 200 determines that the regeneration control is in execution (YES in S102), the controller 200 calculates an estimated value of a tail pipe (T/P) gas temperature, which is the outlet temperature of the exhaust passage, based on the third exhaust gas temperature Tex3 indicated by the signal from the third exhaust gas temperature sensor 56h (S103).

[0054] The estimated value of the T/P gas temperature may be calculated using any known method, as long as it is calculated using the third exhaust gas temperature Tex3. For example, the estimated value of the T/P gas temperature is calculated by subtracting a temperature loss from the third exhaust gas temperature Tex3, the temperature loss being a temperature loss from the third exhaust gas temperature sensor 56h to the outlet of the exhaust passage. The temperature loss is calculated by subtracting an exhaust pipe wall temperature from the third exhaust gas temperature Tex3, and multiplying the subtraction result by a predetermined coefficient specified based on the third exhaust gas temperature Tex3 and the intake air amount. The predetermined coefficient is obtained by subtracting a reached temperature ratio from 1. The reached temperature ratio is specified using a two-dimensional map that predetermines a reached temperature ratio corresponding to a combination of a value of the third exhaust gas temperature Tex3 and a value of the intake air amount.

[0055] The exhaust pipe wall temperature is calculated by adding a received heat temperature increased by the heat received by the exhaust pipe to an exhaust pipe wall temperature in a previous control cycle, and subtracting a released heat temperature decreased by the heat escaping from the exhaust pipe to the atmosphere. The received heat temperature is calculated by multiplying a temperature loss in the previous control cycle by the intake air amount and the control cycle, and dividing the multiplication result by a weight of an exhaust system through which the exhaust gas flows and specific heat of the exhaust system. The released heat temperature is calculated by multiplying heat release energy by the control cycle, and dividing the multiplication result by the weight of the exhaust system and the specific heat of the exhaust system. The heat release energy is calculated by adding vehicle speed wind heat release energy to a base value of the heat release energy. The base value of the heat release energy is specified using a two-dimensional map that predetermines a base value of heat release energy corresponding to a combination of a value of a temperature difference and a value of the intake air amount, the temperature difference being obtained by subtracting an outdoor air temperature from the exhaust pipe wall temperature in the previous control cycle. The vehicle speed wind heat release energy is specified using a one-dimensional map that predetermines vehicle speed wind heat release energy corresponding to a vehicle speed (when the vehicle speed is 0, the vehicle speed wind heat release energy is 0).

[0056] Since the signal from the third exhaust gas temperature sensor 56h varies to some extent, it is desirable to use the third exhaust gas temperature Tex3 subjected to a smoothing process.

[0057] Alternatively, the estimated value of the T/P gas temperature may be specified using a map that predetermines an estimated value of a T/P gas temperature corresponding to a combination of any of the above-described parameters.

[0058] Next, the controller 200 determines whether or not the calculated estimated value of the T/P gas temperature is equal to or larger than a value on a line indicating a first determination value at the current time (S104).

[0059] Fig. 3 is a diagram for illustrating determination of the estimated value of the T/P gas temperature in the first embodiment. Referring to Fig. 3, a temperature as the first determination value shown by the line indicating the first determination value decreases with an increase in the elapsed time after the vehicle 2 stops in an idle state. Once the temperature decreases to a certain value, the temperature remains at a fixed value regardless of an increase in the elapsed time.

[0060] When the regeneration control of the PM removal filter is performed while the vehicle 2 is in an idle stop state, the estimated value of the T/P gas temperature comes close to the first determination value. In the example shown in Fig. 3, when the elapsed time indicated by a broken line comes, the estimated value of the T/P gas temperature reaches the first determination value.

[0061] Referring again to Fig. 2, when the controller 200 determines that the estimated value of the T/P gas temperature is equal to or larger than the value on the line indicating the first determination value (YES in S104), the controller 200 prohibits the regeneration control of the PM removal filter 56b (S105). Thus, when the regeneration control is in execution, the regeneration control is forcibly ended. As a result, as shown in Fig. 3, the estimated value of the T/P gas temperature decreases and falls below the first determination value.

[0062] When the controller 200 determines that the vehicle 2 is not in a stop state (NO in S101), when the controller 200 determines that the regeneration control

is not in execution (NO in S102), when the controller 200 determines that the estimated value of the T/P gas temperature is not equal to or larger than the value on the line indicating the first determination value (NO in S104), and after S105, the controller 200 determines whether or not traveling of the vehicle 2 has been started or an operation for manually starting the regeneration control of the PM removal filter 56b has been performed (S106).

[0063] When the controller 200 determines that traveling has been started or the operation for starting the regeneration control has been performed (YES in S106), the controller 200 cancels prohibition of, i.e., permits the regeneration control of the PM removal filter 56b (S107). As a result, when a condition for performing the regeneration control is satisfied, the regeneration control is resumed.

[0064] When the controller 200 determines that traveling has not been started or the operation for starting the regeneration control has not been performed (NO in S106), and after S107, the controller 200 returns the process to a process from which the current process is invoked.

(Second Embodiment)

[0065] In the first embodiment, the control for prohibiting the regeneration control of the PM removal filter 56b based on the first determination value is performed as the control for preventing the high-temperature exhaust gas. In a second embodiment, in addition to the control in the first embodiment, control for decreasing the rotation speed of the engine 1 in an idle state based on a second determination value is performed as the control for preventing the high-temperature exhaust gas.

[0066] Fig. 4 is a flowchart showing a flow of a high-temperature exhaust gas prevention process in the second embodiment. The high-temperature exhaust gas prevention process is invoked from a main process every predetermined control cycle, and is performed by the controller 200. Referring to Fig. 4, the processing in S111 to S113 is the same as the processing in S101 to S103 in Fig. 2, respectively, and thus, redundant description will not be repeated.

[0067] After S113, the controller 200 determines whether or not the control for decreasing the rotation speed of the engine 1 in an idle state is in execution (S114). When the controller 200 determines that the control for decreasing the idle rotation speed is not in execution (NO in S114), the controller 200 determines whether or not the calculated estimated value of the T/P gas temperature is equal to or larger than a value on a line indicating the second determination value at the current time (S115).

[0068] Fig. 5 is a diagram for illustrating determination of the estimated value of the T/P gas temperature in the second embodiment. Referring to Fig. 5, similarly to the first determination value, a temperature as the second determination value shown by the line indicating the second determination value decreases with an increase in the elapsed time after the vehicle 2 stops in an idle state. Once the temperature decreases to a certain value, the temperature remains at a fixed value regardless of an increase in the elapsed time. A decreasing portion of the line indicating the second determination value is lower by several tens of degrees Celsius than a decreasing portion of the line indicating the first determination value.

[0069] When the regeneration control of the PM removal filter is performed while the vehicle 2 is in an idle stop state, the estimated value of the T/P gas temperature comes close to the second determination value and the first determination value. In the example shown in Fig. 5, when the elapsed time in a first phase indicated by a broken line comes, the estimated value of the T/P gas temperature reaches the second determination value. When the elapsed time in a second phase indicated by a broken line comes, the estimated value of the T/P gas temperature reaches the first determination value.

[0070] Referring again to Fig. 4, when the controller 200 determines that the estimated value of the T/P gas temperature is equal to or larger than the value on the line indicating the second determination value (YES in S115), the controller 200 starts to perform the control for decreasing the rotation speed of the engine in an idle state (S116). As a result, the energy of the exhaust gas per unit time decreases, and thus, a decrease in the estimated value of the T/P gas temperature is expected. Unlike the first embodiment, the rotation speed of the engine in an idle state is first decreased, and thus, prohibition of the regeneration control of the PM removal filter 56b can be delayed even slightly.

[0071] When the controller 200 determines that the control for decreasing the idle rotation speed is in execution (YES in S114), the controller 200 performs the processing in S117. Since the processing in S117 and S118 is the same as the processing in S104 and S105 in Fig. 2, respectively, redundant description will not be repeated.

[0072] When the controller 200 determines that the vehicle 2 is not in a stop state (NO in S111), when the controller 200 determines that the regeneration control is not in execution (NO in S112), when the controller 200 determines that the estimated value of the T/P gas temperature is not equal to or larger than the value on the line indicating the second determination value (NO in S115), after S116, when the controller 200 determines that the estimated value of the T/P gas temperature is not equal to or larger than the value on the line indicating the first determination value (NO in S117), and after S118, the controller 200 performs the processing in S119. Since the processing in S119 and S120 is the same as the processing in S106 and S107 in Fig. 2, respectively, redundant description will not be repeated.

[Modifications]

[0073]

(1) In the above-described embodiments, as shown by S103 in Fig. 2 and S113 in Fig. 4, the estimated value of the T/P gas temperature is calculated based on the third exhaust gas temperature Tex3, which is the temperature of the exhaust gas flowing out of the ASC 56g. However, the present disclosure is not limited thereto. The estimated value of the T/P gas temperature may be calculated based on a signal from another temperature sensor. For example, the estimated value of the T/P gas temperature may be calculated based on the first exhaust gas temperature Tex1, which is the temperature of the exhaust gas in the PM removal filter 56b, or may be calculated based on the second exhaust gas temperature Tex2, which is the temperature of the exhaust gas flowing into the SCR catalyst 56e.

However, it is preferable to calculate the T/P gas temperature based on a temperature indicated by a signal from a temperature sensor located at the rearmost end of the exhaust passage closest to the outlet of the exhaust passage. Therefore, in the above-described embodiments, it is preferable to calculate the T/P gas temperature based on the third exhaust gas temperature Tex3.

Alternatively, a temperature sensor may be provided at another portion of the exhaust passage and the estimated value of the T/P gas temperature may be calculated based on a signal from this temperature sensor. Alternatively, a temperature sensor may be provided at the outlet of the exhaust passage and the T/P gas temperature itself may be calculated based on a signal from this temperature sensor.

(2) In the above-described embodiments, as shown in Figs. 3 and 5, the estimated value of the T/P gas temperature is determined using one map. However, the present disclosure is not limited thereto. The estimated value of the T/P gas temperature may be determined using different maps between when the vehicle 2 moves backward before the vehicle 2 stops and when the vehicle 2 moves forward before the vehicle 2 stops. It is conceivable that a distance from an object located around the exhaust vent at the outlet of the exhaust passage is longer when the vehicle 2 moves forward and then stops than when the vehicle 2 moves backward and then stops. Therefore, when the vehicle 2 moves forward and then stops, a determination value (determination value higher than the first determination value and the second determination value) under a condition that is more moderate than those of the first determination value and the second determination value shown in Figs. 3 and 5 can be used. Thus, the regeneration control of the PM removal filter 56b can be further continued.

(3) In the above-described embodiments, as shown by S105 in Fig. 2 and S118 in Fig. 4, the regeneration control of the PM removal filter 56b is prohibited. However, the present disclosure is not limited thereto. The regeneration control of the PM removal filter 56b may be suppressed, as long as the T/P gas temperature decreases. For example, a temperature in the regeneration control may be changed from a high temperature to a minimum temperature that allows regeneration.

(4) In the above-described embodiments, the regeneration control is suppressed by prohibiting the regeneration control, when the estimated value of the T/P gas temperature becomes equal to or larger than the determination value. However, the present disclosure is not limited thereto. The regeneration control may be suppressed in stages in accordance with a difference between the estimated value of the T/P gas temperature and the determination value. For example, the temperature in the regeneration control may be made lower when the difference between the estimated value of the T/P gas temperature and the determination value is small than when the difference between the estimated value of the T/P gas temperature and the determination value is large.

(5) In the above-described embodiments, the exhaust gas treatment device 56 is controlled by the controller 200. This implies that a controller of the exhaust gas treatment device 56 is included in the controller 200. Alternatively, separately from the controller 200, a controller dedicated to the exhaust gas treatment device 56 may be provided.

(6) The above-described embodiments can be understood as disclosure of the exhaust gas treatment device 56. The above-described embodiments can also be understood as disclosure of the controller 200 of the exhaust gas treatment device 56 or disclosure of a method for controlling the exhaust gas treatment device 56. The above-described embodiments can also be understood as disclosure of the engine 1 or the vehicle 2.

[Effects]

[0074]

(1) As described with reference to Fig. 1, the exhaust gas treatment device 56 includes: the PM removal filter 56b that collects particulate matter included in exhaust gas flowing through the exhaust passage of the engine 1 mounted on the vehicle 2; the temperature increasing unit that increases a temperature of the exhaust gas flowing into the PM removal filter 56b; and the controller 200 that performs regeneration control for burning the particulate matter accumulated in the PM removal filter 56b by the exhaust gas having the temperature increased by the temperature increasing unit. As shown by S101 to S105 in Fig. 2 and S111 to S118 in Fig. 4, the controller 200 performs control for decreasing the T/P gas temperature (e.g., regeneration control of the PM removal filter 56b, control for decreasing the rotation speed of the engine 1 in an idle state), when the outlet tem-

perature of the exhaust passage exceeds the first determination value or the second determination value as a result of performance of the regeneration control while the vehicle 2 is in a stop state.

Such a configuration makes it possible to prevent the outlet temperature of the exhaust passage from becoming too high while the vehicle 2 is in a stop state, without providing, for example, a sensor that detects a distance to an object located around the outlet of the exhaust passage. As a result, it is possible to suppress heating of a neighboring object caused by heat for regeneration of the PM removal filter 56b, without increasing the manufacturing cost.

(2) As shown by S105 in Fig. 2 and S118 in Fig. 4, the controller 200 suppresses the regeneration control of the PM removal filter 56b as the control for decreasing the T/P gas temperature. This makes it possible to suppress the outlet temperature of the exhaust passage.

(3) As shown by S105 in Fig. 2 and S118 in Fig. 4, the controller 200 suppresses the regeneration control of the PM removal filter 56b by prohibiting the regeneration control of the PM removal filter 56b. This makes it possible to significantly decrease the outlet temperature of the exhaust passage.

(4) As shown by S116 in Fig. 4, the controller 200 decreases a rotation speed of the engine 1 as the control for decreasing the outlet temperature. This makes it possible to continue the regeneration control of the PM removal filter 56b as long as possible.

(5) As shown by S117 and S118 in Fig. 4, the controller 200 suppresses the regeneration control of the PM removal filter 56b as additional control for decreasing the outlet temperature, when the outlet temperature exceeds the first determination value higher than the second determination value after the rotation speed of the engine 1 is decreased. This makes it possible to suppress heating of a neighboring object while continuing the regeneration control of the PM removal filter 56b as long as possible.

(6) As shown in Figs. 3 and 5, each of the first determination value and the second determination value is a value that becomes smaller in accordance with an elapsed time since the vehicle 2 stops. As the elapsed time since the vehicle 2 stops becomes longer, the heating time of a neighboring object becomes longer. Thus, by making the determination value smaller in accordance with the elapsed time since the vehicle 2 stops, appropriate determination can be made in accordance with the heating time.

(7) As shown in Fig. 1, the exhaust gas treatment device 56 further includes the third exhaust gas temperature sensor 56h provided between the PM removal filter 56b in the exhaust passage and an outlet of the exhaust passage and detecting the temperature of the exhaust gas. The controller 200 estimates the outlet temperature from the third exhaust gas temperature Tex3 detected by the third exhaust gas temperature sensor 56h. This makes it possible to appropriately estimate the outlet temperature.

(8) As shown in Fig. 1, the temperature increasing unit includes: the fuel addition device 56c provided at a position upstream of the PM removal filter 56b in the exhaust passage and adding fuel into the exhaust passage; and the diesel oxidation catalyst 56a provided upstream of the PM removal filter 56b and downstream of the fuel addition device 56c in the exhaust passage, and increasing the temperature of the exhaust gas using the fuel added by the fuel addition device 56c. This makes it possible to efficiently perform the regeneration control of the PM removal filter 56b.

(9) As described with reference to Fig. 1, the controller 200 performs the regeneration control of the PM removal filter 56b when an amount of accumulation of the particulate matter collected by the PM removal filter 56b is larger than a predetermined amount. This makes it possible to appropriately perform the regeneration control of the PM removal filter 56b.

(10) As described in the modifications, when the vehicle 2 moves backward before the vehicle 2 stops, the controller 200 determines whether or not the outlet temperature exceeds the determination value, using a determination value lower than that when the vehicle 2 moves forward before the vehicle 2 stops. It is conceivable that a distance from an object located around the exhaust vent at the outlet of the exhaust passage is longer when the vehicle 2 moves forward and then stops than when the vehicle 2 moves backward and then stops. Therefore, when the vehicle 2 moves backward and then stops, a determination value (determination value lower than the first determination value and the second determination value) under a condition that is stricter than those of the first determination value and the second determination value shown in Figs. 3 and 5 is used. Thus, the regeneration control of the PM removal filter 56b can be further continued.

[0075] The embodiments disclosed herein are also planned to be combined together as appropriate for implementation. It should be understood that the embodiments disclosed herein are illustrative and non-restrictive in every respect. The scope of the present disclosure is defined by the terms of the claims, rather than the description of the embodiments above, and is intended to include any modifications within the scope and meaning equivalent to the terms of the claims.

REFERENCE SIGNS LIST

[0076] 1 engine; 2 vehicle; 10 engine body; 12 cylinder; 14 common rail; 16 injector; 20 air cleaner; 22 first intake pipe; 24 second intake pipe; 26 intercooler; 27 third intake pipe; 28 intake manifold; 29 diesel throttle valve; 30 tur-

bocharger; 32 compressor; 34 compressor wheel; 36 turbine; 38 turbine wheel; 42 connecting shaft; 50 exhaust manifold; 52 first exhaust pipe; 54 second exhaust pipe; 56 exhaust gas treatment device; 56a diesel oxidation catalyst; 56b PM removal filter; 56c fuel addition device; 56d first exhaust gas temperature sensor; 56e SCR catalyst; 56f second exhaust gas temperature sensor; 56h third exhaust gas temperature sensor; 58 third exhaust pipe; 60 EGR device; 62 EGR valve; 64 EGR cooler; 66 EGR passage; 200 controller; 202 engine rotation speed sensor; 204 vehicle speed sensor; 205 accelerator opening degree sensor; 206 water temperature sensor; 208 air flow meter; 210 fuel pump; 212 fuel filter; 214 fuel tank.

Claims

1. An exhaust gas treatment device comprising:

a filter that collects particulate matter included in exhaust gas flowing through an exhaust passage of an engine mounted on a vehicle;
a temperature increasing unit that increases a temperature of the exhaust gas flowing into the filter; and
a controller that performs regeneration control for burning the particulate matter accumulated in the filter by the exhaust gas having the temperature increased by the temperature increasing unit, wherein
the controller performs control for decreasing an outlet temperature of the exhaust passage, when the outlet temperature exceeds a determination value as a result of performance of the regeneration control while the vehicle is in a stop state.

2. The exhaust gas treatment device according to claim 1, wherein
the controller suppresses the regeneration control as the control for decreasing the outlet temperature.

3. The exhaust gas treatment device according to claim 2, wherein
the controller suppresses the regeneration control by prohibiting the regeneration control.

4. The exhaust gas treatment device according to claim 1, wherein
the controller decreases a rotation speed of the engine as the control for decreasing the outlet temperature.

5. The exhaust gas treatment device according to claim 4, wherein
the controller suppresses the regeneration control as additional control for decreasing the outlet temperature, when the outlet temperature exceeds a determination value higher than the determination value after the rotation speed of the engine is decreased.

6. The exhaust gas treatment device according to claim 1, wherein
the determination value is a value that becomes smaller in accordance with an elapsed time since the vehicle stops.

7. The exhaust gas treatment device according to claim 1, further comprising
a temperature sensor provided between the filter in the exhaust passage and an outlet of the exhaust passage and detecting the temperature of the exhaust gas, wherein
the controller estimates the outlet temperature from the temperature detected by the temperature sensor.

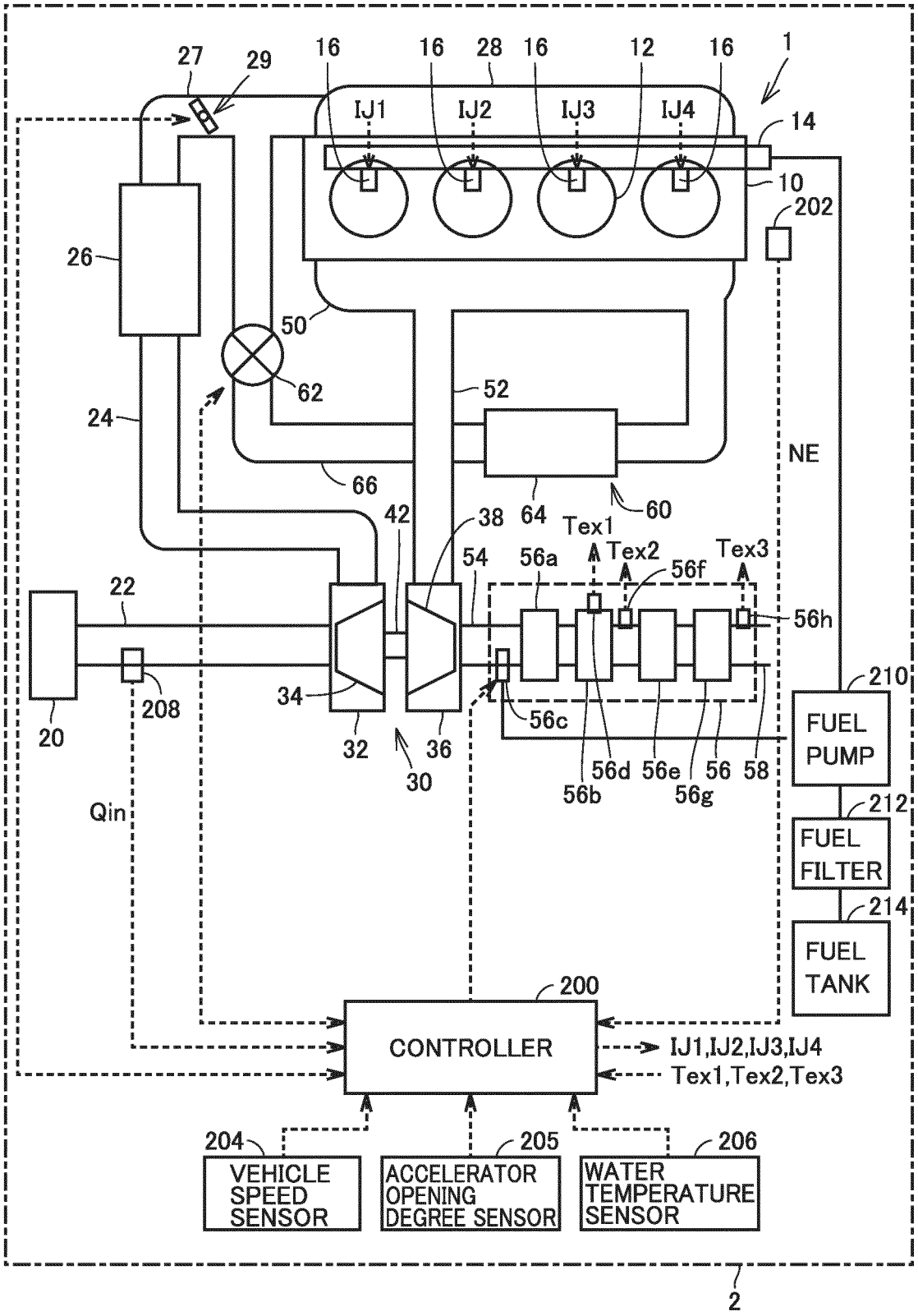
8. The exhaust gas treatment device according to claim 1, wherein
the temperature increasing unit includes:

a fuel addition device provided at a position upstream of the filter in the exhaust passage and adding fuel into the exhaust passage; and
a diesel oxidation catalyst provided upstream of the filter and downstream of the fuel addition device in the exhaust passage, and increasing the temperature of the exhaust gas using the fuel added by the fuel addition device.

9. The exhaust gas treatment device according to claim 1, wherein
the controller performs the regeneration control when an amount of accumulation of the particulate matter collected by the filter is larger than a predetermined amount.

10. The exhaust gas treatment device according to claim 1, wherein
when the vehicle moves backward before the vehicle stops, the controller determines whether or not the outlet temperature exceeds the determination value, using a determination value lower than that when the vehicle moves forward before the vehicle stops.

FIG.1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56a
56b
56c
56d
56e
56f
56g
56h
58
60
62
64
66
200
202
204
205
206
208
210
212
214
IJ1
IJ2
IJ3
IJ4
NE
Qin
Tex1
Tex2
Tex3
CONTROLLER
IJ1,IJ2,IJ3,IJ4
Tex1,Tex2,Tex3
VEHICLE SPEED SENSOR
ACCELERATOR OPENING DEGREE SENSOR
WATER TEMPERATURE SENSOR
FUEL PUMP
FUEL FILTER
FUEL TANK

FIG.2

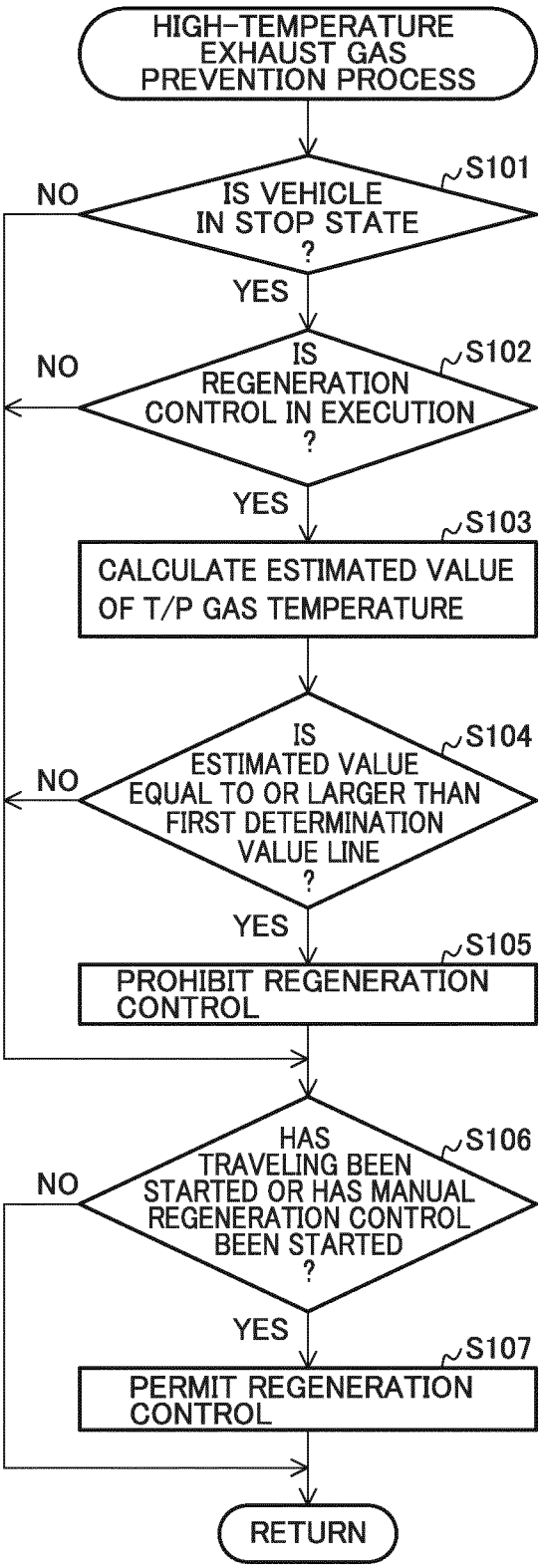

HIGH-TEMPERATURE EXHAUST GAS PREVENTION PROCESS
S101
IS VEHICLE IN STOP STATE ?
NO
YES
S102
IS REGENERATION CONTROL IN EXECUTION ?
NO
YES
S103
CALCULATE ESTIMATED VALUE OF T/P GAS TEMPERATURE
S104
IS ESTIMATED VALUE EQUAL TO OR LARGER THAN FIRST DETERMINATION VALUE LINE ?
NO
YES
S105
PROHIBIT REGENERATION CONTROL
S106
HAS TRAVELING BEEN STARTED OR HAS MANUAL REGENERATION CONTROL BEEN STARTED ?
NO
YES
S107
PERMIT REGENERATION CONTROL
RETURN

FIG.3

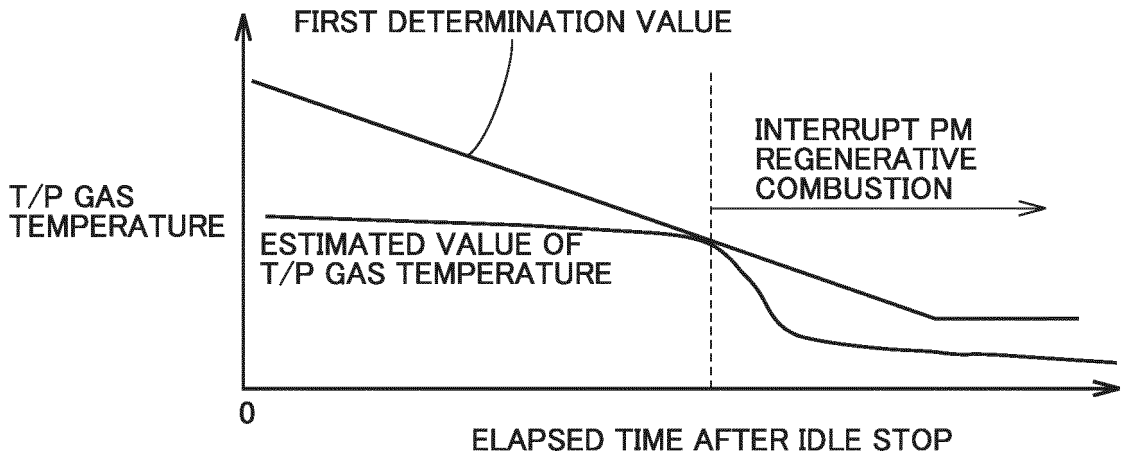

FIRST DETERMINATION VALUE
INTERRUPT PM REGENERATIVE COMBUSTION
T/P GAS TEMPERATURE
ESTIMATED VALUE OF T/P GAS TEMPERATURE
0
ELAPSED TIME AFTER IDLE STOP

FIG.4

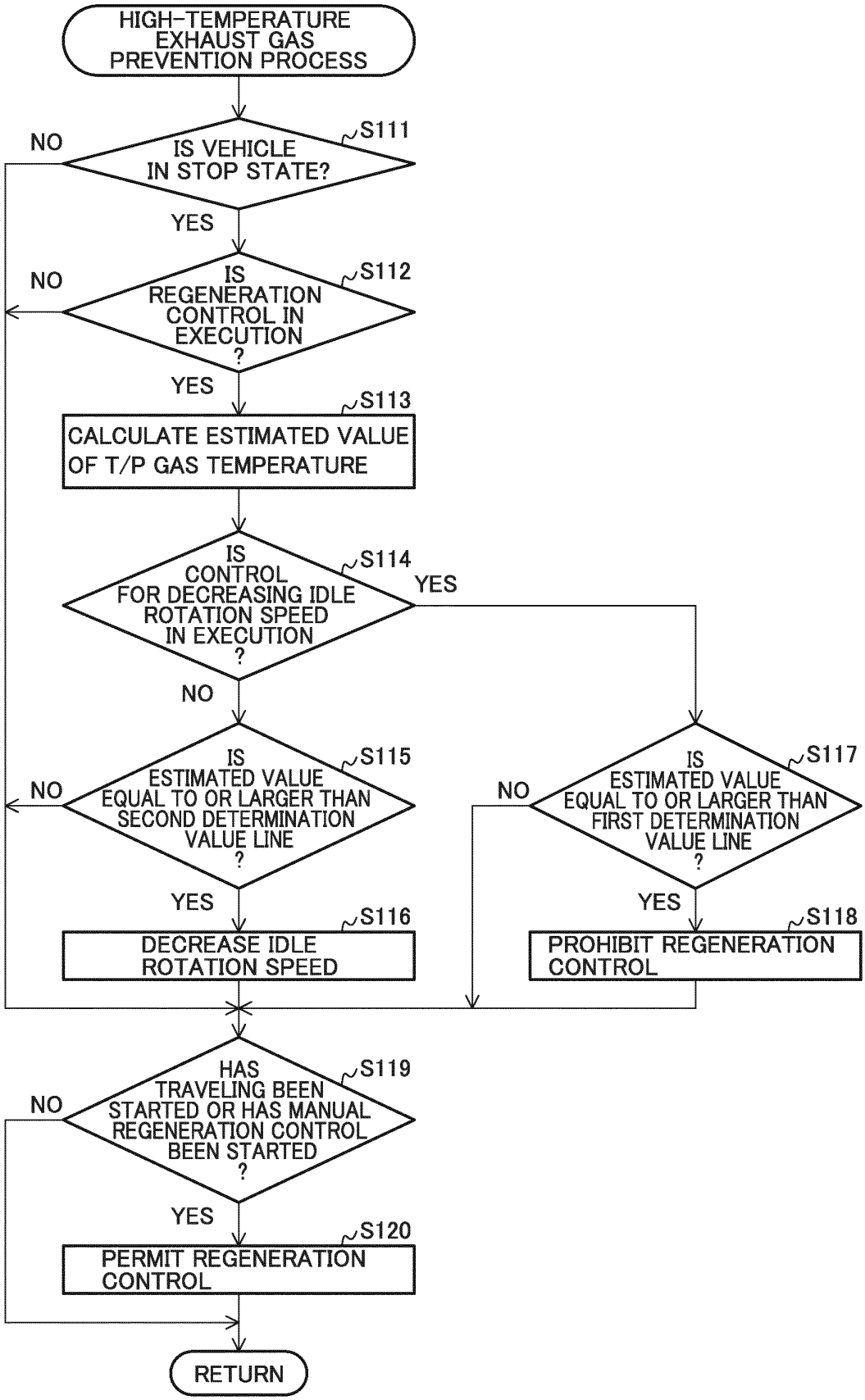
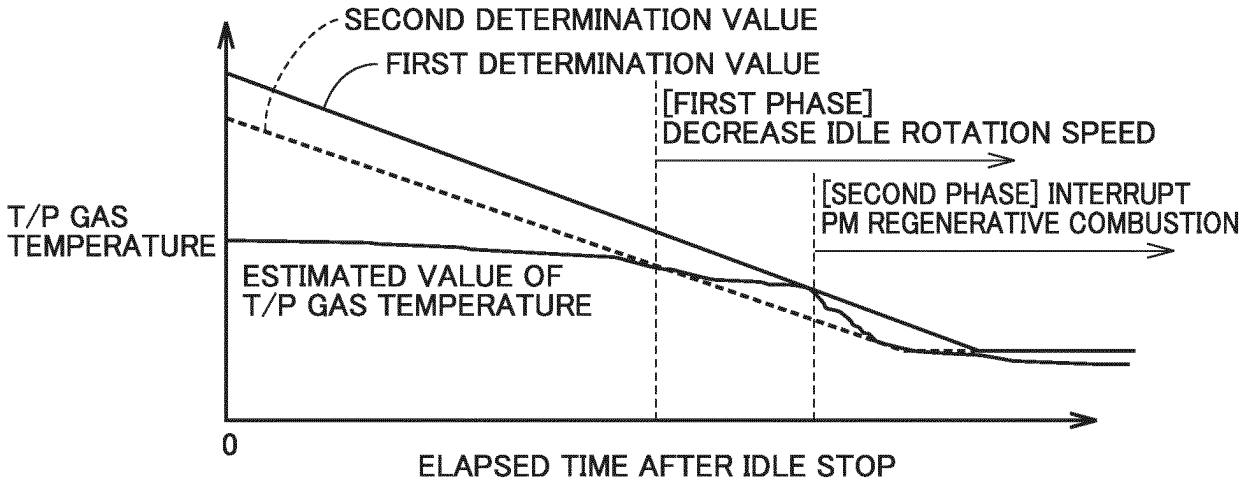

HIGH-TEMPERATURE EXHAUST GAS PREVENTION PROCESS
S111
IS VEHICLE IN STOP STATE?
NO
YES
S112
IS REGENERATION CONTROL IN EXECUTION ?
NO
YES
S113
CALCULATE ESTIMATED VALUE OF T/P GAS TEMPERATURE
S114
IS CONTROL FOR DECREASING IDLE ROTATION SPEED IN EXECUTION ?
YES
NO
S115
IS ESTIMATED VALUE EQUAL TO OR LARGER THAN SECOND DETERMINATION VALUE LINE ?
NO
YES
S116
DECREASE IDLE ROTATION SPEED
S117
IS ESTIMATED VALUE EQUAL TO OR LARGER THAN FIRST DETERMINATION VALUE LINE ?
NO
YES
S118
PROHIBIT REGENERATION CONTROL
S119
HAS TRAVELING BEEN STARTED OR HAS MANUAL REGENERATION CONTROL BEEN STARTED ?
NO
YES
S120
PERMIT REGENERATION CONTROL
RETURN

FIG.5


SECOND DETERMINATION VALUE
FIRST DETERMINATION VALUE
[FIRST PHASE]
DECREASE IDLE ROTATION SPEED
[SECOND PHASE] INTERRUPT
PM REGENERATIVE COMBUSTION
T/P GAS
TEMPERATURE
ESTIMATED VALUE OF
T/P GAS TEMPERATURE
0
ELAPSED TIME AFTER IDLE STOP

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2019/027184

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. F01N3/025(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)
Int.Cl. F01N3/025

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2019
Registered utility model specifications of Japan	1996-2019
Published registered utility model applications of Japan	1994-2019

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2015-121199 A (TOYOTA MOTOR CORP.) 02 July 2015, paragraphs [0018]-[0085], fig. 1-10 & WO 2015/097520 A1, paragraphs [0017]-[0084], fig. 1-10	1-3, 7-9 4
Y	JP 3-67013 A (MAZDA MOTOR CORPORATION) 22 March 1991, page 5, lower left column, lines 15-19 (Family: none)	4
A	JP 2005-264774 A (HINO MOTORS, LTD.) 29 September 2005, paragraphs [0011]-[0021], fig. 1-3 (Family: none)	1-10
PX	JP 2018-145837 A (HINO MOTORS, LTD.) 20 September 2018, paragraphs [0014]-[0060], fig. 1-5 (Family: none)	1-3, 7, 9

☐ 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
03 September 2019 (03.09.2019)	10 September 2019 (10.09.2019)

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

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2005264774 A **[0002] [0003]**