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

(11) **EP 4 549 721 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
07.05.2025 Bulletin 2025/19

(21) Application number: **24210115.2**

(22) Date of filing: **31.10.2024**

(51) International Patent Classification (IPC):
F02D 41/10 (2006.01) ***F02D 41/12*** (2006.01)
F02D 41/14 (2006.01) ***F02D 41/30*** (2006.01)
F02D 31/00 (2006.01) ***F02D 41/00*** (2006.01)
F02D 41/02 (2006.01)

(52) Cooperative Patent Classification (CPC):
F02D 41/1454; F02D 31/009; F02D 41/0097; F02D 41/10; F02D 41/123; F02D 41/126; F02D 41/1475; F02D 41/30; F02D 2041/0265; F02D 2200/101; F02D 2200/1012

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
GE KH MA MD TN

(30) Priority: **02.11.2023 JP 2023188946**

(71) Applicant: **Yamaha Hatsudoki Kabushiki Kaisha**
Iwata-shi, Shizuoka 438-8501 (JP)

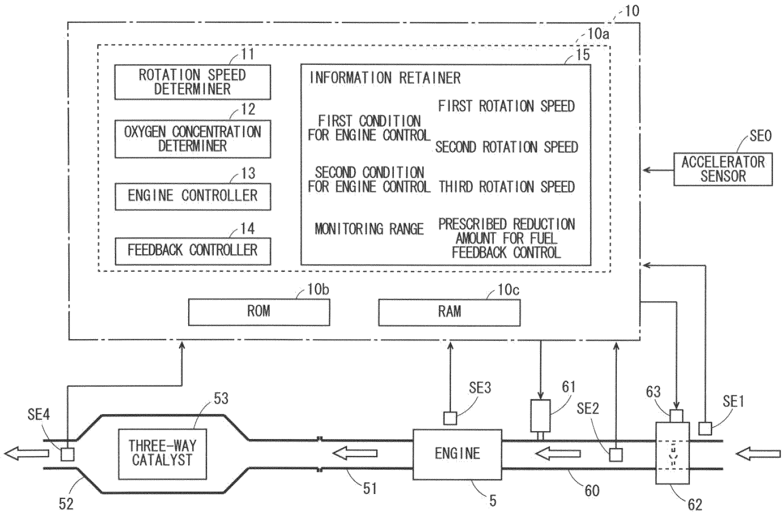
(72) Inventor: **MATSUNAGA, Kazuya**
Iwata-shi, 4388501 (JP)

(74) Representative: **Studio Torta S.p.A.**
Via Viotti, 9
10121 Torino (IT)

(54) **FUEL ADJUSTMENT DEVICE AND VEHICLE**

(57) There is disclosed a fuel adjustment device, including an ECU (10) and a catalyst (53) downstream oxygen sensor (SE4); ECU (10) controlling a fuel injection device (61) that causes an engine (5) to work; the catalyst downstream oxygen sensor (SE4) being provided downstream of a three-way catalyst (53) in an exhaust system attached to engine (5) and detects an oxygen concentration of an exhaust gas; ECU (10) adjusting a fuel supply amount such that an engine rotation speed decreases when the engine rotation speed reaches a first rotation speed (rs1); the first rotation speed (ra1) being the rotation speed corresponding to overspeeding; when the engine rotation speed decreases and reaches a second rotation speed (rs2), an amount of fuel being supplied to engine (5) is changed back to a normal amount; thereafter, when the engine rotation speed is continuously maintained in a monitoring range, the fuel supply amount being adjusted based on a detection result of the catalyst downstream oxygen sensor (SE4); the monitoring range is a range that includes the second rotation speed (rs2) and is lower than the first rotation speed (rs1).

FIG.2



EP 4 549 721 A1

Description

Technical Field

[0001] The present disclosure relates to a fuel adjustment device and a vehicle that adjust an amount of fuel to be supplied to an engine.

Prior Art

[0002] The control for stopping the supply of fuel to an engine (hereinafter referred to as over-Rev limit control) in order to prevent an engine rotation speed from becoming excessively high is known. In the over-Rev limit control, because the engine rotation speed reaches a predetermined first rotation speed, for example, the supply of fuel to the engine is stopped. Thereafter, the engine rotation speed decreases to a predetermined second rotation speed lower than the first rotation speed, so that the supply of fuel to the engine is resumed.

[0003] Suppose that a throttle valve is maintained fully opened after the over-Rev limit control, for example. In this case, the engine rotation speed increases from the second rotation speed and reaches the first rotation speed again. Thus, the over-Rev limit control is executed again, and the supply of fuel to the engine is stopped. In this manner, the repetition of the stop of the supply of fuel to the engine and the restart of the supply of fuel to the engine may increase the temperature of a catalyst provided in an exhaust system of the engine and promote deterioration of the catalyst.

[0004] JP 2012-241691 A describes a fuel supply device that supplies fuel such that an air-fuel ratio of gas flowing into a three-way catalyst is leaner than a theoretical air-fuel ratio after restart of the supply of fuel to an engine, in order to suppress an increase in temperature of the catalyst caused by repetition of the above-mentioned over-Rev limit control. However, in practice, it is difficult to appropriately adjust an amount of fuel to be supplied to the engine without causing misfiring of the engine.

Description of the invention

[0005] An object of the present disclosure is to provide a fuel adjustment device and a vehicle that can appropriately prevent shortening of service life of a catalyst caused by suppression of overspeeding of an engine.

[0006] A fuel adjustment device according to one aspect of the present disclosure includes a controller that controls an engine driver that causes an engine to work, and an oxygen sensor that is provided downstream of a catalyst that cleans an exhaust gas in an exhaust system attached to the engine, and detects an oxygen concentration of the exhaust gas, wherein the engine driver includes a fuel supplier that supplies fuel to the engine, the controller, when a rotation speed of the engine reaches a first rotation speed due to an increase in rotation speed of the engine with the engine driver working according to a first condition, causes the engine driver to work according to a second condition different from the first condition such that the rotation speed of the engine decreases, when the rotation speed of the engine reaches a second rotation speed lower than the first rotation speed from the first rotation speed with the engine driver working according to the second condition, changes back a working condition of the engine driver from the second condition to the first condition, when the rotation speed of the engine is continuously maintained in a monitoring range from a point in time at which the working condition of the engine driver is changed back from the second condition to the first condition, adjusts a fuel supply amount of the fuel supplier based on a detection result of the oxygen sensor, and the monitoring range is a range that includes the second rotation speed and is lower than the first rotation speed.

[0007] A vehicle according to another aspect of the present disclosure includes an engine, an exhaust system, a catalyst provided in the exhaust system, an engine driver, the above-mentioned fuel adjustment device, and a drive wheel driven by the engine.

[0008] With the present disclosure, it is possible to appropriately prevent shortening of the service life of a catalyst caused by suppression of overspeeding of an engine.

[0009] Other features, elements, characteristics, and advantages of the present disclosure will become more apparent from the following description of preferred embodiments of the present disclosure with reference to the attached drawings.

Brief Description of the drawings

[0010]

Fig. 1 is a right side view of a motorcycle according to one embodiment of the present disclosure;

Fig. 2 is a block diagram showing the control system of the motorcycle of Fig. 1;

Fig. 3 is a flowchart of a fuel adjustment process according to one embodiment of the present disclosure;

Fig. 4 is a flowchart showing the details of a process to be executed in a CPU of Fig. 2 when fuel feedback control is turned ON; and

Fig. 5 is a time chart for explaining a specific work example of an engine in the fuel adjustment process of Fig. 3.

Embodiments of the invention

[0011] A fuel adjustment device and a vehicle including the fuel adjustment device according to one embodiment of the present disclosure be described below with reference to the drawings. A motorcycle will be described as one example of the vehicle.

1. Outline of Configuration of Motorcycle

[0012] Fig. 1 is a right side view of the motorcycle according to one embodiment of the present disclosure. In Fig. 1, the motorcycle 100 standing up to be perpendicular to the road surface is shown. The motorcycle 100 of Fig. 1 includes a metallic body frame 1. The body frame 1 includes a head pipe 1h and a plurality of frame members. The head pipe 1h is located in a front portion of the vehicle, and the plurality of frame members are provided to extend toward a rear portion of the vehicle from the head pipe 1h.

[0013] A front fork 2 is provided at the head pipe 1h to be rotatable about the central axis of the head pipe 1h. A front wheel 3 is rotatably supported at the lower end of the front fork 2. A handle 4 is provided at the upper end of the front fork 2. An accelerator grip 4g is provided at the handle 4 to be operable by a rider.

[0014] The body frame 1 supports an engine 5 such that the engine 5 is located at a position farther downward than the head pipe 1h. In the present embodiment, the engine 5 is provided integrally with a transmission (not shown) and forms an engine unit. Further, the body frame 1 supports a fuel tank 8 such that the fuel tank 8 is located at a position farther upward than the engine 5 and farther rearward than the head pipe 1h. Further, the body frame 1 supports a seat 9 such that the seat 9 is located at a position farther rearward than the fuel tank 8.

[0015] An ECU (Electronic Control Unit) 10 is provided to be surrounded by the engine 5, the fuel tank 8 and the seat 9. The ECU 10 includes a CPU (Central Processing Unit) 10a (Fig. 2), a ROM (Read Only Memory) 10b (Fig. 2) and a RAM (Random Access Memory) 10c (Fig. 2). The ROM 10b is made of a nonvolatile memory, for example, and stores a system program, a fuel adjustment program, the information associated with these programs, and the like. The RAM 10c is made of a volatile memory, for example, is used as a working area for the CPU 10a and temporarily stores various data. The CPU 10a executes the fuel adjustment program stored in the ROM 10b to implement various functions. Details of various functions implemented by the CPU 10a will be described below.

[0016] The fuel adjustment program in the present embodiment may be provided in the form of being stored in a computer-readable recording medium and may be installed in a storage device connectable to the ROM 10b or the ECU 10. Further, in a case in which the ECU 10 is connectable to a communication network, the fuel adjustment program delivered from a server connected to the communication network may be installed in the ROM 10b or the storage device with the ECU 10 connected to the communication network.

[0017] A rear arm 6 is provided to extend rearwardly from a lower portion at the center of the body frame 1 in a forward-and-rearward direction of the motorcycle 100. The rear arm 6 is supported at the body frame 1 with use of a pivot shaft (not shown). A rear wheel 7 is rotatably supported at the rear end of the rear arm 6. The rear wheel 7 is rotated as a drive wheel by motive power generated by the engine 5.

[0018] The engine 5 has an intake port for supplying an air-fuel mixture into a combustion chamber and an exhaust port for exhausting a combusted gas from the combustion chamber. An intake pipe 60 is connected to the intake port of the engine 5. A fuel injection device 61 (Fig. 2) and a throttle valve 62 (Fig. 2) are provided at the intake pipe 60. One end of an exhaust pipe 51 is connected to the exhaust port of the engine 5. A muffler 52 is connected to the other end of the exhaust pipe 51. A three-way catalyst 53 is arranged in the muffler 52. The three-way catalyst 53 cleans an exhaust gas exhausted from the engine 5. The three-way catalyst 53 may be provided in the exhaust pipe 51 instead of the muffler 52.

2. Over-Rev Limit Control and Fuel Feedback Control

[0019] In the motorcycle 100 according to the present embodiment, the over-Rev limit control described in the background art is executed to prevent the rotation speed of the engine 5 (engine rotation speed) from becoming excessively high. Specifically, in the present embodiment, as the over-Rev limit control, in a case in which the engine rotation speed reaches a first rotation speed due to an increase in engine rotation speed, the supply of fuel to the engine 5 is stopped until the engine rotation speed decreases to a second rotation speed lower than the first rotation speed. The first rotation speed and the second rotation speed are defined according to the type of the engine 5 such that the engine 5 is not damaged or the engine 5 does not malfunction due to an excessive increase in rotation speed.

[0020] Suppose that the throttle valve 62 is maintained fully opened after the over-Rev limit control, for example. In this case, the supply of fuel to the engine 5 is resumed, so that the engine rotation speed increases. Thus, when the engine rotation speed reaches the first rotation speed, the over-Rev limit control is executed again.

[0021] In a case in which fuel is not supplied to the engine 5 during the over-Rev limit control, the gas exhausted from the engine 5 (exhaust gas) includes a large amount of oxygen. Thus, in the three-way catalyst 53, oxygen in the exhaust gas is occluded in the three-way catalyst 53 by reduction reaction. On the other hand, when a large amount of fuel is supplied to the engine 5 after the over-Rev limit control, an amount of oxygen included in the exhaust gas decreases. Thus, in the three-way catalyst 53, occluded oxygen is released from the three-way catalyst 53 due to oxidation reaction.

[0022] When an increase in engine rotation speed, and a decrease in engine rotation speed caused by the over-Rev limit control are repeated at a short cycle, the oxygen concentration of the exhaust gas of the engine 5 may largely and regularly change as described above. In other words, the air-fuel ratio of the exhaust gas of the engine 5 may largely and regularly change. In this case, strong reduction reaction and strong oxidation reaction repeatedly occur in the three-way catalyst 53. Thus, the temperature of the three-way catalyst 53 may excessively increase, and deterioration of the three-way catalyst 53 may be promoted.

[0023] As such, in the present embodiment, in a case in which the engine rotation speed is in a specific monitoring range after the over-Rev limit control, control for suppressing an occurrence of the oxidation reaction in the three-way catalyst 53 is executed. The monitoring range is set to a range that is lower than the first rotation speed and includes the second rotation speed.

[0024] The above-mentioned control (control for suppressing an occurrence of oxidation reaction in the three-way catalyst 53) is the feedback control for adjusting an amount of fuel to be supplied to the engine 5 based on the oxygen concentration of an exhaust gas flowing downstream of the three-way catalyst 53. In the following description, this feedback control is referred to as fuel feedback control.

3. Control System of Motorcycle 100

[0025] Fig. 2 is a block diagram showing a control system of the motorcycle 100 of Fig. 1. As shown in Fig. 2, the motorcycle 100 according to the present embodiment, as the configuration of the control system, includes the ECU 10, the fuel injection device 61, a throttle actuator 63, an accelerator sensor SE0, a throttle sensor SE1, an intake pressure sensor SE2, a crank sensor SE3 and a catalyst downstream oxygen sensor SE4. In the present embodiment, the configuration including the ECU 10 and the catalyst downstream oxygen sensor SE4 is equivalent to the fuel adjustment device of the present disclosure.

[0026] The accelerator sensor SE0 is provided at the handle 4 of Fig. 1. The accelerator sensor SE0 detects an amount of operation (accelerator opening) by the rider of the accelerator grip 4g and outputs an electrical signal indicating the detected accelerator opening.

[0027] The throttle actuator 63 adjusts an opening of the throttle valve 62 (throttle opening), thereby adjusting an amount of air guided from an air cleaner (not shown) to the engine 5. The fuel injection device 61 injects fuel into the intake port of the engine 5 such that an air-fuel mixture is guided to the combustion chamber of the engine 5. Thus, the fuel is supplied to the engine 5. The throttle sensor SE1 is provided in the vicinity of the throttle valve 62. The throttle sensorSE1 detects an opening of the throttle valve 62 and outputs an electrical signal indicating the detected throttle opening.

[0028] The intake pressure sensor SE2 is provided at a portion farther downstream than the throttle valve 62 in the intake pipe 60. The intake pressure sensor SE2 detects a pressure in the intake pipe 60 (intake pressure) as an intake state of the engine 5 and outputs an electrical signal indicating the detected intake pressure. The crank sensor SE3 is provided in the vicinity of the engine 5. The crank sensor SE3 detects a rotation speed of the crankshaft of the engine 5a (engine rotation speed) and outputs an electrical signal indicating the detected engine rotation speed.

[0029] The catalyst downstream oxygen sensor SE4 is provided at a portion farther downstream than the three-way catalyst 53 in the muffler 52. The catalyst downstream oxygen sensor SE4 detects the oxygen concentration of an exhaust gas after being exhausted from the engine 5 and being cleaned by the three-way catalyst 53 and outputs an electrical signal indicating the detected oxygen concentration. As described above, the three-way catalyst 53 may be provided in the exhaust pipe 51 instead of the muffler 52. Therefore, in a case in which the three-way catalyst 53 is provided in the exhaust pipe 51, the catalyst downstream oxygen sensor SE4 may be provided in the exhaust pipe 51 so as to be located in a portion farther downstream than the three-way catalyst 53.

[0030] The ECU 10 includes a CPU 10a, a ROM 10b and a RAM 10c. The CPU 10a includes, as functions, a rotation speed determiner 11, an oxygen-concentration determiner 12, an engine controller 13, a feedback controller 14 and an information retainer 15. These functions of the CPU 10a are implemented by execution by the CPU 10a of the fuel adjustment program stored in the ROM 10b. Part or all of the plurality of functions of the CPU 10a may be implemented by hardware such as an electronic circuit.

[0031] When the motorcycle 100 is powered on, the information retainer 15 reads at least part of a plurality of information pieces stored in the ROM 10b and stores the read information. The information retained by the information retainer 15 includes a "FIRST CONDITION FOR ENGINE CONTROL," a "SECOND CONDITION FOR ENGINE CONTROL," a "MONITORING RANGE," a "FIRST ROTATION SPEED," a "SECOND ROTATION SPEED," a "THIRD ROTATION SPEED" and a "PRESCRIBED REDUCTION AMOUNT FOR FUEL FEEDBACK CONTROL."

[0032] In the following description, the working state of the engine 5 obtained when the over-Rev limit control is not executed is referred to as a normal working state. In the present embodiment, the normal working state of the engine 5 refers to a state in which an engine rotation speed is defined according to the magnitude of at least an accelerator opening or a throttle opening, for example.

[0033] The "FIRST CONDITION FOR ENGINE CONTROL (hereinafter referred to as a first condition)" includes the information representing an amount of fuel to be supplied to the engine 5 (an amount of fuel to be supplied to the engine 5 per cycle) when the engine 5 is in the normal working state. Specifically, the first condition includes a map representing the predetermined relationship among a throttle opening, an engine rotation speed and an amount of fuel to be supplied to the engine 5. Alternatively, the first condition includes a map representing the predetermined relationship among a pressure in the intake pipe 60 (intake pressure), an engine rotation speed and an amount of fuel to be supplied to the engine 5. According to these maps, when the engine 5 is in the normal working state, an amount of fuel to be supplied to the engine 5 is adjusted based on a throttle opening or an intake pressure, and an engine rotation speed.

[0034] The "SECOND CONDITION FOR ENGINE CONTROL (hereinafter referred to as a second condition)" includes the information representing an amount of fuel to be supplied to the engine 5 during the over-Rev limit control. In the present embodiment, an amount of fuel to be supplied to the engine 5 during the over-Rev limit control is 0. According to the second condition, during the over-Rev limit control, the fuel is not supplied to the engine 5 regardless of a throttle opening and an intake pressure.

[0035] The "MONITORING RANGE" is the range of the engine rotation speed. In the present embodiment, the "MONITORING RANGE" is the range equal to or higher than the "THIRD ROTATION SPEED," described below, and lowerthan the "FIRST ROTATION SPEED." The "FIRST ROTATION SPEED" is a rotation speed serving as a reference for starting the over-Rev limit control with respect to the engine 5 in the normal working state, and defines the upper limit of the "MONITORING RANGE" as described above. The "SECOND ROTATION SPEED" is a rotation speed serving as a reference for ending the over-Rev limit control and changing the engine 5 back to the normal working state, and is set in the above-mentioned "MONITORING RANGE." The "THIRD ROTATION SPEED" is a rotation speed lower than the "SECOND ROTATION SPEED" and is the lower limit of the "MONITORING RANGE."

[0036] A "PRESCRIBED REDUCTION AMOUNT FOR FUEL FEEDBACK CONTROL (hereinafter referred to as a prescribed reduction amount)" is used to gradually reduce an amount of fuel to be supplied to the engine 5 in stages during the above-mentioned fuel feedback control. The specific method of using the prescribed reduction amount will be described below.

[0037] The rotation speed determiner 11 acquires an engine rotation speed by receiving the output of the crank sensor SE3. Further, the rotation speed determiner 11 determines whether the engine rotation speed has reached the first rotation speed due to an increase in engine rotation speed when the engine 5 is in the normal working state. Further, the rotation speed determiner 11 determines whether the engine rotation speed has reached the second rotation speed due to a decrease in engine rotation speed during the over-Rev limit control of the engine 5. Further, the rotation speed determiner 11 determines whether the engine rotation speed is continuously in the monitoring range after the over-Rev limit control of the engine 5.

[0038] The oxygen-concentration determiner 12 receives the output of the catalyst downstream oxygen sensor SE4. Thus, the oxygen-concentration determiner 12 determines, based on a detected oxygen concentration, whether the oxygen concentration of an exhaust gas after being cleaned by the three-way catalyst 53 is higher than an oxygen concentration corresponding to a theoretical air-fuel ratio (hereinafter referred to as a reference concentration). In other words, the oxygen-concentration determiner 12 determines whether the air-fuel ratio of the exhaust gas flowing downstream of the three-way catalyst 53 is larger than the theoretical air-fuel ratio (lean).

[0039] The engine controller 13 acquires an accelerator opening by receiving the output of the accelerator sensor SE0, and controls the throttle actuator 63 based on the accelerator opening. Thus, a throttle opening is adjusted.

[0040] Further, the engine controller 13 acquires a throttle opening by receiving the output of the throttle sensor SE1, and acquires an intake pressure of the engine 5 by receiving the output of the intake pressure sensor SE2. Further, the engine controller 13 acquires an engine rotation speed by receiving the output of the crank sensor SE3.

[0041] Here, suppose that a first condition stored in the information retainer 15 includes a map representing the relationship among a throttle opening, an engine rotation speed and a fuel supply amount. In this case, when the engine 5 is in the normal working state, the engine controller 13 sets an amount of fuel to be supplied to the engine 5 based on the first condition, the acquired throttle opening and the acquired engine rotation speed. Further, the engine controller 13 controls the fuel injection device 61 based on the set fuel supply amount.

[0042] On the other hand, suppose that a first condition stored in the information retainer 15 includes a map representing the relationship among an intake pressure, an engine rotation speed and a fuel supply amount. In this case, when the engine 5 is in the normal working state, the engine controller 13 sets an amount of fuel to be supplied to the engine 5 based on the first condition, the acquired intake pressure and the acquired engine rotation speed. Further, the engine controller 13 controls the fuel injection device 61 based on the set fuel supply amount. In this manner, an amount of fuel to be supplied to the engine 5 per cycle is suitably adjusted.

[0043] In addition to the above-mentioned example, during the over-Rev limit control of the engine 5, the engine controller 13 sets an amount of fuel to be supplied to the engine 5 to 0 based on a second condition stored in the information retainer 15. That is, the supply of fuel to the engine 5 is stopped.

[0044] The feedback controller 14 executes the fuel feedback control when the engine rotation speed is continuously in the monitoring range after the over-Rev limit control of the engine 5. Specifically, based on a detection result of the oxygen-concentration determiner 12, the feedback controller 14 adjusts an amount of fuel to be supplied to the engine 5 in stages such that the oxygen concentration of an exhaust gas flowing downstream of the three-way catalyst 53 is higher than the reference concentration. Thus, during the fuel feedback control, in a case in which the air-fuel ratio of the exhaust gas is not lean, the amount of fuel to be supplied to the engine 5 is reduced in stages from the fuel supply amount that is set according to a first condition to the amount that does not cause misfiring of the engine 5.

4. Fuel Adjustment Process

[0045] Fig. 3 is a flowchart of a fuel adjustment process according to one embodiment of the present disclosure. The fuel adjustment process is started when the CPU 10a of the ECU 10 executes the fuel adjustment program in response to starting of the engine 5. In the following description, execution of the fuel feedback control of the engine 5 is referred to as turning ON of the fuel feedback control, and non-execution of the fuel feedback control of the engine 5 is referred to as turning OFF of the fuel feedback control.

[0046] In an initial state, the information retainer 15 stores a first condition, a second condition, a monitoring range, a first rotation speed, a second rotation speed, a third rotation speed and a prescribed reduction amount of Fig. 2. Further, in the initial state, the fuel feedback control of the engine 5 is turned OFF.

[0047] As shown in Fig. 3, when the fuel adjustment process is started, the engine controller 13 drives the engine 5 according to the first condition (step S11). That is, the engine controller 13 sets an amount of fuel to be supplied to the engine 5 based on the map of the first condition and the output of the various sensors (SE0 to SE3), and controls the fuel injection device 61. Thus, the working state of the engine 5 is maintained to be the normal working state.

[0048] Next, based on the output of the crank sensor SE3, the rotation speed determiner 11 determines whether an engine rotation speed has reached the first rotation speed due to an increase in engine rotation speed (step S12). In a case in which the engine rotation speed has not reached the first rotation speed, the process of the step S12 is repeated. On the other hand, when the engine rotation speed reaches the first rotation speed, the engine controller 13 drives the engine 5 according to the second condition (step S13). That is, the engine controller 13 sets an amount of fuel to be supplied to the engine 5 to 0 based on the second condition (fuel cut). In this manner, the over-Rev limit control is started in the step S13, and the engine rotation speed decreases.

[0049] Next, based on the output of the crank sensor SE3, the rotation speed determiner 11 determines whether the engine rotation speed has reached the second rotation speed due to a decrease in engine rotation speed (step S14). In a case in which the engine rotation speed has not reached the second rotation speed, the process of the step S14 is repeated. On the other hand, when the engine rotation speed reaches the second rotation speed, the engine controller 13 drives the engine 5 according to the first condition similarly to the process of the step S11 (step S15). In this manner, the over-Rev limit control ends in the step S15. At this time, the engine rotation speed is lower than the first rotation speed by a constant speed (the difference between the first rotation speed and the second rotation speed).

[0050] Next, based on the output of the crank sensor SE3, the rotation speed determiner 11 determines whether the engine rotation speed is in the monitoring range (step S16). In a case in which the engine rotation speed is not in the monitoring range, the rotation speed determiner 11 causes the process to be executed to return to the process of the step S12. On the other hand, in a case in which the engine rotation speed is in the monitoring range, the feedback controller 14 turns ON the fuel feedback control using the catalyst downstream oxygen sensor SE4 (step S17). Details of the process to be executed by the CPU 10a when the fuel feedback control is turned ON will be described below.

[0051] Next, based on the output of the crank sensor SE3, similarly to the process of the step S16, the rotation speed determiner 11 determines whether the engine rotation speed is in the monitoring range (step S18). In a case in which the engine rotation speed is not in the monitoring range, the feedback controller 14 turns OFF the fuel feedback control (step S19), and causes the process to be executed to return to the process of step S12.

[0052] On the other hand, in a case in which the engine rotation speed is in the monitoring range in the step S18, the rotation speed determiner 11 determines, similarly to the process of the step S12, whether the engine rotation speed has reached the first rotation speed due to an increase in engine rotation speed (step S20). In a case in which the engine rotation speed has not reached the first rotation speed, the rotation speed determiner 11 causes the process to be executed to return to the process of the step S18. On the other hand, when the engine rotation speed reaches the first rotation speed, the feedback controller 14 turns OFF the fuel feedback control (step S21), and causes the process to be executed to return to the process of the step S13.

[0053] Fig. 4 is a flowchart showing the details of the process to be executed in the CPU 10a of Fig. 2 when the fuel feedback control is turned ON. The series of processes shown in Fig. 4 is started when the fuel feedback control is switched from OFF to ON in the process of the step S17 of Fig. 3.

[0054] When the fuel feedback control is turned ON in the process of the step S17, the oxygen-concentration determiner 12 determines whether the oxygen concentration of the exhaust gas is higher than the reference concentration based on the output of the catalyst downstream oxygen sensor SE4 (step S31). In a case in which the oxygen concentration of the exhaust gas is higher than the reference concentration, that is, the air-fuel ratio of the exhaust gas is lean, the process of the step S31 is repeated.

[0055] On the other hand, in a case in which the oxygen concentration of the exhaust gas is equal to or lower than the reference concentration, that is, the air-fuel ratio of the exhaust gas is the theoretical air-fuel ratio or rich, the feedback controller 14 reduces the amount of fuel to be supplied to the engine 5 from a set amount by a prescribed reduction amount (step S32). Specifically, the amount of fuel to be supplied to the engine 5 is adjusted to an amount obtained when the fuel supply amount set according to the first condition is reduced by the prescribed reduction amount. It can also be said that this adjustment process is a process of correcting a fuel supply amount that is set according to the first condition. Thereafter, the feedback controller 14 causes the process to be executed to proceed to the step S31.

[0056] The above-mentioned process of the steps S31 and S32 are continuously executed at predetermined time intervals until the fuel feedback control is turned OFF in the process of the step S19 or the step S21 of Fig. 3. With the process of the steps S31 and S32, in a case in which being the theoretical air-fuel ratio or rich, the air-fuel ratio of the exhaust gas is adjusted in stages to be lean for each predetermined number of cycles, for example. Thus, even in a case in which the over-Rev limit control is repeated at a short cycle, the change in reaction occurring in the three-way catalyst 53 is gradually stabilized.

[0057] In this manner, the air-fuel ratio of the exhaust gas is maintained lean, so that an occurrence of oxidation reaction in the three-way catalyst 53 is suppressed. As a result, a rapid increase in temperature of the three-way catalyst 53 due to repetition of the strong oxidation reaction and the strong reduction reaction in the three-way catalyst 53 is suppressed.

5. Specific Work Example of Engine 5 by Fuel Adjustment Process

[0058] Fig. 5 is a time chart for explaining the specific work example of the engine 5 by the fuel adjustment process of Fig. 3. Three items relating to the work of the engine 5 are shown at the left end of Fig. 5. The three items are "ENGINE ROTATION SPEED," a "CONDITION FOR ENGINE CONTROL" and "FUEL FEEDBACK CONTROL," and are arranged in this order from the top row (first row) to the bottom row (third row) in a vertical direction.

[0059] At the right of each item, the change of the state corresponding to the item is shown in a chronological order using a common time axis. At the right of the item "ENGINE ROTATION SPEED" of the first row, one example of the temporal change of the engine rotation speed is shown using the graph in which the ordinate indicates the engine rotation speed and the abscissa is used as a time axis.

[0060] In the graph of the first row, the reference characters "rs1," "rs2" and "rs3" provided on the ordinate respectively indicate the first rotation speed, the second rotation speed and the third rotation speed, described above. Further, the outlined arrow MR shown in the graph of the first row indicates the range that is equal to or higher than the third rotation speed rs3, and is lower than the first rotation speed rs1, as the above-mentioned monitoring range.

[0061] At the right of the item "CONDITION FOR ENGINE CONTROL" of the second row, it is shown that the condition used for driving the engine 5 at each point in time on the time axis is either the first condition or the second condition. At the right of the item "FUEL FEEDBACK CONTROL" of the third row, it is shown whether the fuel feedback control is turned ON or OFF at each point in time on the time axis.

[0062] At a point t11 in time at which the engine 5 is in the initial state, the engine 5 is in the normal working state, and the engine rotation speed is lower than the third rotation speed rs3. In this case, the engine 5 is driven according to the first condition, and the fuel feedback control is turned OFF.

[0063] Suppose that an accelerator opening is maintained fully open because the rider continuously operates the accelerator grip 4g in the period from the point t11 in time to a point t21 in time, described below, for example. In this case, a large amount of air-fuel mixture is introduced into the engine 5 as the time passes the point t11 in time, so that the engine rotation speed increases.

[0064] When the engine rotation speed reaches the first rotation speed rs1 at a point t12 in time due to an increase in engine rotation speed, the over-Rev limit control is started. Specifically, by the process of the steps S12 and S13 of Fig. 3, the condition used for driving the engine 5 is changed from the first condition to the second condition. Thus, the engine 5 is driven according to the second condition. When the engine 5 is driven according to the second condition, fuel is not supplied to the engine 5. Therefore, the engine rotation speed decreases.

[0065] When the engine rotation speed reaches the second rotation speed rs2 at a point t13 in time due to a decrease in engine rotation speed, the over-Rev limit control ends due to the process of the step S14 of Fig. 3. Further, by the process of the step S15 of Fig. 3, the condition used for driving the engine 5 is changed from the second condition to the first condition. Further, at the point t13 in time, the engine rotation speed is in the monitoring range MR. In this case, the fuel feedback control is turned ON by the control of the steps S16 and S17 of Fig. 3. Thus, a large amount of air-fuel mixture is introduced into the engine 5 while an air-fuel ratio of the exhaust gas is adjusted to be lean. Thus, the engine rotation speed increases while being maintained in the monitoring range MR.

[0066] Thereafter, when the engine rotation speed reaches the first rotation speed rs1 again at a point t14 in time, the fuel feedback control is turned OFF by the process of the steps S20 and S21 of Fig. 3. Further, by the process of the step S13 of Fig. 3, the condition used for driving the engine 5 is changed again from the first condition to the second condition, and the over-Rev limit control is started. Thus, the engine rotation speed decreases again.

[0067] When the engine rotation speed reaches the second rotation speed rs2 at a point t15 in time due to a decrease in engine rotation speed, the over-Rev limit control ends due to the process of the step S14 of Fig. 3. Further, by the process of the step S15 of Fig. 3, the condition used for driving the engine 5 is changed again from the second condition to the first condition.

[0068] In the example of Fig. 5, as described above, the accelerator opening is maintained fully opened in the period from the point t11 to the point t21 in time. Thus, the processes executed at the points t12 and t13 in time are similarly repeated at the points t14 and t15 in time as described above. Further, the processes executed at the points t12 and t13 in time are similarly repeated at points t16 and t17 in time, and are similarly repeated at the points t18 and t19 in time. Further, the process executed at the point 12 in time is similarly repeated at a point t20 in time.

[0069] Here, suppose that an accelerator opening is reduced because the rider sets the operation amount of the accelerator grip 4g to 0 at the point t21 in time. In this case, the engine rotation speed further decreases from the point t21 in time. Thereafter, in a case in which the engine rotation speed falls below the third engine rotation speed rs3, that is, the engine rotation speed deviates from the monitoring range MR, at a point t22 in time, the fuel feedback control is turned OFF by the process of the steps S18 and S19 of Fig. 3.

6. Effects

[0070]

(a) In the above-mentioned motorcycle 100, when the engine rotation speed reaches the first engine rotation speed rs1 with the engine 5 driven according to the first condition, the over-Rev limit control is executed. Thus, the engine 5 is driven according to the second condition, and the engine rotation speed decreases. Therefore, overspeeding of the engine 5 is suppressed.

[0071] When the engine rotation speed decreases to the second rotation speed rs2, the condition used for driving the engine 5 is changed back from the second condition to the first condition. In this state, when the engine rotation speed is maintained in the monitoring range MR, the engine rotation speed is highly likely to reach the first rotation speed rs1 again in a relatively short period of time. Thus, when the over-Rev limit control is periodically executed, strong oxidation reaction and strong reduction reaction alternately occur in the three-way catalyst 53, and the temperature of the three-way catalyst 53 may become excessively high.

[0072] As such, in the above-mentioned motorcycle 100, when the engine rotation speed is continuously in the monitoring range MR after the over-Rev limit control, the fuel feedback control based on the output of the catalyst downstream oxygen sensor SE4 is turned ON. Thus, when the engine rotation speed is continuously in the monitoring range MR after the over-Rev limit control, the air-fuel ratio of the exhaust gas is adjusted to be lean, and the reaction occurring in the three-way catalyst 53 is limited to the reduction reaction.

[0073] Here, the reason why the output of the catalyst downstream oxygen sensor SE4 is used in the fuel feedback control will be described. The exhaust gas immediately after being discharged from the engine 5 has large variations in regard to the oxygen concentration. Therefore, in regard to the exhaust gas immediately after being exhausted from the engine 5, even when the oxygen concentration is detected, the detection result is unstable. It is difficult to appropriately adjust the air-fuel ratio of the exhaust gas using the unstable detection result.

[0074] In contrast, the three-way catalyst 53 functions as a filter that reduces variations in concentration of oxygen in the exhaust gas flowing through the exhaust pipe 51 and the muffler 52. Therefore, with the catalyst downstream oxygen sensor SE4, it is possible to obtain a stable detection result in regard to the concentration of oxygen in the exhaust gas as compared to a case in which an oxygen-sensor provided upstream of the three-way catalyst 53 is used. Thus, in the fuel feedback control, an amount of fuel to be supplied by the fuel injection device 61 is appropriately adjusted based on the detection result of the catalyst downstream oxygen sensor SE4. As a result, shortening of the service life of the three-way catalyst 53 caused by suppression of overspeeding of the engine 5 is appropriately prevented.

[0075] (b) Further, with the above-mentioned fuel feedback control, it is not necessary to determine a fuel supply amount in order to protect the three-way catalyst 53 after the over-Rev limit control using an additional map. Thus, it is possible to prevent shortening of the service life of the three-way catalyst 53 with a simple method without requiring complicated work such as creation of an additional map.

[0076] (c) The monitoring range MR is set to a continuous range that is equal to or higher than the third rotation speed rs3 lower than the second rotation speed rs2, and is lower than the first rotation speed rs1. In this case, even in a case in which the engine rotation speed temporarily becomes lower than the second rotation speed rs2 after the over-Rev limit control ends, the fuel feedback control is executed unless the engine rotation speed decreases to the third rotation speed rs3. Thus, it is possible to more appropriately control the reaction occurring in the three-way catalyst 53.

[0077] (d) In the fuel feedback control, a fuel supply amount is adjusted for every predetermined number of cycles until the air-fuel ratio of an exhaust gas becomes lean. Therefore, it is possible to appropriately adjust the fuel supply amount without accurately identifying the degree of deviation between an actual air-fuel ratio and a theoretical air-fuel ratio of the exhaust gas. Therefore, it is possible to use an inexpensive oxygen sensor capable of detecting only whether an oxygen concentration is higher than the oxygen concentration corresponding to the theoretical air-fuel ratio as the catalyst downstream oxygen sensor SE4.

7. Other Embodiments

[0078]

(a) While the second condition includes the information representing that an amount of fuel to be supplied to the engine 5 during the over-Rev limit control is 0 in the above-mentioned embodiment, the present disclosure is not limited to this. The second condition may include the information representing that an amount of fuel to be supplied to the engine 5 during the over-Rev limit control is a specific value larger than 0. In this case, the specific value larger than 0 is set lower than a value of the fuel supply amount to be set based on the map of the first condition when the engine 5 is in the normal working state. Thus, the engine rotation speed can gradually decrease in the over-Rev limit control.

(b) While the second condition includes the information representing that an amount of fuel to be supplied to the engine 5 during the over-Rev limit control is 0 in the above-mentioned embodiment, the present disclosure is not limited to this. The second condition may include the information for adjusting an opening of the throttle valve 62 in addition to the information for adjusting a fuel supply amount or instead of the information for adjusting a fuel supply amount. For example, the second condition may include the information for setting an opening of the throttle valve 62 to a value significantly smaller than an opening of the throttle valve 62 obtained when the engine 5 is in the normal working state. Also in this case, the engine rotation speed can forcibly decrease in the over-Rev limit control.

(c) While the monitoring range MR serving as the reference for executing the fuel feedback control is set equal to or higher than the third rotation speed rs3 and lower than the first rotation speed rs1 in the above-mentioned embodiment, the present disclosure is not limited to this.

[0079] The monitoring range MR may be set equal to or higher than the second rotation speed rs2 and lower than the first rotation speed rs1 instead of the range equal to or higher than the third rotation speed rs3 and lower than the first rotation speed rs1. In other words, in the above-mentioned embodiment, the second rotation speed rs2 and the third rotation speed rs3 may be set to a same value.

[0080] (d) While the CPU 10a has the information retainer 15 as a function in the motorcycle 100 according to the above-mentioned embodiment, the present disclosure is not limited to this. Each information piece retained by the information retainer 15 is stored in the ROM 10b in advance. Therefore, the other functions (11, 12, 13, 14) of the CPU 10a may suitably read the information required for the process of the function from the ROM 10b and retain the information. In this case, the information retainer 15 is not required.

[0081] (e) In the motorcycle 100 according to the above-mentioned embodiment, the catalyst downstream oxygen sensor SE4 is used to execute the fuel feedback control. As the catalyst downstream oxygen sensor SE, it is possible to use an oxygen sensor that detects only whether the concentration of oxygen in gas is higher than the oxygen concentration corresponding to a theoretical air-fuel ratio or an air-fuel ratio sensor that detects the concentration of oxygen in gas in more detail.

[0082] (f) While the above-mentioned embodiment is an example in which the present disclosure is applied to a motorcycle, the present disclosure is not limited to this. The present disclosure may be applied to another straddled vehicle such as a motor tricycle or an ATV (All Terrain Vehicle), or another straddled vehicle such as a motor tricycle other than a straddled vehicle, and a four-wheeled automobile.

8. Correspondences Between Constituent Elements in Claims and Parts in Preferred Embodiments

[0083] In the following paragraphs, non-limiting examples of correspondences between various elements recited in the claims below and those described above with respect to various preferred embodiments of the present disclosure are explained. As each of constituent elements recited in the claims, various other elements having configurations or functions described in the claims can be also used.

[0084] In the above-mentioned embodiment, the engine 5 is an example of an engine, the fuel injection device 61, the throttle valve 62 and the throttle actuator 63 are examples of an engine driver, the ECU 10 is an example of a controller, the exhaust pipe 51 and the muffler 52 are examples of an exhaust system, the three-way catalyst 53 is an example of a catalyst, the catalyst downstream oxygen sensor SE4 is an example of an oxygen sensor, and the fuel injection device 61 is an example of a fuel supplier.

[0085] Further, the first rotation speed rs1 is an example of a first rotation speed, the second rotation speed rs2 is an example of a second rotation speed, the monitoring range MR is an example of a monitoring range, the configuration including the ECU 10 and the catalyst downstream oxygen sensor SE4 is an example of a fuel adjustment device, the third rotation speed rs3 is an example of a third rotation speed, the rear wheel 7 is an example of a drive wheel, and the motorcycle 100 is an example of a vehicle.

9. Overview of Embodiments

[0086] (Item 1) A fuel adjustment device according to item 1 includes a controller that controls an engine driver that causes an engine to work, and an oxygen sensor that is provided downstream of a catalyst that cleans an exhaust gas in an exhaust system attached to the engine, and detects an oxygen concentration of the exhaust gas, wherein the engine driver includes a fuel supplier that supplies fuel to the engine, the controller, when a rotation speed of the engine reaches a first rotation speed due to an increase in rotation speed of the engine with the engine driver working according to a first condition, causes the engine driver to work according to a second condition different from the first condition such that the rotation speed of the engine decreases, when the rotation speed of the engine reaches a second rotation speed lower than the first rotation speed from the first rotation speed with the engine driver working according to the second condition, changes back a working condition of the engine driver from the second condition to the first condition, when the rotation speed of the engine is continuously maintained in a monitoring range from a point in time at which the working condition of the engine driver is changed back from the second condition to the first condition, adjusts a fuel supply amount of the fuel supplier based on a detection result of the oxygen sensor, and the monitoring range is a range that includes the second rotation speed and is lower than the first rotation speed.

[0087] With the fuel adjustment device, when the engine rotation speed reaches the first rotation speed with the engine driver working according to the first condition, the working condition of the engine driver is switched. The engine driver works according to the second condition, so that the engine rotation speed decreases. Therefore, the engine rotation speed is prevented from excessively increasing to exceed the first rotation speed. That is, overspeeding of the engine is suppressed.

[0088] When the engine rotation speed decreases to the second rotation speed, the working condition of the engine driver is changed back from the second condition to the first condition. Thereafter, in a case in which being maintained in the monitoring range, the engine rotation speed is highly likely to reach the first rotation speed again in a relatively short period of time. When the switching of the working condition of the engine driver is repeated, the air-fuel ratio of gas flowing from the engine to the exhaust system may regularly change. When the oxidation reaction and the reduction reaction in the catalyst are alternately repeated as the air-fuel ratio changes, the temperature of the catalyst may become excessively high.

[0089] In order to suppress excessive increase of the temperature of the catalyst without misfiring of the engine, it is preferable to reduce the intensity of at least one of the oxidation reaction and the reduction reaction. The reaction occurring in the catalyst and a degree of reaction are defined based on the air-fuel ratio of the air-fuel mixture to be supplied to the engine, for example. Therefore, when the oxygen concentration of gas exhausted from the engine is found, the air-fuel ratio of the air-fuel mixture to be supplied to the engine can be appropriately adjusted based on the oxygen concentration.

[0090] The exhaust gas immediately after being discharged from the engine has large variations in regard to the oxygen concentration. In regard to the exhaust gas immediately after being exhausted from the engine, even when an oxygen concentration is detected, the detection result is unstable. It is difficult to appropriately adjust the air-fuel ratio of the air-fuel mixture using the unstable detection result.

[0091] In contrast, the catalyst functions as a filter that reduces variations in concentration of oxygen in the exhaust gas flowing through the exhaust system. With the above-mentioned configuration, the oxygen concentration of the exhaust gas of the engine is detected by the oxygen sensor located downstream of the catalyst. In this case, because the stable detection result in regard to the oxygen concentration in the exhaust gas can be obtained, the fuel supply amount of the fuel supplier is suitably adjusted based on the detection result of the oxygen sensor. Therefore, it is possible to cause the oxidation reaction and the reduction reaction to occur appropriately and selectively in the catalyst. As a result, shortening of the service life of the catalyst due to the suppression of overspeeding of the engine is appropriately prevented.

[0092] (Item 2) The fuel adjustment device according to item 1, wherein the controller, when the fuel supply amount of the fuel supplier is adjusted, may adjust the fuel supplier such that fuel having an amount different from a fuel supply amount corresponding to the first condition and a fuel supply amount corresponding to the second condition is supplied to the engine.

[0093] In this case, an amount of fuel to be supplied to the engine can be more appropriately adjusted based on the detection result of the oxygen sensor.

[0094] (Item 3) The fuel adjustment device according to item 1 or 2, wherein the first condition may include that an amount of fuel to be supplied from the fuel supplier to the engine is a first supply amount, and the second condition may include that an amount of fuel to be supplied from the fuel supplier to the engine is 0 or a second supply amount lower than the first supply amount.

[0095] In this case, in the control for suppressing overspeeding of the engine, the fuel is not supplied to the engine or an amount of fuel to be supplied to the engine is reduced. Thus, the engine rotation speed decreases.

[0096] (Item 4) The fuel adjustment device according to any one of items 1 to 3, wherein adjustment of a fuel supply amount of the fuel supplier based on a detection result of the oxygen sensor may include execution of feedback control of the fuel supplier such that an oxygen concentration detected by the oxygen sensor is higher than an oxygen concentration corresponding to a theoretical air-fuel ratio.

[0097] In this case, when the engine rotation speed is maintained in the monitoring range after the working condition of the engine driver is changed back from the second condition to the first condition, the oxygen concentration of the exhaust gas is increased by the feedback control based on the detection result of the oxygen sensor. Thus, when the air-fuel ratio of the exhaust gas is maintained lean, the reaction occurring in the catalyst is limited to the reduction reaction. As a result, repetition of strong oxidation reaction and strong reduction reaction in the catalyst is suppressed, and the temperature of the catalyst is prevented from becoming excessively high.

[0098] (Item 5) The fuel adjustment device according to item 4, wherein feedback control of the fuel supplier may include determination of whether the oxygen concentration detected by the oxygen sensor is higher than the oxygen concentration corresponding to the theoretical air-fuel ratio, and reduction of the fuel supply amount of the fuel supplier from a preset fuel supply amount by a prescribed reduction amount when the detected oxygen concentration is equal to or lower than the oxygen concentration corresponding to the theoretical air-fuel ratio.

[0099] In this case, in a case in which the air-fuel ratio of the exhaust gas is not lean, the fuel supply amount is reduced by a prescribed reduction amount for each predetermined number of cycles, for example. Therefore, the change in reaction occurring in the catalyst is gradually stabilized.

[0100] Further, in this case, because the fuel supply amount is adjusted in stages until the air-fuel ratio of the exhaust gas becomes lean, it is possible to appropriately adjust the fuel supply amount without accurately identifying the degree of deviation between an actual air-fuel ratio and a theoretical air-fuel ratio of the exhaust gas. Therefore, it is possible to use an inexpensive oxygen sensor capable of detecting only whether an oxygen concentration is higher than the oxygen concentration corresponding to the theoretical air-fuel ratio.

[0101] (Item 6) The fuel adjustment device according to any one of items 1 to 5, wherein the monitoring range may be a continuous range that is equal to or higher than a third rotation speed lower than the second rotation speed, and is lower than the first rotation speed.

[0102] In this case, even in a case in which the engine rotation speed is temporarily lower than the second rotation speed after the working condition of the engine driver is changed back from the second condition to the first condition, the fuel injection amount of the fuel supplier is adjusted unless the engine rotation speed decreases to the third rotation speed. Thus, the reaction occurring in the catalyst can be controlled more appropriately.

[0103] (Item 7) A vehicle according to item 7 includes an engine, an exhaust system, a catalyst provided in the exhaust system, an engine driver, the above-mentioned fuel adjustment device, and a drive wheel driven by the engine.

[0104] The vehicle includes the above-mentioned fuel adjustment device. Therefore, shortening of the service life of the catalyst caused by the control for suppressing overspeeding of the engine is prevented.

[0105] While preferred embodiments of the present disclosure have been described above, it is to be understood that variations and modifications will be apparent to those skilled in the art without departing the scope and spirit of the present disclosure. The scope of the present disclosure, therefore, is to be determined solely by the following claims.

Claims

1. A fuel adjustment device comprising:

> a controller (10) that controls an engine driver (61, 62, 63) that causes an engine (5) to work; and
> an oxygen sensor (SE4) that is provided downstream of a catalyst (53) that cleans an exhaust gas in an exhaust system (51, 52) attached to the engine (5), and detects an oxygen concentration of the exhaust gas, wherein
> the engine driver (61, 62, 63) includes a fuel supplier (61) that supplies fuel to the engine (5),
> the controller (13),
> when a rotation speed of the engine (5) reaches a first rotation speed (rs1) due to an increase in rotation speed of the engine (5) with the engine driver (61, 62, 63) working according to a first condition, causes the engine driver (61, 62, 63) to work according to a second condition different from the first condition such that the rotation speed of the engine (5) decreases,
> when the rotation speed of the engine (5) reaches a second rotation speed (rs2) lower than the first rotation speed (rs1) from the first rotation speed (rs1) with the engine driver (61, 62, 63) working according to the second condition, changes back a working condition of the engine driver (61, 62, 63) from the second condition to the first condition,
> when the rotation speed of the engine (5) is continuously maintained in a monitoring range from a point in time at which the working condition of the engine driver (61, 62, 63) is changed back from the second condition to the first condition, adjusts a fuel supply amount of the fuel supplier (61) based on a detection result of the oxygen sensor (SE4), and
> the monitoring range is a range that includes the second rotation speed (rs2) and is lower than the first rotation speed (rs1).

2. The fuel adjustment device according to claim 1, wherein

the controller (13),
when the fuel supply amount of the fuel supplier (61) is adjusted, adjusts the fuel supplier (61) such that fuel having an amount different from a fuel supply amount corresponding to the first condition and a fuel supply amount corresponding to the second condition is supplied to the engine (5).

3. The fuel adjustment device according to claim 1 or 2, wherein

the first condition includes that an amount of fuel to be supplied from the fuel supplier (61) to the engine (5) is a first supply amount, and
the second condition includes that an amount of fuel to be supplied from the fuel supplier (61) to the engine (5) is 0 or a second supply amount lower than the first supply amount.

4. The fuel adjustment device according to any one of claims 1 to 3, wherein
adjustment of a fuel supply amount of the fuel supplier (61) based on a detection result of the oxygen sensor (SE4) includes execution of feedback control of the fuel supplier (61) such that an oxygen concentration detected by the oxygen sensor (SE4) is higher than an oxygen concentration corresponding to a theoretical air-fuel ratio.

5. The fuel adjustment device according to claim 4, wherein
feedback control of the fuel supplier (61) includes determination of whether the oxygen concentration detected by the oxygen sensor (SE4) is higher than the oxygen concentration corresponding to the theoretical air-fuel ratio, and reduction of the fuel supply amount of the fuel supplier (61) from a preset fuel supply amount by a prescribed reduction amount when the detected oxygen concentration is equal to or lower than the oxygen concentration corresponding to the theoretical air-fuel ratio.

6. The fuel adjustment device according to any one of claims 1 to 5, wherein
the monitoring range is a continuous range that is equal to or higher than a third rotation speed (rs3) lower than the second rotation speed (rs2), and is lower than the first rotation speed (rs1).

7. A vehicle (100) comprising:

an engine (5);
an exhaust system (51, 52);
a catalyst (53) provided in the exhaust system (51, 52);
an engine driver;
the fuel adjustment device according to any one of claims 1 to 6; and
a drive wheel (7) driven by the engine (5).

FIG.1

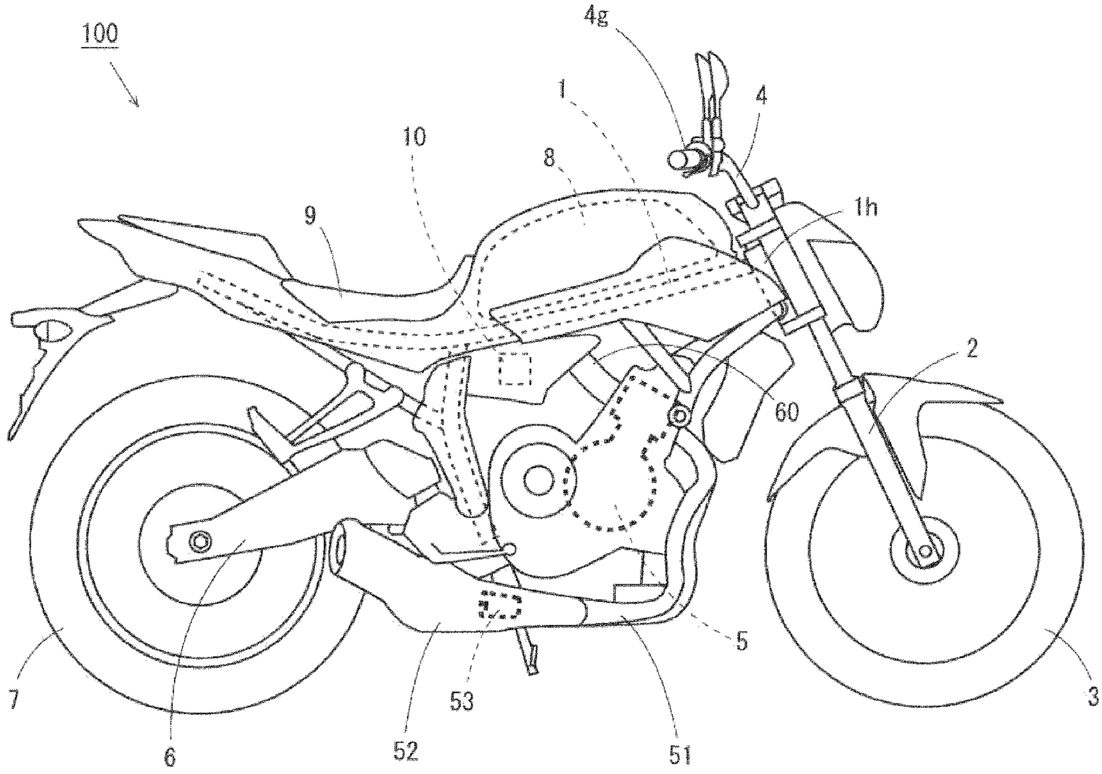


FIG.2

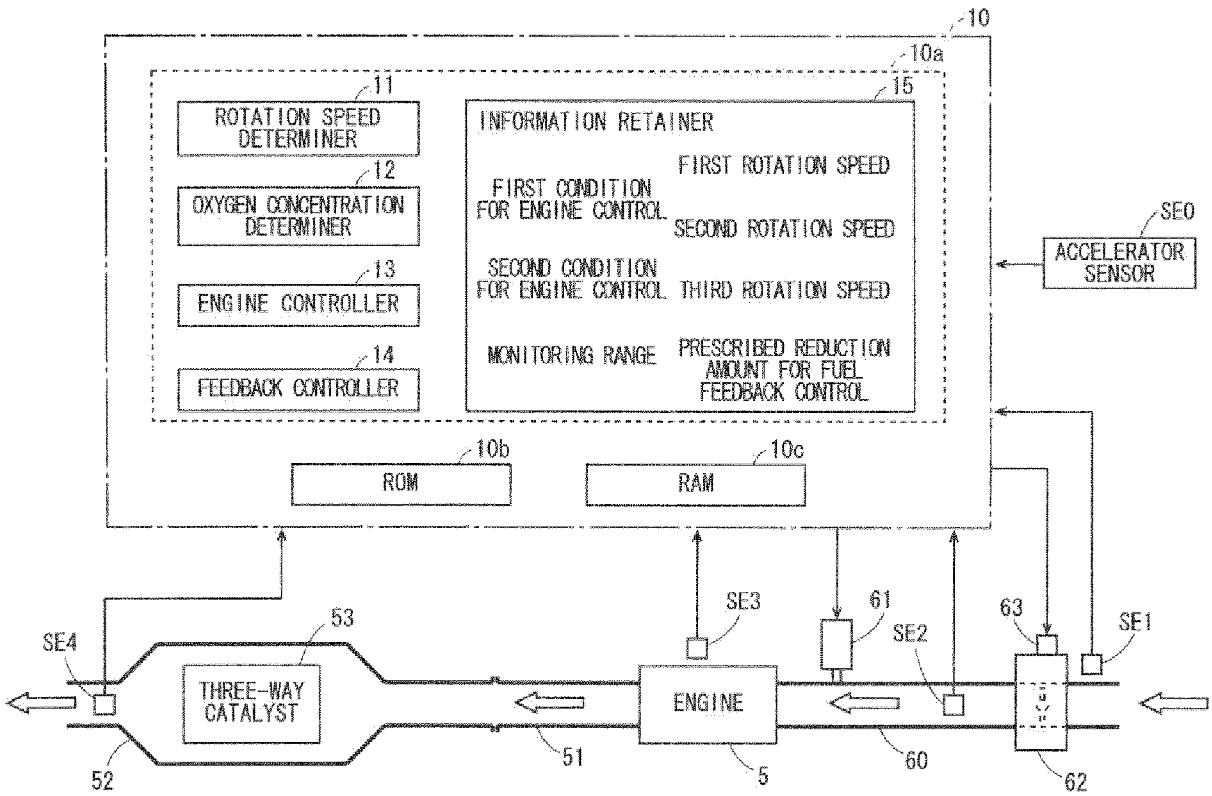

10
10a
11
ROTATION SPEED DETERMINER
12
OXYGEN CONCENTRATION DETERMINER
13
ENGINE CONTROLLER
14
FEEDBACK CONTROLLER
15
INFORMATION RETAINER
FIRST CONDITION FOR ENGINE CONTROL
FIRST ROTATION SPEED
SECOND ROTATION SPEED
SECOND CONDITION FOR ENGINE CONTROL
THIRD ROTATION SPEED
MONITORING RANGE
PRESCRIBED REDUCTION AMOUNT FOR FUEL FEEDBACK CONTROL
10b
ROM
10c
RAM
SE0
ACCELERATOR SENSOR
SE4
53
THREE-WAY CATALYST
52
51
SE3
ENGINE
5
61
SE2
60
63
SE1
62

FIG.3

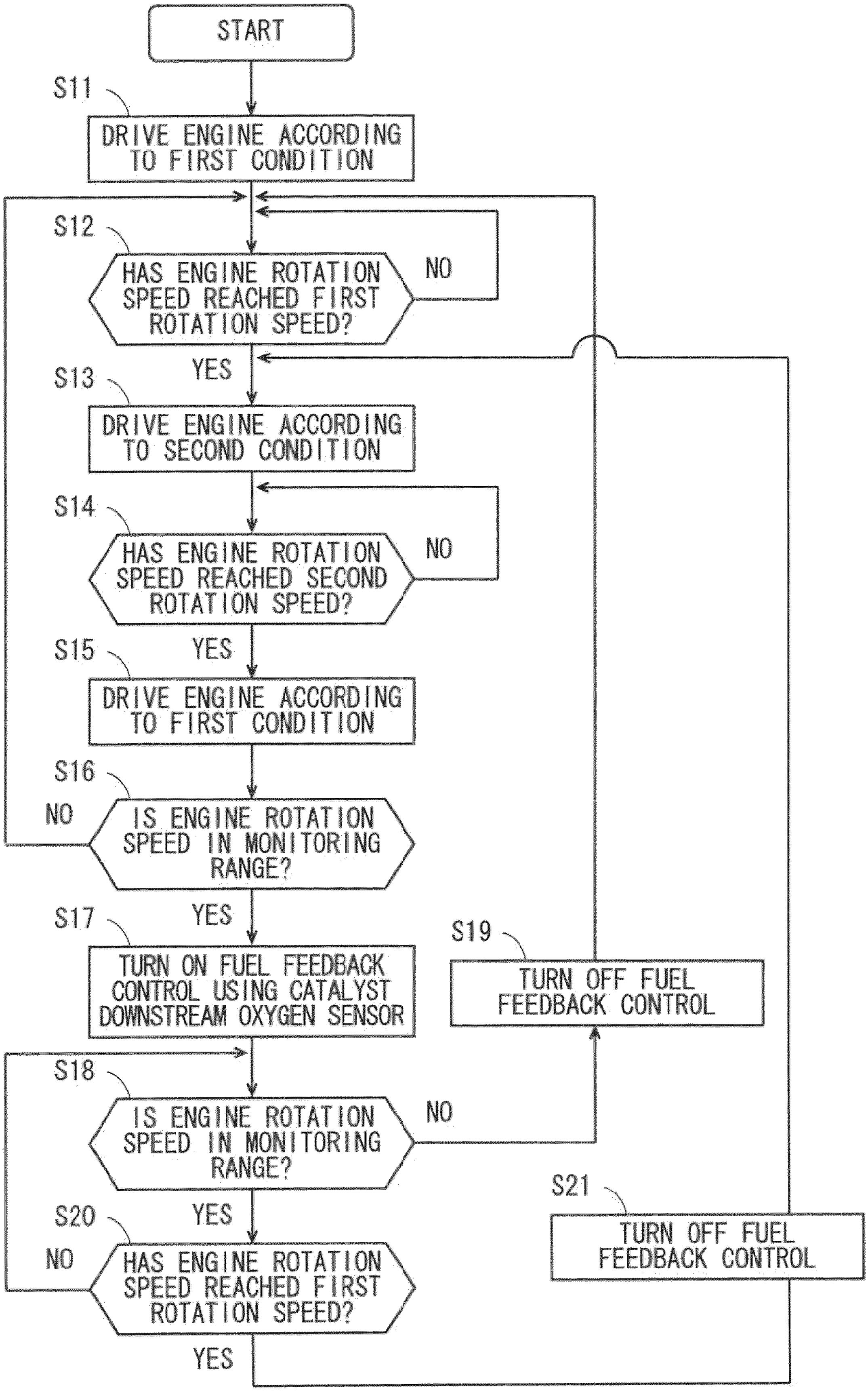

START
S11
DRIVE ENGINE ACCORDING TO FIRST CONDITION
S12
HAS ENGINE ROTATION SPEED REACHED FIRST ROTATION SPEED?
NO
YES
S13
DRIVE ENGINE ACCORDING TO SECOND CONDITION
S14
HAS ENGINE ROTATION SPEED REACHED SECOND ROTATION SPEED?
NO
YES
S15
DRIVE ENGINE ACCORDING TO FIRST CONDITION
S16
IS ENGINE ROTATION SPEED IN MONITORING RANGE?
NO
YES
S17
TURN ON FUEL FEEDBACK CONTROL USING CATALYST DOWNSTREAM OXYGEN SENSOR
S19
TURN OFF FUEL FEEDBACK CONTROL
S18
IS ENGINE ROTATION SPEED IN MONITORING RANGE?
NO
YES
S21
TURN OFF FUEL FEEDBACK CONTROL
S20
HAS ENGINE ROTATION SPEED REACHED FIRST ROTATION SPEED?
NO
YES

FIG.4

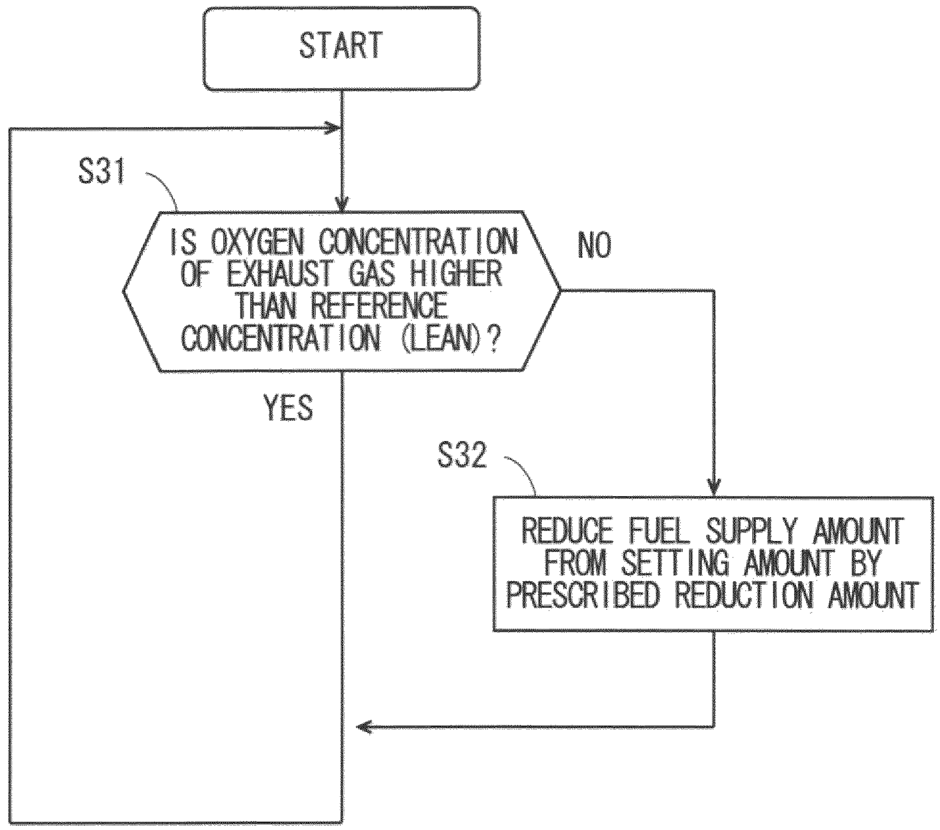
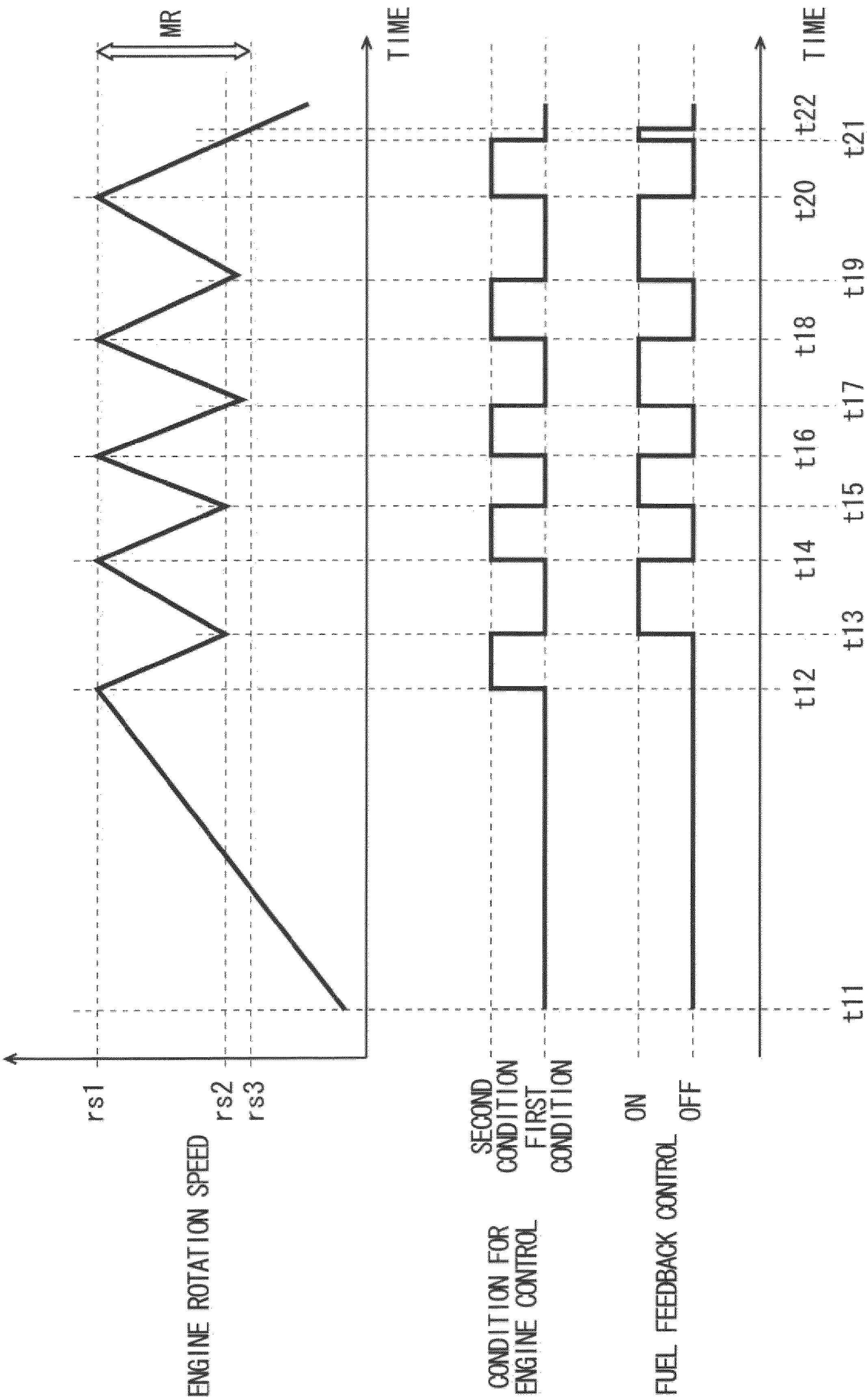

START
S31
IS OXYGEN CONCENTRATION OF EXHAUST GAS HIGHER THAN REFERENCE CONCENTRATION (LEAN)?
NO
YES
S32
REDUCE FUEL SUPPLY AMOUNT FROM SETTING AMOUNT BY PRESCRIBED REDUCTION AMOUNT

FIG.5


ENGINE ROTATION SPEED
rs1
rs2
rs3
MR
TIME
CONDITION FOR ENGINE CONTROL
SECOND CONDITION
FIRST CONDITION
FUEL FEEDBACK CONTROL
ON
OFF
TIME
t11
t12
t13
t14
t15
t16
t17
t18
t19
t20
t21
t22

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 24 21 0115

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 5 390 637 A (YOSHIOKA MAMORU [JP] ET AL) 21 February 1995 (1995-02-21) * column 5, line 43 - column 10, line 2; claims 1-9; figures 1-10 * * column 11, lines 9-23 *	1-7	INV. F02D41/10 F02D41/12 F02D41/14 F02D41/30 F02D31/00 F02D41/00 ADD. F02D41/02
X	JP 2005 076499 A (HONDA MOTOR CO LTD) 24 March 2005 (2005-03-24) * paragraphs [0027], [0032] - [0044]; figures 1-4 *	1-3,7	
X A	DE 10 2015 114251 A1 (BAYERISCHE MOTOREN WERKE AG [DE]; BOSCH GMBH ROBERT [DE]) 2 March 2017 (2017-03-02) * paragraphs [0015] - [0018], [0036] - [0049]; claims 1-6; figure 1 *	1-3,7 4-6	
X A	US 8 577 524 B2 (KADO TAKUYA [JP]; YAMAHA MOTOR CO LTD [JP]) 5 November 2013 (2013-11-05) * column 9, lines 27-35; claims 1-12; figures 1-10 *	1-3 4-7	TECHNICAL FIELDS SEARCHED (IPC)
X	US 5 730 103 A (TAKIZAWA OSAMU [JP] ET AL) 24 March 1998 (1998-03-24) * column 4, lines 27-38, 48-62; claims 1-7; figures 1-6 *	1-3,7	F02D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	24 March 2025	Boye, Michael

4

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 24 21 0115

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

24-03-2025

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5390637 A	21-02-1995	JP 2946962 B2	13-09-1999
		JP H06117302 A	26-04-1994
		US 5390637 A	21-02-1995
JP 2005076499 A	24-03-2005	JP 3967700 B2	29-08-2007
		JP 2005076499 A	24-03-2005
DE 102015114251 A1	02-03-2017	CN 106476812 A	08-03-2017
		DE 102015114251 A1	02-03-2017
		FR 3040351 A1	03-03-2017
		KR 20170026267 A	08-03-2017
		US 2017058806 A1	02-03-2017
US 8577524 B2	05-11-2013	JP 2013086559 A	13-05-2013
		US 2013096743 A1	18-04-2013
		US 2013238177 A1	12-09-2013
US 5730103 A	24-03-1998	JP 3092082 B2	25-09-2000
		JP H09195810 A	29-07-1997
		US 5730103 A	24-03-1998

EPO FORM P0459

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

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 2012241691 A **[0004]**