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(54) Activation determining system for oxygen sensor

(57) In an activation determining system, a signal processing circuit is configured to output a signal converging to a predetermined convergence value VP when the oxygen sensor is maintained in the deactivated state. A deactivation determining section is configured to determine that the oxygen sensor is in the deactivated state when an output value Vd (n) from the signal processing circuit varies towards the convergence value VP for a predetermined period of time or longer during execution of fuel supply cut-off or when the output value Vd(n) varies towards the convergence value VP by a predetermined amount or greater during execution of the fuel supply cut-off.

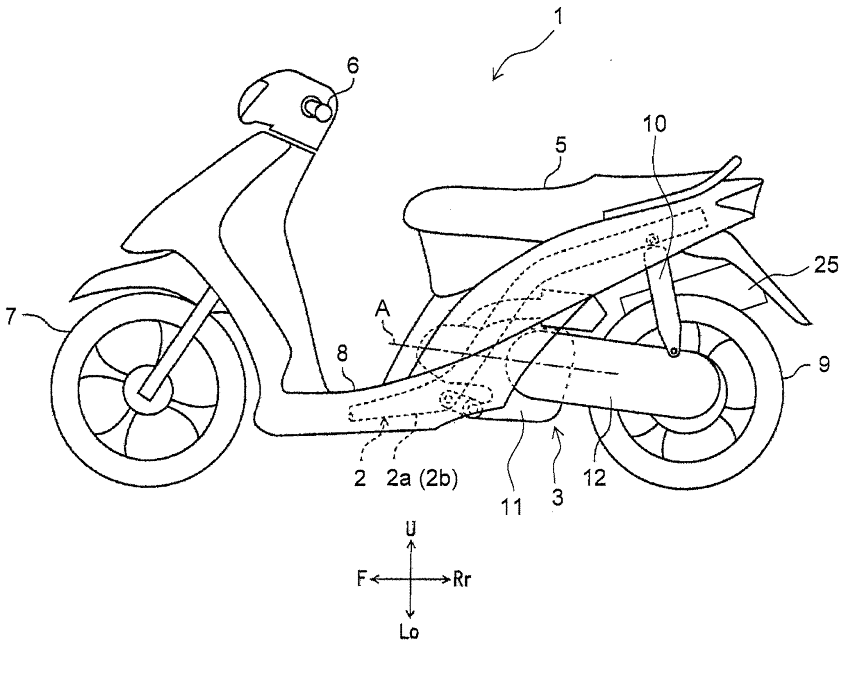

FIG. 1

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Description

BACKGROUND OF THE INVENTION

Technical Field

[0001] The present invention relates to an activation determination system for an oxygen sensor.

Background Art

[0002] The oxygen sensors have been so far used for appropriately controlling the air-fuel ratio of the mixture gas to be supplied to the internal combustion engine. Output values from the oxygen sensor vary in accordance with concentration of oxygen in the exhaust gas. It is therefore possible to obtain the concentration of oxygen in the exhaust gas by detecting the output value from the oxygen sensor. Further, based on the output value from the oxygen sensor, estimation is executed for which of a rich state and a lean state the mixture gas to be supplied to the internal combustion engine is in. For example, a sensor using stabilized zirconia is used as the oxygen sensor as described in Japan Laid-open Patent Application Publication No. JP-A-2006-170938.

[0003] In the aforementioned oxygen sensor, however, internal resistance is extremely increased in a low temperature state. Therefore, the output from the oxygen sensor of a low temperature state may different from that of a high temperature state even when the air-fuel ratio is identical between the low temperature state and the high temperature state. Specifically, in a low temperature state, the oxygen sensor may output a value in accordance with an oxygen concentration different from the actual oxygen concentration. Therefore, it is herein difficult to appropriately control the air-fuel ratio when a feedback control is executed for the air-fuel ratio using the output value from the oxygen sensor. The output value from the oxygen sensor herein converges to a predetermined convergence value in a deactivated state. Therefore, the well-known determining devices are configured to determine whether or not the output value from the oxygen sensor falls in a predetermined deactivation range including the convergence value in order to determine whether or not the oxygen sensor is in a deactivated state. When it is determined that the oxygen sensor is in a deactivated state, the feedback control using the output value from the oxygen sensor is configured to be stopped. It is thereby possible to avoid execution of an unsuitable control for the actual condition of the internal combustion engine.

[0004] The oxygen sensor is configured to output a value of representing the lean state when the fuel supply cut-off is executed in controlling the internal combustion engine. Subsequently, the output value from the oxygen sensor converges to the aforementioned convergence value when the temperature of the oxygen sensor is reduced in conjunction with reduction in temperature of the internal combustion engine. In this case, depending on settings of the deactivation range, the oxygen sensor could be in the deactivated state before the output value from the oxygen sensor reaches the aforementioned deactivation range. However, the above deactivated state of the oxygen sensor cannot be appropriately determined by the well-known methods of determining whether or not the output value from the oxygen sensor falls in the deactivation range. In view of this, it is possible to assume a method of determining the deactivated state of the oxygen sensor and stopping a feedback control immediately after execution of the fuel supply cut-off. In the method, however, the feedback control is actually stopped when the oxygen sensor is in the activated state. Therefore, exhaust deterioration may be unnecessarily caused.

[0005] It is an object of the present invention to provide an activation determining system for an oxygen sensor for appropriately determining a deactivated state of the oxygen sensor and simultaneously for inhibiting exhaust deterioration.

SUMMARY OF THE INVENTION

[0006] An activation determining system for an oxygen sensor according to an aspect of the present invention includes an oxygen sensor, a signal processing circuit, a deactivation determining section and a fuel supply cut-off determining section. The oxygen sensor is configured to output a signal in accordance with an oxygen concentration in an exhaust gas from an internal combustion engine when the oxygen sensor is in an activated state. The signal processing circuit is configured to receive the signal inputted thereto from the oxygen sensor. The signal processing circuit is configured to output a signal in accordance with the signal inputted thereto from the oxygen sensor when the oxygen sensor is in the activated state. The signal processing circuit is configured to output a signal converging to a predetermined lean output value when the oxygen sensor is in the activated state and an oxygen sensor atmosphere is maintained in the same state as the standard atmosphere. The signal processing circuit is configured to output a signal converging to a predetermined convergence value different from the lean output value when the oxygen sensor is maintained in a deactivated state. The deactivation determining section is configured to determine that the oxygen sensor is in the deactivated state when the output value from the signal processing circuit falls in a predetermined deactivation range including the convergence value. The fuel supply cut-off determining section is configured to determine whether or not a fuel supply cut-off is currently executed in the internal combustion engine. Further, the deactivation determining section is configured to determine that the oxygen sensor is in the deactivated state when the output value from the signal processing circuit varies towards the convergence value for a predetermined period of time or longer during execution of the fuel supply cut-off or when the output value from the signal processing circuit varies towards the convergence value by a predetermined amount or greater during execution of the fuel supply cut-off.

Advantageous Effects of Invention

[0007] According to the activation determining system for an oxygen sensor of the aforementioned aspect of the present invention, the deactivation determining section is configured to determine the deactivated state of the oxygen sensor based on the amount of or the period of time of variation in the output value from the signal processing circuit. During execution of the fuel supply cut-off, the oxygen sensor atmosphere enters a state with a large oxygen partial pressure as seen in the standard atmosphere, for instance. Accordingly, the output value from the signal processing circuit does not exceed a predetermined range representing a lean state when the oxygen sensor is in the activated state during execution of the fuel supply cut-off. Therefore, it is possible to appropriately determine that the oxygen sensor is in the deactivated state by detecting that the output value from the signal processing circuit varies towards the convergence value. Further, it is possible to reduce a period of time that the oxygen sensor is determined to be in the deactivated state even though it is actually in the activated state, compared to a configuration of determining that the oxygen sensor is in the deactivated state immediately after execution of the fuel supply cut-off. Therefore, it is possible to execute a control using the output result from the oxygen sensor as long as possible. Exhaust deterioration can be thereby inhibited.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Referring now to the attached drawings which form a portion of this original disclosure:

[0009] FIG. 1 is a side view of a motorcycle according to an exemplary embodiment of the present invention;

[0010] FIG. 2 is a side view of a power unit and a rear wheel according to the exemplary embodiment of the present invention;

[0011] FIG. 3 is a front view of a vehicle body frame, the power unit and the rear wheel according to the exemplary embodiment of the present invention, seen from the front side of a cylinder axis;

[0012] FIG. 4 is a configuration diagram of the engine and a control system;

[0013] FIG. 5 is a configuration block diagram of an electric control unit (ECU);

[0014] FIG. 6 is a schematic configuration diagram of a signal processing circuit and an oxygen sensor;

[0015] FIG. 7 is a chart representing an output characteristic of the signal processing circuit;

[0016] FIG. 8 is a flowchart representing a deactivation determining processing;

[0017] FIG. 9 is a time chart representing output values from the signal processing circuit in the deactivation determining processing;

[0018] FIG. 10 is a time chart representing output values from the signal processing circuit in a deactivation determining processing according to one of the other exemplary embodiments of the present invention;

[0019] FIG. 11 is a schematic configuration diagram of a signal processing circuit and an oxygen sensor according to one of the other exemplary embodiments of the present invention;

[0020] FIG. 12 is a time chart representing output values from the signal processing circuit in the deactivation determining processing according to one of the other exemplary embodiments of the present invention;

[0021] FIG. 13 is a flowchart representing the deactivation determining processing according to one of the other exemplary embodiments of the present invention;

[0022] FIG. 14 is a time chart representing output values from the signal processing circuit in a deactivation determining processing according to one of the other exemplary embodiments of the present invention; and

[0023] FIG. 15 is a time chart representing output values in a deactivation determining processing according to one of the other exemplary embodiments of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0024] An exemplary embodiment of the present invention will be hereinafter explained with reference to the drawings. FIG. 1 is a side view of a motorcycle 1 as a saddle-ride type vehicle according to an exemplary embodiment of the present invention. It should be noted that crisscrossed arrows in the drawings represent respective directions. Reference numerals "F", "Rr", "U" "Lo", "R" and "L", attached to the arrows, refer to "front", "rear", "upper", "lower", "right" and "left" directions, respectively. Further, it should be noted in the present exemplary embodiment that the front, rear, right, left, upper and lower directions respectively refer to the directions seen from a rider seated on a seat 5.

[0025] The motorcycle 1 is of a scooter type. The motorcycle 1 includes a vehicle body frame 2 and a power unit 3. The power unit 3 is attached to the vehicle body frame 2. Specifically, the power unit 3 is attached to the vehicle body frame 2 while being pivotable up and down. The seat 5 is disposed over the power unit 3 for allowing a rider to be seated thereon. A handle unit 6 and a front wheel 7 are disposed forwards of the seat 5. A foot rest 8 is disposed between the seat 5 and the handle unit 6 for allowing a rider to put his/her feet thereon. A rear wheel 9 is disposed under the seat 5. A rear cushion unit 10 is disposed between the power unit 3 and the vehicle body frame 2.

[0026] The power unit 3 includes an engine 11 and a power transmission 12. The engine 11 corresponds to an internal combustion engine of the present invention. The rear wheel 9 is rotatably attached to the rear portion of the power transmission 12. Driving force generated in the engine 11 is transmitted to the rear wheel 9 through the power transmission 12.

[0027] FIG. 2 is a side view of the power unit 3 and the rear wheel 9. The rear wheel 9 is disposed rearwards of the engine 11. The rear wheel 9 is disposed for aligning with the power transmission 12 in the transverse (i.e., right-and-left) direction of the motorcycle 1. The engine 11 includes a crankcase 13, a cylinder body 14, a cylinder head 15 and a cylinder head cover 16. The cylinder body 14 is attached to the crankcase 13. The cylinder body 14 is disposed forwards of the crankcase 13. The cylinder head 15 is attached to the cylinder body 14. The cylinder head 15 is disposed forwards of the cylinder body 14. The cylinder head cover 16 is attached to the cylinder head 15. The cylinder head cover 16 is disposed forwards of the cylinder head 15. An air intake duct 21 is connected to the top surface of the cylinder head 15. An air cleaner 22 is connected to the air intake duct 21. The air intake duct 21 forms an air intake path 31 (see FIG. 4) to be described. Air is supplied to a combustion chamber of the engine 11 through the air intake duct 21. Further, the cylinder head 15 includes an exhaust port 23 on the bottom surface thereof. The exhaust port 23 is protruded downwards from the bottom surface of the cylinder head 15. An exhaust duct 24 is connected to the exhaust port 23. A muffler 25 is connected to the exhaust duct 24. The exhaust port 23 and the exhaust duct 24 form an exhaust path 36 to be described (see FIG. 4). Exhaust gas is discharged from the combustion chamber of the engine 11 through the exhaust duct 24.

[0028] In FIGS. 1 and 2, a dashed dotted line A is the cylinder axis of the engine 11. The cylinder axis A is tilted forwardly upwards in the longitudinal (back-and-forth) direction of the motorcycle 1. It should be noted that each of the angles, formed by the cylinder axis A and the longitudinal direction of the motorcycle 1, is not limited to a particular angle. For example, the tilt angle of the cylinder axis A with respect to the longitudinal direction of the motorcycle 1 may be 0 degrees. In other words, the cylinder axis A may be overlapped with the longitudinal direction of the motorcycle 1.

[0029] FIG. 3 is a front view of the vehicle body frame 2, the power unit 3 and the rear wheel 9, seen from the front side of the cylinder axis A. The vehicle body frame 2 includes a pair of a left-side frame 2a and a right-side frame 2b. The right and left frames 2a and 2b are disposed at a predetermined interval in the transverse direction. As illustrated in FIGS. 1 and 2, the frames 2a and 2b are extended rearwards and upwards in a side view. Further, the frames 2a and 2b intersect with the engine 11 in a side view. As illustrated in FIG. 3, the power transmission 12 is disposed on the left side of the engine 11. Further, the power transmission 12 is disposed rearwards of the frames 2a and 2b. The crankcase 13 is disposed rearwards of the frames 2a and 2b. The rear wheel 9 is disposed rearwards of the engine 11. Seen from the front side of the cylinder axis A, the cylinder body 14, the cylinder head 15 and the cylinder head cover 16 are herein disposed transversely between the frames 2a and 2b for allowing the power unit 3 to pivot up and down without being interfered with by the frames 2a and 2b. Further, an oxygen sensor 40 to be described is attached to the cylinder head 15. The oxygen sensor 40 is configured to detect concentration of oxygen in the exhaust gas to be discharged from the combustion chamber of the engine 11. Specifically, the oxygen sensor 40 is attached to the exhaust port 23 of the cylinder head 15.

[0030] FIG. 4 is a configuration diagram of the engine 11 and a control system of the engine 11. As illustrated in FIG. 4, the engine 11 includes a piston 26, a crankshaft 27 and a conrod (connecting rod) 28. The piston 26 is movably disposed within the cylinder body 14. The crankshaft 27 is rotatably disposed within the aforementioned crankcase 13. The conrod 28 couples the piston 26 and the crankshaft 27.

[0031] Further, the engine 11 includes a fuel injecting valve 32, an ignition device 33, an intake valve 34 and an exhaust valve 35. The fuel injecting valve 32 is configured to supply fuel to a combustion chamber 29 within the cylinder head 15. In the present exemplary embodiment, the fuel injecting valve 32 is disposed for injecting fuel into the air intake path 31. It should be noted that the fuel injecting valve 32 may be disposed for injecting fuel into the combustion chamber 29. The fuel injecting valve 32 is connected to a fuel tank 38 through a fuel pipe 37. The fuel tank 38 includes a fuel pump 39 and a fuel sensor 46 in the inside thereof. The fuel pump 39 is configured to supply fuel to the fuel pipe 37. The fuel sensor 46 is configured to detect the amount of fuel contained in the fuel tank 38. The ignition device 33 is configured to ignite fuel contained in the combustion chamber 29. The engine 11 includes a rotary speed sensor 41 and an engine temperature sensor 42. The rotary speed sensor 41 is configured to detect the rotary speed of the crankshaft 27 for detecting the engine speed. The engine temperature sensor 42 is configured to detect the temperature of the engine 11. It should be noted that the engine temperature sensor 42 may be configured to detect the temperature of a portion (e.g., the cylinder) of the engine 11. When the engine 11 is of a water-cooled type, the engine temperature sensor 42 may be alternatively configured to detect the temperature of a coolant of the engine 11. In other words, the engine temperature sensor 42 may be configured to directly detect the temperature of the engine 11. Alternatively, the engine temperature sensor 42 may be configured to indirectly detect the temperature of the engine 11 through the detection of the temperature of the coolant or the like. The intake valve 34 is configured to be opened or closed for connecting or disconnecting the air intake path 31 and the combustion chamber 29. On the other hand, the exhaust valve 35 is configured to be opened or closed for connecting or disconnecting the combustion chamber 29 and the exhaust path 36.

[0032] The air intake path 31 is provided with an intake temperature sensor 43 and an intake pressure sensor 44. The intake temperature sensor 43 is configured to detect the temperature of air to be inhaled into the combustion chamber 29 through the air intake path 31. The intake pressure sensor 44 is configured to detect the intake pressure that is the internal pressure of the air intake path 31. Further, the air intake path 31 is provided with a throttle valve 51. The opening degree of the throttle valve 51 is configured to be regulated for regulating the amount of air to be supplied to the combustion chamber 29 through the air intake path 31. The throttle valve 51 is provided with a throttle position sensor 45 (see FIG. 5). The throttle position sensor 45 is configured to detect the opening degree of the throttle valve 51 (hereinafter referred to as "a throttle opening degree").

[0033] The exhaust path 36 is provided with a catalyst 52. Further, the exhaust path 36 is provided with the oxygen sensor 40 as an air-fuel ratio sensor, as described above. The oxygen sensor 40 can detect which of a rich state or a lean state the mixture gas is in. The rich state herein refers to a state that the air-fuel ratio of the mixture gas is less than a theoretical air-fuel ratio thereof. By contrast, the lean state herein refers to a state that the air-fuel ratio of the mixture gas is greater than the theoretical air-fuel ratio thereof. The oxygen sensor 40 will be described in detail in the following paragraphs.

[0034] The motorcycle 1 includes an ECU (Electric Control Unit) 60 configured to control the engine 11. FIG. 5 is a configuration block diagram of the ECU 60. The ECU 60 includes a computing portion 61, a storage portion 62, an input portion 63 and an output portion 64. The computing portion 61 includes a CPU, for instance, and is configured to execute a variety of computing processing for controls to be described. The storage portion 62 includes memory devices such as a ROM and a RAM, for instance, and is configured to store a variety of information and control programs for executing controls to be described. Each of the input and output portions 63 and 64 includes an interface circuit. The aforementioned various sensors 40 to 46 are connected to the input portion 63. The input portion 63 is configured to receive a detection signal from each of the sensors 40 to 46. Specifically, the sensors connected to the input portion 63 include the rotary speed sensor 41, the engine temperature sensor 42, the intake temperature sensor 43, the intake pressure sensor 44, the throttle position sensor 45, the oxygen sensor 40 and the fuel sensor 46. On the other hand, the fuel injecting valve 32 and the ignition device 33 are connected to the output portion 64. The output portion 64 is configured to output a command signal to the fuel injecting valve 32 and the ignition device 33 based on the result of the computing processing executed by the computing portion 61.

[0035] The ECU 60 is configured to execute a variety of controls such as a control of the amount of fuel to be injected from the fuel injecting valve 32 and a control of the timing of ignition by the ignition device 33 based on the signals from the respective sensors 40 to 46. Specifically, the ECU 60 is configured to correct the period of time of opening the fuel injecting valve 32 based on the signal from the oxygen sensor 40. Accordingly, a feedback control is executed for the air-fuel ratio of the mixture gas in order to obtain a desired air-fuel ratio. It should be noted that detection accuracy of the oxygen sensor 40 is deteriorated when the temperature of the solid electrolyte element in the oxygen sensor 40 is low. In other words, the oxygen sensor 40 is in a deactivated state and detection reliability thereof is lowered when the temperature thereof is low. By contrast, the oxygen sensor 40 is in an activated state and detection reliability thereof is elevated when the temperature thereof is sufficiently high. It is difficult to accurately control the air-fuel ratio when a feedback control is executed for the air-fuel ratio of the mixture gas based on the signal from the oxygen sensor 40 under the condition that the oxygen sensor 40 is in the deactivated state. In view of the above, the ECU 60 is firstly configured to determine which of the activated state and the deactivated state the oxygen sensor 40 is in. When determining that the oxygen sensor 40 is in the activated state, the ECU 60 is configured to execute the aforementioned feedback control. When determining that the oxygen sensor 40 is in the deactivated state, by contrast, the ECU 60 is configured to execute not the aforementioned feedback control but a feedforward control for the fuel injecting valve 32 based on the fuel injection controlling amount preliminarily stored in the storage portion 62. The following explanation relates to the activation determining system for the oxygen sensor 40, i.e., the system for determining which of the deactivated state and the activated state the oxygen sensor 40 is in. The activation determining system for the oxygen sensor 40 includes the oxygen sensor 40, a fuel supply cut-off determining section 65, a deactivation determining section 66 and a lean/rich determining section 67.

[0036] The oxygen sensor 40 is a sensor using a solid electrolyte made of, for instance, stabilized zirconia. In the activated state, the oxygen sensor 40 is configured to output a signal with a voltage value in accordance with the concentration of oxygen in the exhaust gas. FIG. 6 is a schematic configuration diagram of the oxygen sensor 40 and the input portion 63. As represented in FIG. 6, the input portion 63 includes a signal processing circuit 68 to be connected to the oxygen sensor 40. The signal processing circuit 68 is configured to receive the signal from the oxygen sensor 40. The signal processing circuit 68 is a pull-up circuit and includes an input line 69 and a pull-up resistance R1. The input line 69 connects the oxygen sensor 40 and the computing portion 61. The input line 69 is connected to a power source Vcc, while the pull-up resistance R1 is disposed between the power source Vcc and the input line 69.

[0037] FIG. 7 represents an output characteristic of a signal to be outputted from the signal processing circuit 68 to the computing portion 61. In the chart of FIG. 7, the vertical axis represents an output value (voltage) from the signal processing circuit 68, whereas the horizontal axis represents time. A solid line L1 represents a signal to be outputted from the signal processing circuit 68 when the oxygen sensor 40 is in the activated state. The signal processing circuit 68 is configured to output a signal to the computing portion 61 in accordance with a signal inputted thereto from the oxygen sensor 40 when the oxygen sensor 40 is in the activated state. The oxygen sensor 40 is a binary sensor. The binary oxygen sensor is of a type that the output value thereof extremely varies when the rich state is changed into the lean state and vice versa. As represented with the solid line L1 in FIG. 7, the signal processing circuit 68 is configured to output a signal with an output value converging towards a predetermined rich output value VR when the mixture gas is in the rich state. By contrast, the signal processing circuit 68 is configured to output a signal with an output value converging towards a predetermined lean output value VL when the mixture gas is in the lean state. Therefore, the signal processing circuit 68 is configured to output a signal with an output value converging to the lean output value VL when the oxygen sensor 40 is in the activated state and the atmosphere of the oxygen sensor 40 is simultaneously maintained in the same state as the standard atmosphere. In the oxygen sensor 40 of the present exemplary embodiment, the rich output value VR is greater than the lean output value VL. For example, the lean output value VL is 0 volts.

[0038] In FIG. 7, a broken line L2 represents a signal to be outputted from the signal processing circuit 68 when the oxygen sensor 40 is in the deactivated state. As represented with the broken line L2, the signal processing circuit 68 is configured to output a signal with an output value converging to a predetermined convergence value VP when the oxygen sensor 40 is in the deactivated state. As described above, the signal processing circuit 68 is a pull-up circuit. An internal resistance R0 of the oxygen sensor 40 is locally maximized when the oxygen sensor 40 is in the deactivated state. The signal processing circuit 68 is herein configured to output a signal with a predetermined pull-up voltage to be produced by the pull-up resistance R1 and the power source Vcc in the signal processing circuit 68. Therefore, an output value from the signal processing circuit 68 converges to the predetermined pull-up voltage greater than 0 volts when the oxygen sensor 40 is in the deactivated state. The aforementioned convergence value VP thus corresponds to the pull-up voltage. The pull-up voltage is an intermediate value between the lean output value VL and the rich output value VR. In the present exemplary embodiment, the pull-up voltage is greater than the lean output value VL and is less than the rich output value VR. In other words, the convergence value VP is different from the lean output value VL. The oxygen sensor 40 is herein so-called a heater-less sensor, and is not equipped with a heater for heating the aforementioned element. Therefore, the exhaust gas from the engine 11 functions as a heat source for heating the element of the oxygen sensor 40. Therefore, the oxygen sensor 40 is in the deactivated state when the temperature of the exhaust gas from the engine 11 is lowered. When the oxygen sensor 40 is in the deactivated state, the output value from the signal processing circuit 68 converges towards the convergence value VP.

[0039] As represented in FIG. 5, the lean/rich determining section 67, the fuel supply cut-off determining section 65 and the deactivation determining section 66 are included in the aforementioned computing portion 61. In other words, the computing portion 61 is configured to execute a function as the lean/rich determining section 67, a function as the fuel supply cut-off determining section 65 and a function as the deactivation determining section 66.

[0040] The fuel supply cut-off determining section 65 is configured to determine whether or not fuel supply cut-off is currently executed for the engine 11. For example, the fuel supply cut-off determining section 65 is configured to determine whether or not the fuel supply cut-off is currently executed for the engine 11 based on a command signal to the fuel injecting valve 32. Alternatively, the fuel supply cut-off determining section 65 may be configured to determine whether or not the fuel supply cut-off is currently executed for the engine 11 based on the engine speed and the throttle opening degree. It should be noted that the fuel supply cut-off is configured to be executed when a single or plurality of predetermined conditions for executing the fuel supply cut-off is satisfied during travelling of the motorcycle 1. An exemplary condition for executing the fuel supply cut-off is that the engine speed becomes greater than or equal to a predetermined speed, and simultaneously, the throttle opening degree is less than or equal to a predetermined opening degree. By contrast, the fuel supply cut-off is stopped and the normal operation is executed again when a single or plurality of predetermined conditions for stopping the fuel supply cut-off is satisfied during execution of the fuel supply cut-off. An exemplary condition for stopping the fuel supply cut-off is that the engine speed becomes less than or equal to a predetermined speed. Accordingly, engine stalls are prevented. Alternatively, an exemplary condition for stopping the fuel supply cut-off may be that the throttle opening degree becomes greater than or equal to a predetermined degree. Accordingly, the fuel supply cut-off can be stopped in response to a rider' s demand for acceleration.

[0041] The deactivation determining section 66 is configured to determine that the oxygen sensor 40 is in the deactivated state when the output value from the signal processing circuit 68 falls in a predetermined deactivation range during execution of the normal operation, i.e., during non-execution of the fuel supply cut-off. As represented in FIG. 7, the predetermined deactivation range Rna includes the aforementioned convergence value VP. The deactivation determining section 66 is configured to determine that the oxygen sensor 40 is in the deactivated state when the output value from the signal processing circuit 68 falls in the deactivation range Rna for a predetermined period of time or longer during non-execution of the fuel supply cut-off. An appropriate period of time for determining the deactivated state of the oxygen sensor 40 has been preliminarily obtained through experiments, simulations and/or the like, and is herein set as the predetermined period of time. The predetermined deactivation range Rna is a range between a first activation determining value VI and a second activation determining value V2. The first activation determining value V1 is an intermediate value between the lean output value VL and the convergence value VP. In the present exemplary embodiment, the first activation determining value V1 is greater than the lean output value VL and is less than the convergence value VP. The second activation determining value V2 is an intermediate value between the rich output value VR and the convergence value VP. In the present exemplary embodiment, the second activation determining value V2 is less than the rich output value VR and is greater than the convergence value VP. Further, the second activation determining value V2 is greater than the first activation determining value V1. An appropriate value for accurately determining whether or not the oxygen sensor 40 is in the deactivated state has been preliminarily obtained through experiments, simulations and/or the like, and is herein set as each of the first and second activation determining values V1 and V2. The deactivation determining section 66 is configured to determine that the oxygen sensor 40 is in the deactivated state when the output value from the signal processing circuit 68 is greater than or equal to the first activation determining value V1 and is simultaneously less than or equal to the second activation determining value V2. The temperature of the exhaust gas is lowered, for instance, in a low temperature environment or when the engine 11 is idled while the temperature thereof is lowered because of rain. In such situations, the temperature of the oxygen sensor 40 is lowered and enters the deactivated state even during non-execution of the fuel supply cut-off. It should be noted that a range between the lean output value VL and the first activation determining value V1 will be hereinafter referred to as "a first activation range Ra1". Further, the aforementioned range between the rich output value VR and the second activation determining value V2 will be hereinafter referred to as "a second activation range Ra2". The deactivation range Rna is set between the first activation range Ra1 and the second activation range Ra2. The deactivation determining section 66 is configured to determine that the oxygen sensor 40 is in the activated state when the output value from the signal processing circuit 68 falls in the first activation range Ra1 for a predetermined period of time or longer during execution of the normal operation. Further, the deactivation determining section 66 is configured to determine that the oxygen sensor 40 is in the activated state when the output value from the signal processing circuit 68 falls in the second activation range Ra2 for a predetermined period of time or longer during execution of the normal operation. An appropriate period of time for determining the activated state of the oxygen sensor 40 has been preliminarily obtained through experiments, simulations and/or the like, and is herein set as the predetermined period of time.

[0042] The lean/rich determining section 67 is configured to compare the output value from the signal processing circuit 68 with a predetermined determining threshold VA under the condition that the oxygen sensor 40 is determined to be in the activated state in order to determine which of the lean state and the rich state the mixture gas is in. Specifically, the lean/rich determining section 67 is configured to determine that the mixture gas is in the lean state when the output value from the signal processing circuit 68 is less than or equal to the predetermined determining threshold VA under the condition that the oxygen sensor 40 is determined to be in the activated state. By contrast, the lean/rich determining section 67 is configured to determine that the mixture gas of the engine 11 is in the rich state when the output value from the oxygen sensor 40 is greater than or equal to the predetermined determining threshold VA under the condition that the oxygen sensor 40 is determined to be in the activated state. The determining threshold VA is an intermediate value between the first activation range Ra1 and the second activation range Ra2. Therefore, the determining threshold VA falls in the deactivation range Rna.

[0043] The deactivation determining section 66 is configured to execute a deactivation determining processing represented in FIG. 8 when the fuel supply cut-off determining section 65 determines that the fuel supply cut-off of the engine 11 is currently executed.

[0044] First in Step S1, an output value Vd (n) from the signal processing circuit 68 (hereinafter simply referred to as "an output value Vd(n) ") is loaded in the deactivation determining section 66. Loading of the output value Vd (n) is configured to be repeated at predetermined cycles as described below. For example, the output value Vd (n) is configured to be loaded at a cycle that a calculation for the feedback control is executed based on the output value Vd (n) . It should be noted that "n" represents frequency of calculations for the feedback control. Specifically, "n" is set to be 1 in the first calculation. Likewise, "n" is set to be 2 in the second calculation. FIG. 9 is an exemplary time chart representing variation in the output value Vd(n) when the fuel supply cut-off is executed. In a time period from a point-of-time to to a point-of-time t1, the oxygen sensor 40 is in the activated state while the mixture gas is in the rich state. Therefore, the output value Vd(n) falls in the second activation range Ra2. When the fuel supply cut-off is executed at the point-of-time t1, the atmosphere of the oxygen sensor 40 becomes similar to the standard atmosphere with a large oxygen partial pressure. In other words, the atmosphere of the oxygen sensor 40 becomes the lean state when the fuel supply cut-off is executed. Therefore, the output value Vd(n) is reduced and falls in the first activation range Ra1 at the point-of-time t1 and thereafter.

[0045] Next in Step S2, it is determined whether or not the output value Vd(n) is less than a bottom output value Vbottom. The processing proceeds to Step S3 when the output value Vd(n) is less than the bottom output value

Vbottom. In Step S3, the output value Vd(n) is set as the bottom output value. The processing then returns to Step S1. It should be noted that the output value Vd (n) is set as the bottom output value Vbottom in the first calculation without execution of Steps S2 and S3. Through the processing of Steps S1 to S3, the bottom output value Vbottom is updated to the newly loaded output value Vd (n) when the output value Vd (n) is continuously reduced (from the point-of-time t1 to a point-of-time t2) after the onset of the fuel supply cut-off as represented in FIG. 9.

[0046] On the other hand, the processing proceeds to Step S4 when it is determined in Step S2 that the output value Vd(n) is greater than or equal to the bottom output value Vbottom. As represented in FIG. 9, the output value Vd(n) is herein reduced to the minimum (at the point-of-time t2) after the onset of the fuel supply cut-off. In other words, the output value Vd(n) reaches the lean output value VL. The minimum of the output value Vd(n) is then set as the bottom output value Vbottom. In FIG. 9, the minimum of the output value Vd(n) is equal to the lean output value VL. However, the minimum of the output value Vd(n) may be greater than the lean output value VL.

[0047] In Step S4, it is determined whether or not a difference between the output value Vd(n) and the bottom output value Vbottom is greater than or equal to a predetermined threshold Vth. As represented in FIG. 9, it is herein determined whether or not an increase dV from the minimum of the output value Vd (n) is greater than or equal to the predetermined threshold Vth. The processing returns to Step S1 when the difference between the output value Vd(n) and the bottom output value Vbottom is not greater than or equal to the predetermined threshold Vth. On the other hand, the processing proceeds to Step S5 when the difference between the output value Vd(n) and the bottom output value Vbottom is greater than or equal to the predetermined threshold Vth. In Step S5, it is determined that the oxygen sensor 40 is in the deactivated state. Specifically, it is determined that the oxygen sensor 40 is in the deactivated state when the increase dV from the minimum of the output value Vd(n) becomes greater than or equal to the predetermined threshold Vth (at a point-of-time t3) as represented in FIG. 9. That is to say, it is determined that the oxygen sensor 40 is in the deactivated state when the output value Vd(n) varies towards the convergence value VP by a predetermined amount or greater during execution of the fuel supply cut-off. In other words, it is determined that the oxygen sensor 40 is in the deactivated state when the output value Vd (n) varies towards the convergence value VP by a predetermined amount or greater from a value most deviating from the convergence value VP during execution of the fuel supply cut-off. Further put differently, it is determined that the oxygen sensor 40 is in the deactivated state when the output value Vd(n) varies towards the convergence value VP by a predetermined amount or greater from a value as a turning point from a trend deviating from the convergence value VP to a trend converging to the convergence value VP during execution of the fuel supply cut-off. It should be noted that a value for appropriately determining that the oxygen sensor 40 enters the deactivated state during execution of the fuel supply cut-off has been preliminarily obtained through experiments, simulations and/or the like, and is herein set as the predetermined threshold Vth. The predetermined threshold Vth is less than the first activation determining value V1. In other words, the predetermined threshold Vth is an intermediate value between the lean output value VL and the first activation determining value V1. It should be noted that the output value Vd(n) and the bottom output value Vbottom are configured to be reset at the end of the fuel supply cut-off.

[0048] The activation determining system for the oxygen sensor 40 according to the present exemplary embodiment has the following features.

[0049] The deactivation determining section 66 is configured to determine the deactivation state of the oxygen sensor 40 based on the increase dV from the minimum of the output value Vd(n) after the onset of the fuel supply cut-off. The output value Vd(n) is not increased from the minimum when the oxygen sensor 40 is in the activated state during execution of the fuel supply cut-off. In other words, a signal with thus increasing output value Vd (n) is not continuously outputted during execution of the fuel supply cut-off when the oxygen sensor 40 is in the activated state. Therefore, it is possible to appropriately determine that the oxygen sensor 40 is in the deactivated state by detecting that the output value Vd(n) is increased towards the convergence value VP. Further, the feedback control can be herein executed as long as possible, compared to the configuration of determining the deactivated state of the oxygen sensor 40 and stopping the feedback control immediately after execution of the fuel supply cut-off. Exhaust deterioration can be thereby inhibited. Yet further, cost increase can be herein inhibited, compared to a structure that a device such as an operational amplifier is added to the input portion 63 of the ECU 60 in order to enhance accuracy in the activation determination for the oxygen sensor 40.

[0050] There is a difference between the method of the deactivation determination for the oxygen sensor 40 during execution of the normal operation and that during execution of the fuel supply cut-off. Specifically, the predetermined threshold Vth to be used in the determination during execution of the fuel supply cut-off is an intermediate value between the lean output value VL and the first activation determining value V1. Therefore, it is possible to determine that the oxygen sensor 40 is in the deactivated state at an earlier stage of a condition that the oxygen sensor 40 is possibly in the deactivated state during execution of the fuel supply cut-off, compared to the configuration of using the same threshold for both the deactivation determination during execution of the normal control and that during execution of the fuel supply cut-off. Especially, the fuel supply cut-off may be executed during travelling of the motorcycle 1. In this case, the deactivation determination for the oxygen sensor 40 can be executed well in advance during travelling of the motorcycle 1 because the deactivated state of the oxygen sensor 40 is determined at an early stage during execution of the fuel supply cut-off as described above. On the other hand, it is often determined that the oxygen sensor 40 is in the deactivated state during execution of the normal operation while the engine 11 is idled. By contrast, the fuel supply cut-off may be executed during travelling of the vehicle. Therefore, it may be determined that the oxygen sensor 40 is in the deactivated state during travelling of the vehicle due to execution of the fuel supply cut-off.

[0051] The signal processing circuit 68 is a pull-up circuit. Therefore, the output value Vd(n) converges towards the convergence value VP when the oxygen sensor 40 is in the deactivated state. It is possible to appropriately determine that the oxygen sensor 40 is in the deactivated state by detecting such variation in the output value Vd(n).

[0052] The oxygen sensor 40 is a binary sensor. Therefore, the output value Vd(n) is not increased from the minimum after the onset of the fuel supply cut-off when the oxygen sensor 40 is in the activated state during execution of the fuel supply cut-off. Therefore, it is possible to appropriately determine that the oxygen sensor 40 is in the deactivated state by detecting variation in the output value Vd(n) as described above.

[0053] In the heater-less oxygen sensor 40, the temperature of the element tends to be lowered during execution of the fuel supply cut-off. Therefore, the present invention is especially effective for the heater-less oxygen sensor 40.

[0054] The exemplary embodiment of the present invention has been explained above. The present invention is not limited to the aforementioned exemplary embodiment, and a variety of changes can be herein made without departing from the scope of the present invention.

[0055] The saddle-ride type vehicle is not limited to the aforementioned motorcycle, and may be other vehicles such as the all-terrain vehicles or the snowmobiles. Further, the motorcycle is not limited to the aforementioned scooter, and may be other motorcycles such as the mopeds or the sport-type motorcycles.

[0056] In the aforementioned exemplary embodiment, the lean output value VL is less than the rich output value VR. As represented in FIG. 10, however, the lean output value VL may be greater than the rich output value VR. In other words, the output value Vd(n) of the aforementioned exemplary embodiment may be herein vertically turned upside down. In this case, it is determined that the oxygen sensor 40 is in the deactivated state when a reduction dV from the maximum of the output value Vd (n) becomes greater than the predetermined threshold Vth.

[0057] The signal processing circuit 68 is not limited to the pull-up circuit and may be a pull-down circuit represented in FIG. 11. Specifically, the signal processing circuit 68 represented in FIG. 11 includes the input line 69 and a pull-down resistance R2. The input line 69 connects the oxygen sensor 40 and the computing portion 61. The input line 69 is connected to a ground G, while the pull-down resistance R2 is disposed between the ground G and the input line 69. When the oxygen sensor 40 is in the deactivated state, the output value Vd (n) from the signal processing circuit 68 converges to 0 V. In other words, the predetermined convergence value of the present invention is herein set to be 0 V. In other words, the lean output value VL is herein required to be different from 0 V. This is because the deactivated state of the oxygen sensor 40 is determined by variation in the output value Vd(n) from the lean output value VL to the convergence value VP.

[0058] The oxygen sensor 40 is not limited to the binary sensor and may be a liner sensor. Specifically, the oxygen sensor 40 may be a sensor of a type configured to linearly output a value in accordance with the oxygen concentration in the activated state. The signal processing circuit 68 may be integrated with the oxygen sensor 40 without being included in the input portion 63 of the ECU 60.

[0059] In the aforementioned activation determination represented in FIG. 8, a smoothing processing may be executed for the loaded output value Vd(n). The smoothing processing herein refers to a processing of averaging the output value Vd(n).

[0060] In the aforementioned exemplary embodiment, the deactivation determining section 66 is configured to determine that the oxygen sensor 40 is in the deactivated state when the increase dV of the output value Vd(n) becomes greater than or equal to the predetermined threshold Vth during execution of the fuel supply cut-off. However, the deactivation determining section 66 may be configured to determine that the oxygen sensor 40 is in the deactivated state when the output value Vd(n) is continuously increased for a predetermined period of time or longer during execution of the fuel supply cut-off. Specifically, as represented in FIG. 12, the deactivation determining section 66 may be configured to determine that the oxygen sensor 40 is in the deactivated state when a period-of-time dt of continuous increase in the output value Vd(n) becomes a predetermined period of time or longer. FIG. 13 is a flowchart representing the deactivation determining processing corresponding to the above configuration.

[0061] First in Step S10, a variable Tm is reset to 0. The variable Tm represents frequency that increase in the output value Vd(n) is consecutively detected as described in the following paragraphs.

[0062] Steps S11 to S13 are the same as Steps S1 to S3 in the aforementioned exemplary embodiment. In short, it is detected that the output value Vd(n) reaches the minimum after the onset of the fuel supply cut-off.

[0063] Next in Step S14, it is determined whether or not the output value Vd(n) is greater than a previously detected output value Vd(n-1). The processing proceeds to Step S15 when the output value Vd(n) is greater than the previously detected output value Vd(n-1). In Step S15, 1 is added to the variable Tm. The consecutively detected frequency of increase in the output value Vd(n) is herein counted after the output value Vd(n) reaches the minimum.

[0064] Next in Step S16, it is determined whether or not the variable Tm is greater than or equal to a predetermined threshold Tth. The processing proceeds to Step S11 and the output value Vd(n) is loaded again when the variable Tm is not greater than or equal to the predetermined threshold Tth. Referring again to Step S14, the processing returns to Step S10 and the variable Tm is reset to 0 when it is determined that the output value Vd (n) is not greater than the previously detected output value Vd(n-1).

[0065] The processing proceeds to Step S17 when it is determined that the variable Tm is greater than or equal to the predetermined threshold Tth in Step S16. In Step S17, it is determined that the oxygen sensor 40 is in the deactivated state. In other words, it is determined that the oxygen sensor 40 is in the deactivated state when the consecutively detected frequency of increase in the output value Vd(n) becomes greater than or equal to the predetermined threshold Tth. It should be noted that a value for appropriately determining that the oxygen sensor 40 enters the deactivated state during execution of the fuel supply cut-off has been preliminarily obtained through experiments, simulation and/or the like, and is herein set as the predetermined threshold Tth.

[0066] As represented in FIG. 12, through the aforementioned deactivation determining processing, it is determined that the oxygen sensor 40 is in the deactivated state when the period-of-time dt of continuous increase in the output value Vd(n) from the lean output value VL becomes greater than or equal to the predetermined period of time. That is to say, the deactivation determining section 66 may be configured to determine that the oxygen sensor 40 is in the deactivated state when the output value Vd(n) continuously varies towards the convergence value VP for a predetermined period of time or longer during execution of the fuel supply cut-off. In other words, the deactivation determining section 66 may be configured to determine that the oxygen sensor 40 is in the deactivated state when the output value Vd (n) continuously varies towards the convergence value VP from a value most deviating from the convergence value VP for a predetermined period of time or longer during execution of the fuel supply cut-off. Further put differently, the deactivation determining section 66 may be configured to determine that the oxygen sensor 40 is in the deactivated state when the output value Vd(n) continuously varies towards the convergence value VP from a value as a turning point from a trend deviating from the convergence value VP to a trend converging to the convergence value VP for a predetermined period of time or longer during execution of the fuel supply cut-off.

[0067] In the deactivation determining processing represented in FIG. 13, the consecutively detected frequency of increase in the output value Vd(n) is used as the information for representing the period of time of continuous increase in the output value Vd(n). However, a timer may be configured to directly count the period of time of continuous increase in the output value Vd(n).

[0068] In the deactivation determining processing represented in FIG. 13, the output value Vd(n) may be vertically turned upside down as represented in FIG. 14. In this case, it is determined that the oxygen sensor 40 is in the deactivated state when a period-of-time dt of continuous reduction in the output value Vd (n) from the maximum becomes a predetermined period-of-time or longer.

[0069] In the aforementioned exemplary embodiment, monitoring of increase in the output value Vd(n) is started from the onset of execution of the fuel supply cut-off. However, monitoring of increase in the output value Vd (n) may be started after a predetermined period of time elapses from the onset of execution of the fuels supply cut-off. As represented in FIG. 15, for instance, the aforementioned determination of the deactivated state for the oxygen sensor may be started after a predetermined period-of-time dt elapses from a point-of-time t1 corresponding to the onset of execution of the fuel supply cut-off. Even when a signal of representing the rich state is outputted in spite of lack of fuel injection immediately after the onset of the fuel supply cut-off, it is possible to prevent wrong determination that the oxygen sensor 40 is in the deactivated state based on the signal. The following reasons are related to the fact that a signal of representing the rich state is outputted in spite of lack of fuel injection immediately after the onset of execution of the fuel supply cut-off. One of the reasons is that it takes time for the exhaust gas to move from the exhaust port of the engine to the oxygen sensor. Therefore, when combustion is in the rich state immediately before the onset of execution of the fuel supply cut-off, a signal of representing the rich state is outputted until the exhaust gas reaches the oxygen sensor from the timing recognized by the ECU regarding the onset of execution of the fuel supply cut-off. Because of this, a signal of representing the rich state is outputted in spite of lack of fuel injection immediately after the onset of execution of the fuel supply cut-off. Another reason is response delay of the oxygen sensor. Yet another reason is that the fuel adhered to the intake port enters the combustion chamber during execution of the fuel supply cut-off and combustion is herein executed. In this case, a signal of representing the rich state is similarly outputted in spite of lack of fuel injection immediately after the onset of execution of the fuel supply cut-off. Even when the aforementioned phenomena occur, wrong determination can be prevented by starting the aforementioned determination of the deactivated state for the oxygen sensor after a predetermined period of time elapses from the onset of execution of the fuel supply cut-off.

Industrial Applicability

[0070] According to the present invention, it is possible to provide an activation determining system for an oxygen sensor for appropriately determining a deactivated state of the oxygen sensor and simultaneously for inhibiting exhaust deterioration.

Reference Signs List

[0071]

40 Oxygen sensor

65 Fuel supply cut-off determining section

66 Deactivation determining section

68 Signal processing circuit

Claims

1. An activation determining system for an oxygen sensor (40), comprising:

   an oxygen sensor (40) configured to output a signal in accordance with an oxygen concentration in an exhaust gas from an internal combustion engine (11) when the oxygen sensor (40) is in an activated state;
   a signal processing circuit (68) configured to receive the signal inputted thereto from the oxygen sensor (40), the signal processing circuit (68) configured to output a signal in accordance with the signal inputted thereto from the oxygen sensor (40) when the oxygen sensor (40) is in the activated state, the signal processing circuit (68) configured to output a signal converging to a predetermined lean output value (VL) when the oxygen sensor (40) is in the activated state and an oxygen sensor atmosphere is maintained in the same state as the standard atmosphere, the signal processing circuit (68) configured to output a signal converging to a predetermined convergence value (VP) different from the lean output value (VL) when the oxygen sensor (40) is maintained in a deactivated state;
   a deactivation determining section (66) configured to determine that the oxygen sensor (40) is in the deactivated state when the output value (Vd(n)) from the signal processing circuit (68) falls in a predetermined deactivation range (Rna) including the convergence value (VP); and
   a fuel supply cut-off determining section (65) configured to determine whether or not a fuel supply cut-off in the internal combustion engine (11) is currently executed,
   wherein the deactivation determining section (66) is configured to determine that the oxygen sensor (40) is in the deactivated state when the output value (Vd(n)) from the signal processing circuit (68) varies towards the convergence value (VP) for a predetermined period of time (Tth) or longer during execution of the fuel supply cut-off or when the output value (Vd(n)) from the signal processing circuit (68) varies towards the convergence value (VP) by a predetermined amount (Vth) or greater during execution of the fuel supply cut-off.

2. The activation determining system for an oxygen sensor (40) according to claim 1,
   wherein the signal processing circuit(68) includes a pull-up circuit (68), and
   the convergence value (VP) is a value of a pull-up voltage of the pull-up circuit (68).

3. The activation determining system for an oxygen sensor (40) according to claim 1,
   wherein the signal processing circuit (68) includes a pull-down circuit (68), and
   the convergence value (VP) is a value of a pull-down voltage of the pull-down circuit (68).

4. The activation determining system for an oxygen sensor (40) according to one of claims 1 to 3, wherein the oxygen sensor (40) is a binary sensor.

5. The activation determining system for an oxygen sensor (40) according to one of claims 1 to 3, wherein the oxygen sensor (40) is a liner sensor.

6. The activation determining system for an oxygen sensor (40) according to one of claims 1 to 5, wherein the deactivation determining section (66) is configured to determine that the oxygen sensor (40) is in the deactivated state when the output value (Vd(n)) from the signal processing circuit (68) falls in the deactivation range (Rna) for a predetermined period of time or longer during non-execution of the fuel supply cut-off.

7. The activation determining system for an oxygen sensor (40) according to one of claims 1 to 6, wherein the oxygen sensor (40) is a heater-less sensor.

8. The activation determining system for an oxygen sensor (40) according to one of claims 1 to 7, wherein the deactivation determining section (66) is configured to determine that the oxygen sensor (40) is in the deactivated state when the output value (Vd(n)) from the signal processing circuit (68) varies towards the convergence value (VP) from a value most deviating from the convergence value (VP) by a pre-

determined amount or greater during execution of the fuel supply cut-off.

9. The activation determining system for an oxygen sensor (40) according to one of claims 1 to 8, wherein the deactivation determining section (66) is configured to determine that the oxygen sensor (40) is in the deactivated state when the output value (Vd(n)) from the signal processing circuit (68) varies towards the convergence value (VP) by a predetermined amount or greater from a value as a turning point from a trend deviating from the convergence value (VP) to a trend converging to the convergence value (VP) during execution of the fuel supply cut-off.

10. The activation determining system for an oxygen sensor (40) according to one of claims 1 to 9, wherein the deactivation determining section (66) is configured to start determination of the deactivated state of the oxygen sensor (40) during execution of the fuel supply cut-off when a predetermined period of time elapses from an onset of execution of the fuel supply cut-off.

11. A saddle-ride type vehicle, comprising:

the activation determining system for an oxygen sensor (40) according to one of claims 1 to 10.

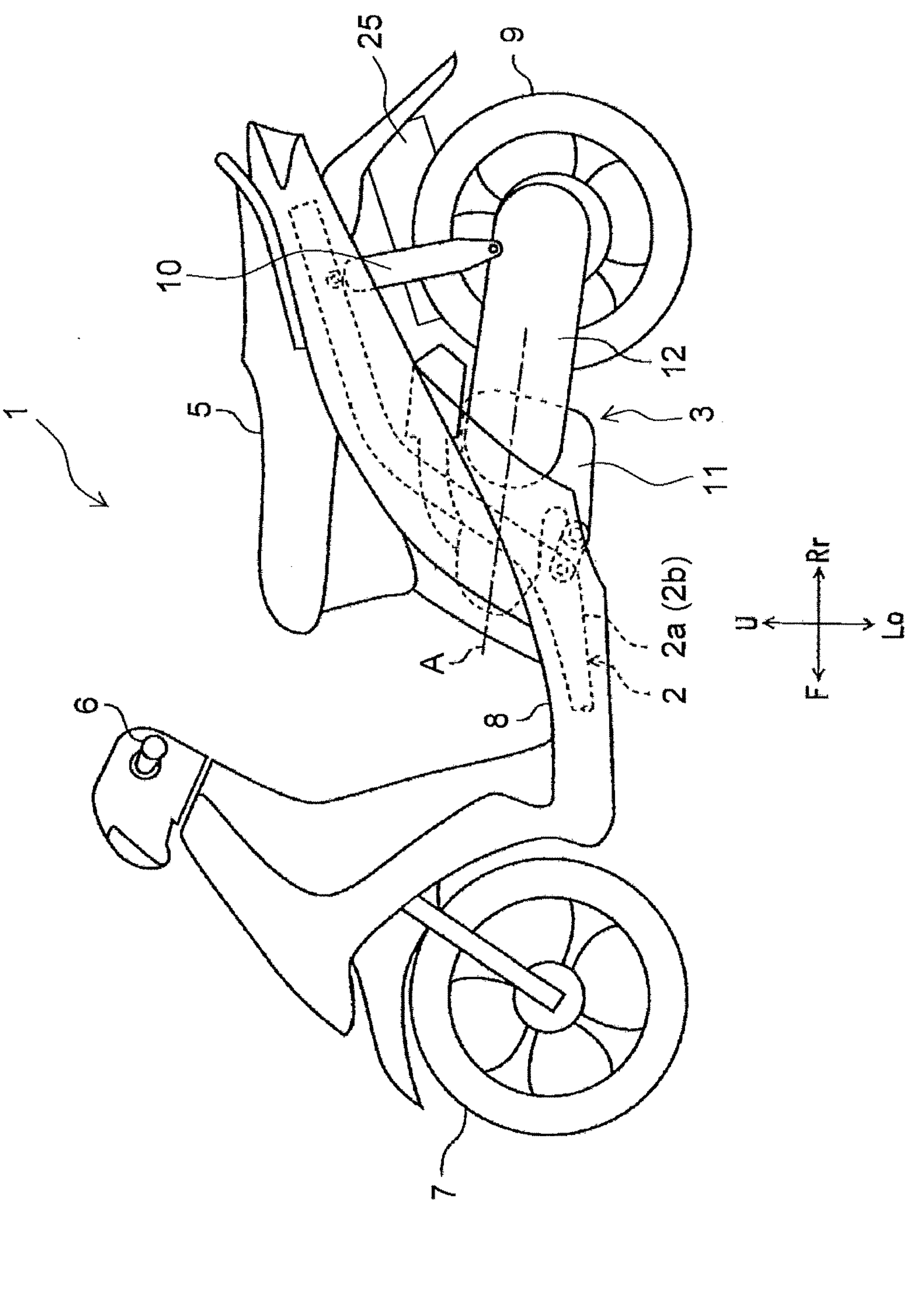

FIG. 1

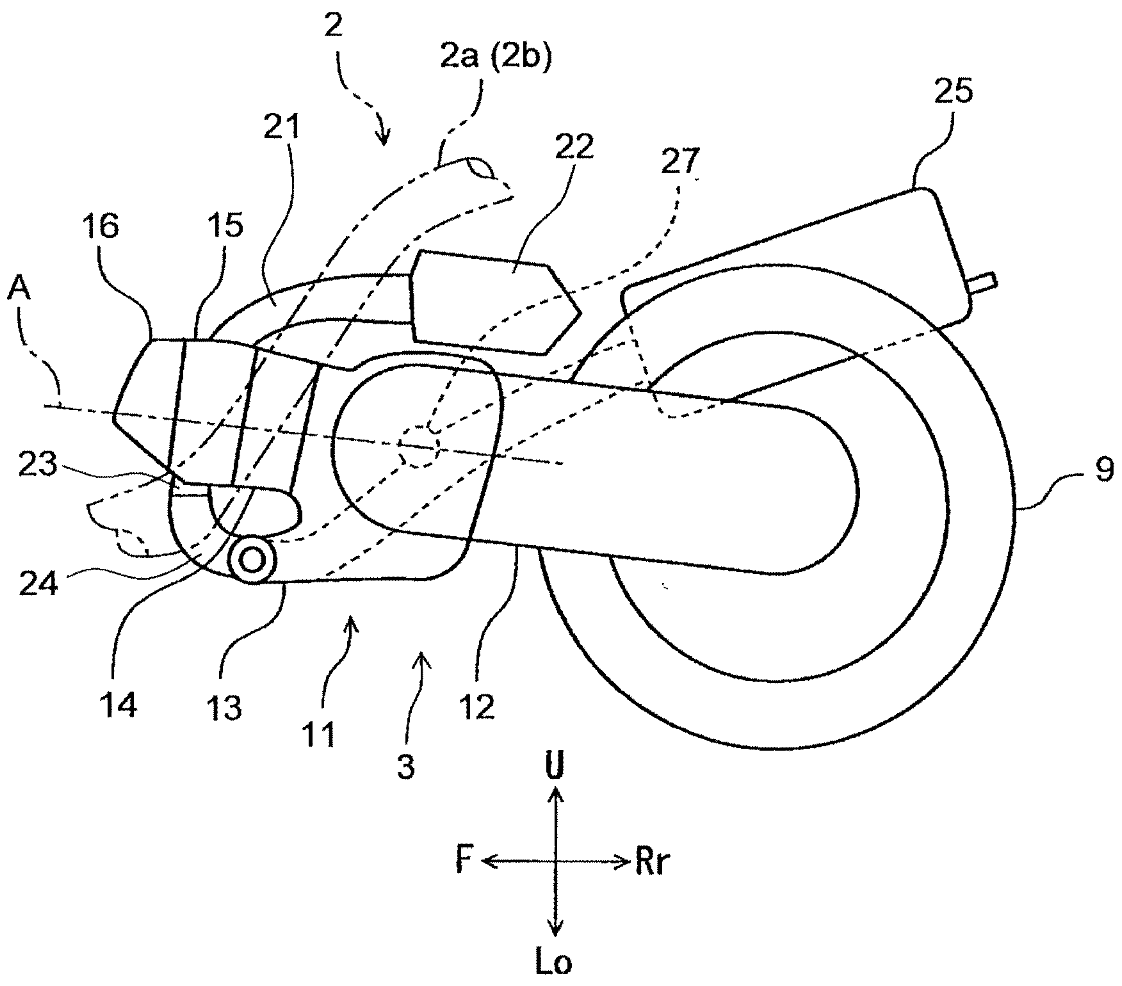

FIG. 2

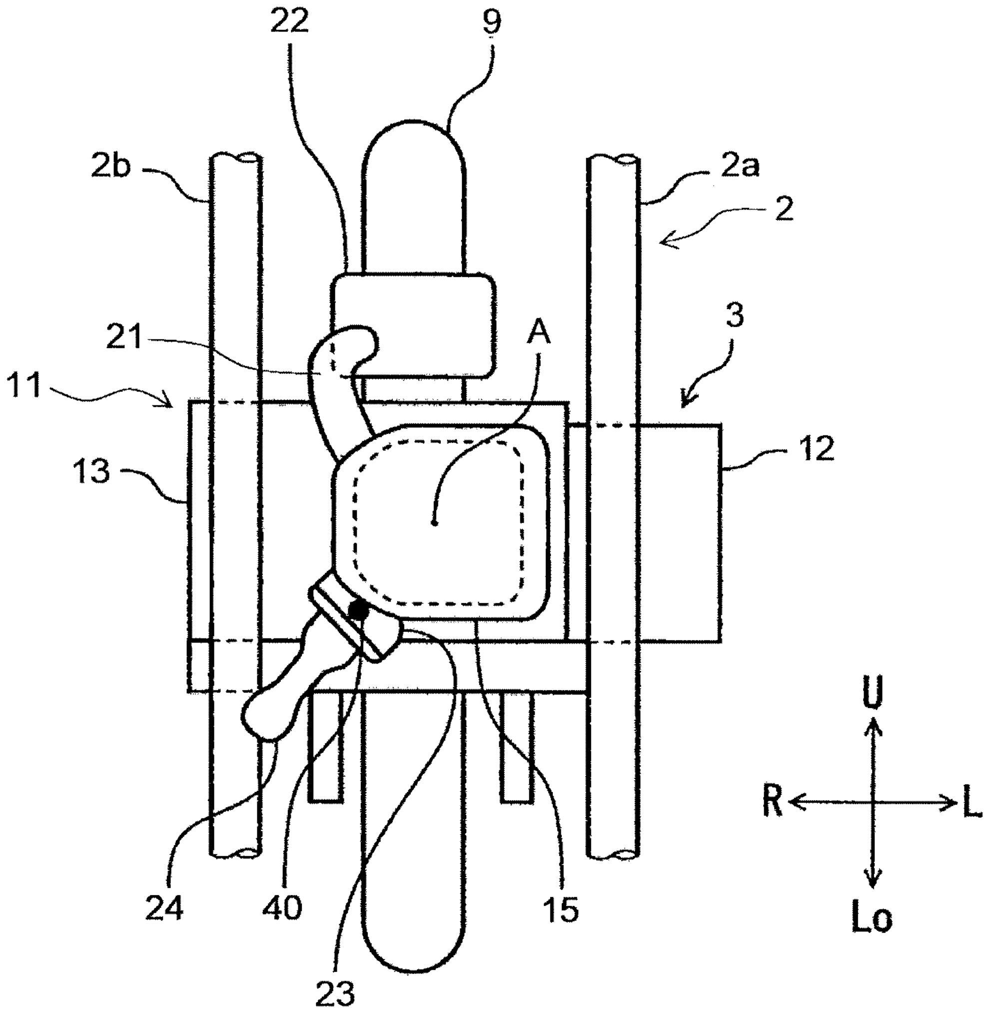

FIG. 3

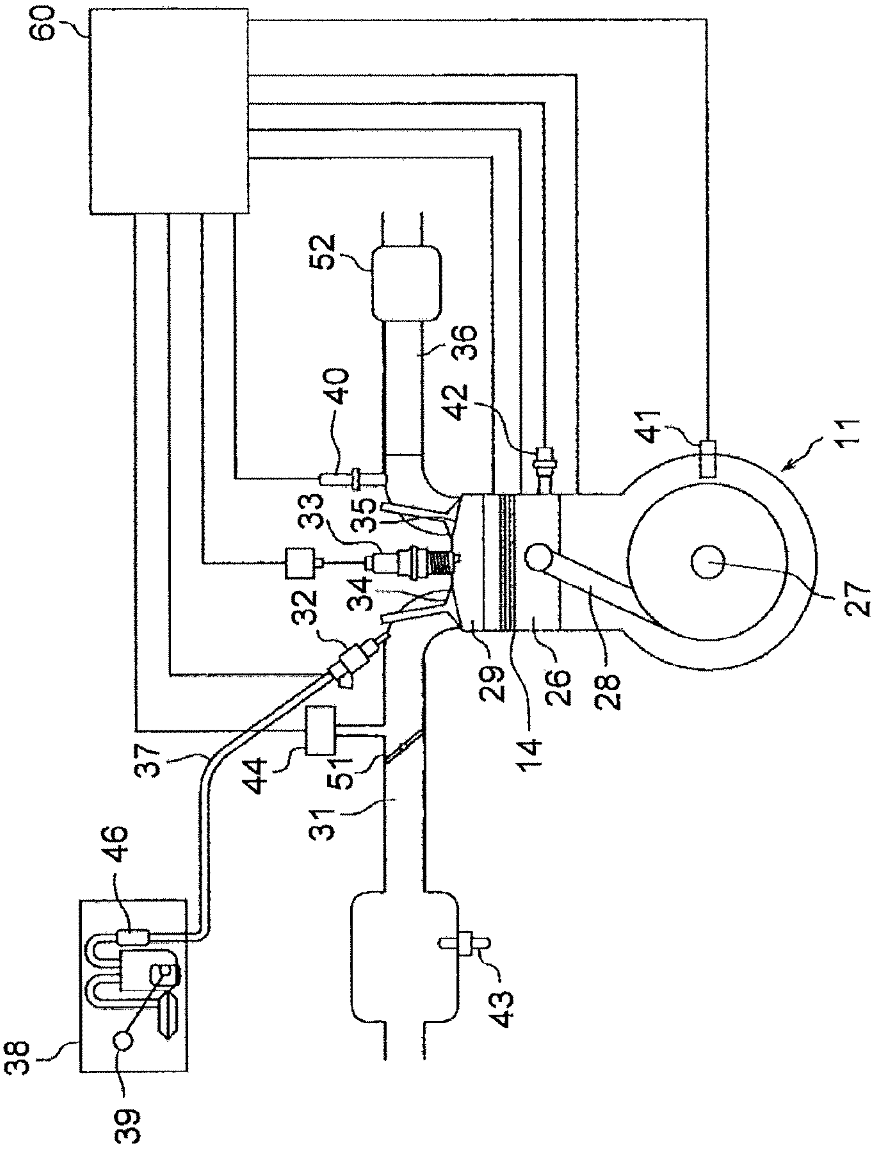

FIG. 4

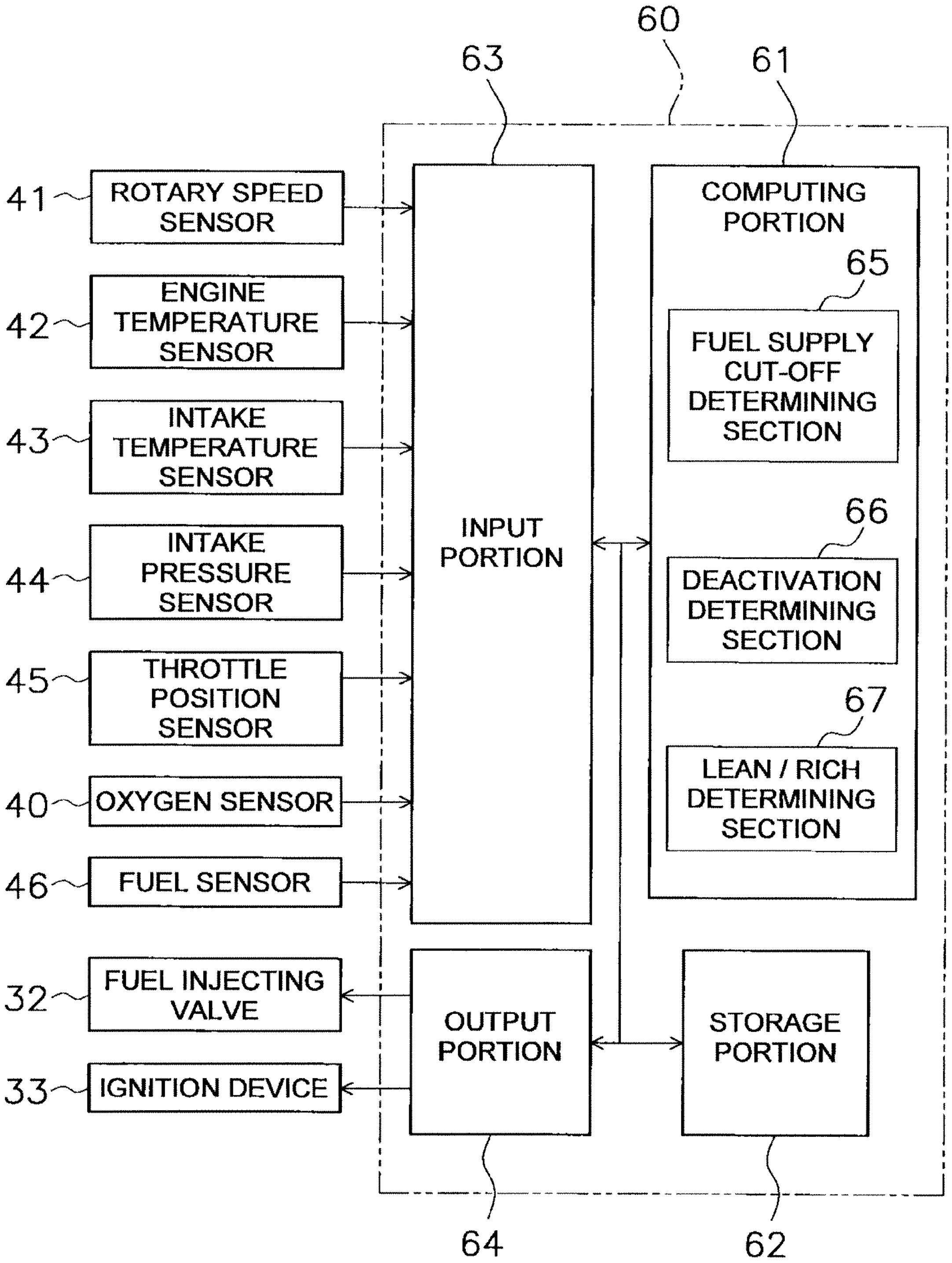
60
63
61
41
ROTARY SPEED SENSOR
42
ENGINE TEMPERATURE SENSOR
43
INTAKE TEMPERATURE SENSOR
44
INTAKE PRESSURE SENSOR
45
THROTTLE POSITION SENSOR
40
OXYGEN SENSOR
46
FUEL SENSOR
32
FUEL INJECTING VALVE
33
IGNITION DEVICE
INPUT PORTION
COMPUTING PORTION
65
FUEL SUPPLY CUT-OFF DETERMINING SECTION
66
DEACTIVATION DETERMINING SECTION
67
LEAN / RICH DETERMINING SECTION
OUTPUT PORTION
STORAGE PORTION
64
62

Fig. 5

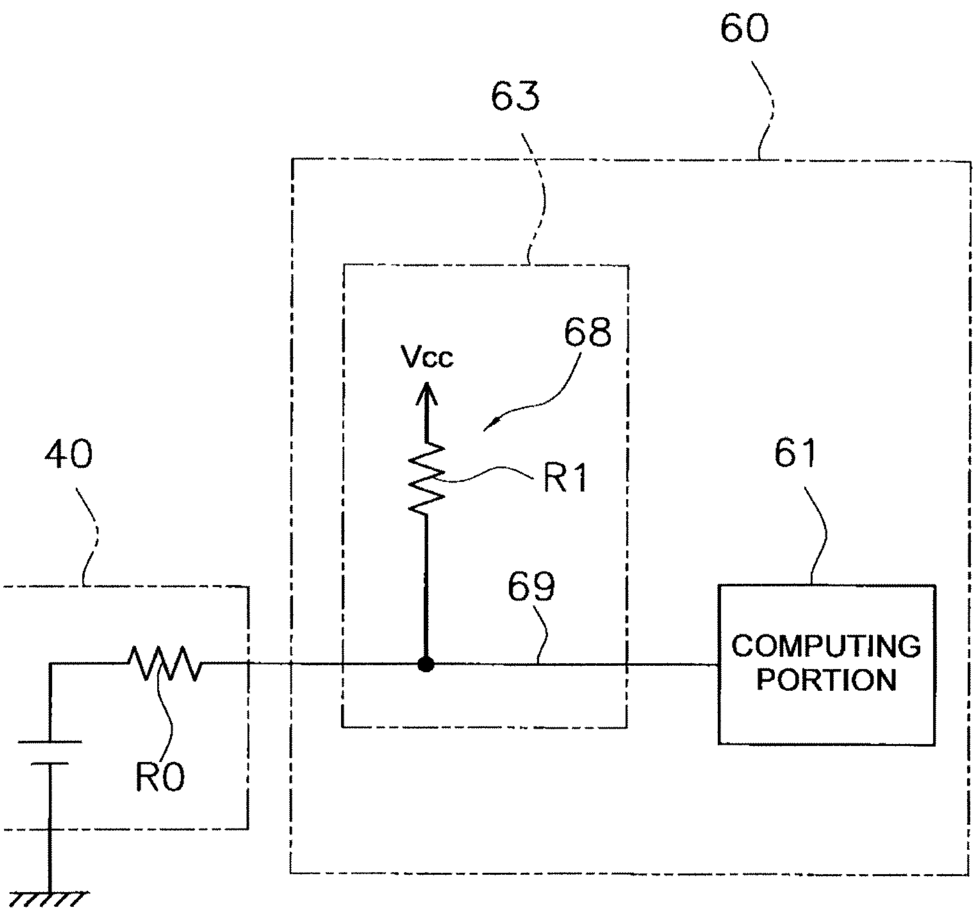

Fig. 6

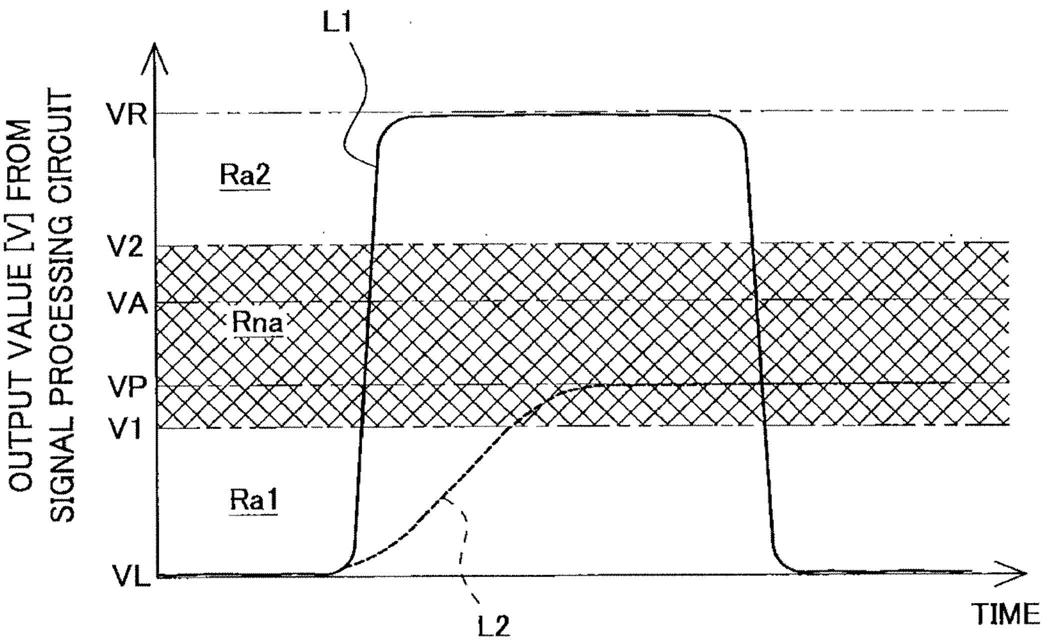
L1
OUTPUT VALUE [V] FROM SIGNAL PROCESSING CIRCUIT
VR
Ra2
V2
VA
Rna
VP
V1
Ra1
VL
L2
TIME

Fig. 7

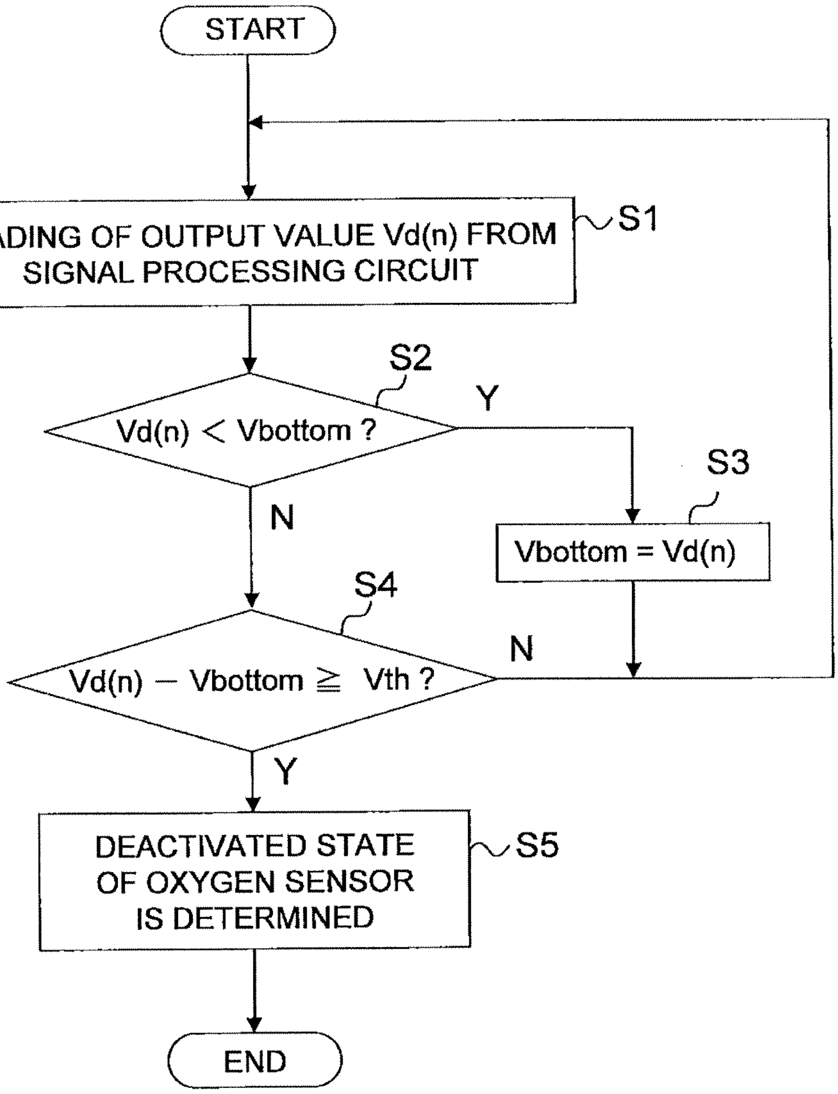
START
LOADING OF OUTPUT VALUE Vd(n) FROM SIGNAL PROCESSING CIRCUIT
S1
S2
Vd(n) < Vbottom ?
Y
N
S3
Vbottom = Vd(n)
S4
Vd(n) − Vbottom ≧ Vth ?
N
Y
DEACTIVATED STATE OF OXYGEN SENSOR IS DETERMINED
S5
END

FIG. 8

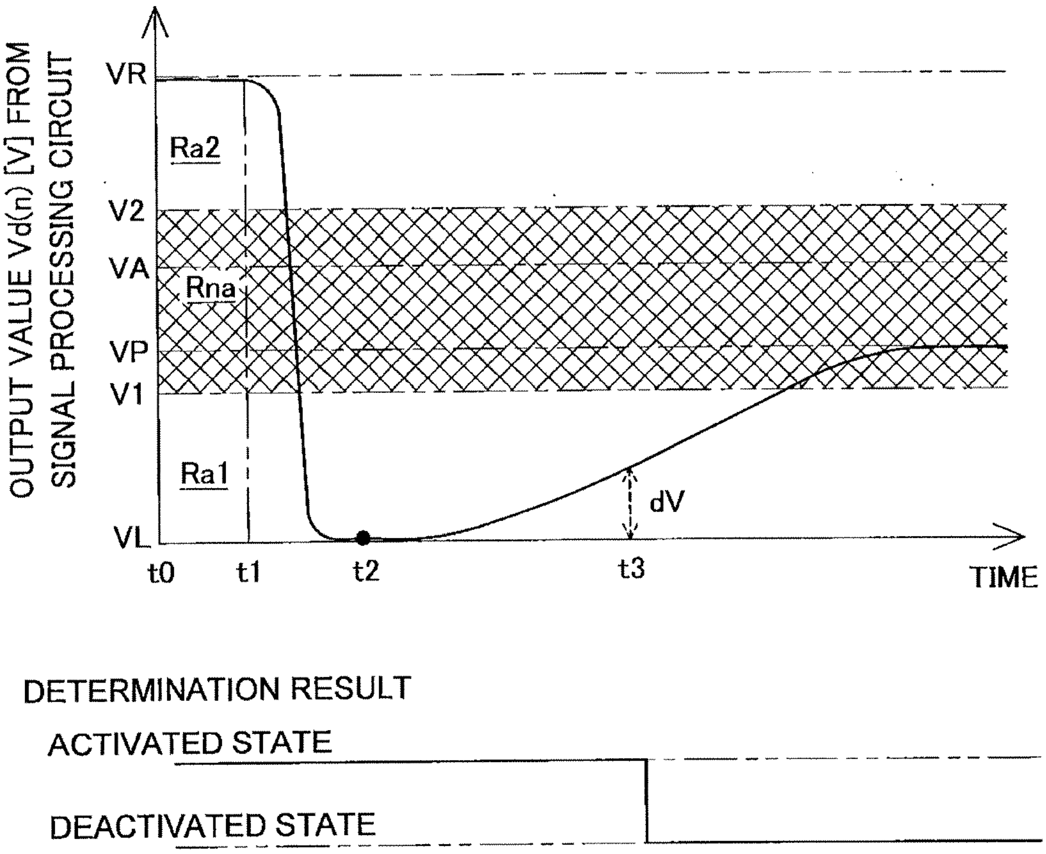
OUTPUT VALUE Vd(n) [V] FROM SIGNAL PROCESSING CIRCUIT
VR
Ra2
V2
VA
Rna
VP
V1
Ra1
VL
dV
t0
t1
t2
t3
TIME
DETERMINATION RESULT
ACTIVATED STATE
DEACTIVATED STATE

Fig. 9

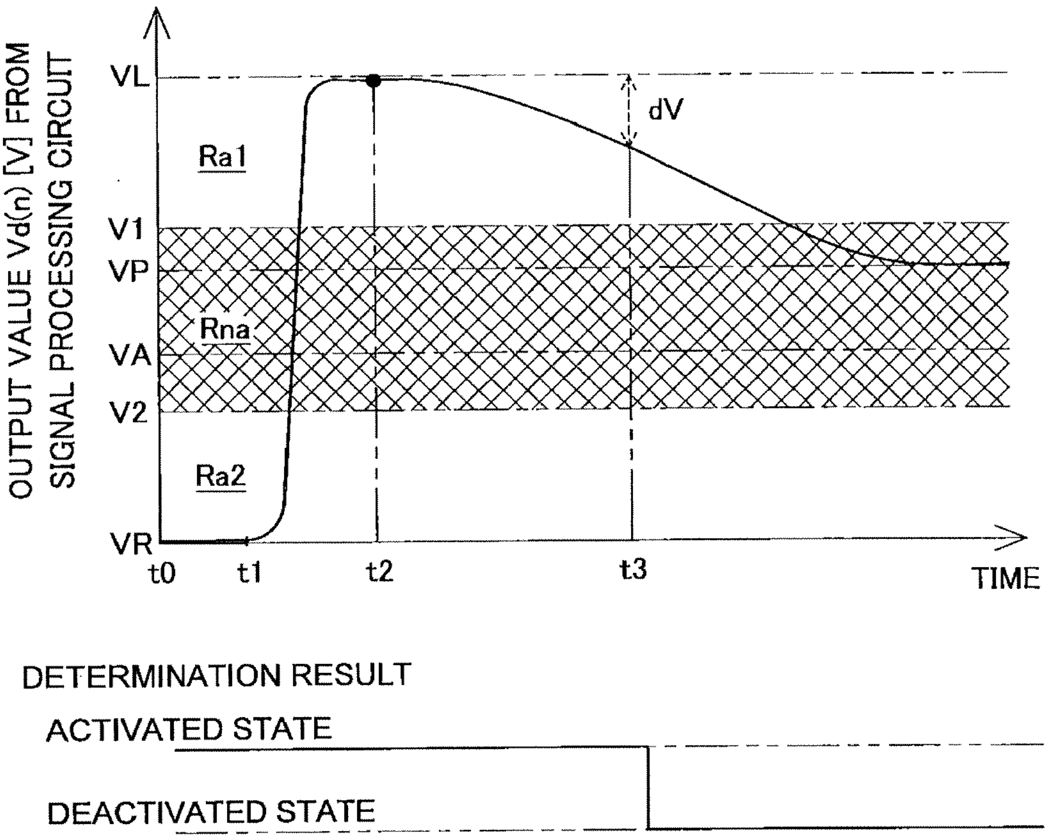
OUTPUT VALUE Vd(n) [V] FROM SIGNAL PROCESSING CIRCUIT
VL
dV
Ra1
V1
VP
Rna
VA
V2
Ra2
VR
t0
t1
t2
t3
TIME
DETERMINATION RESULT
ACTIVATED STATE
DEACTIVATED STATE

Fig. 10

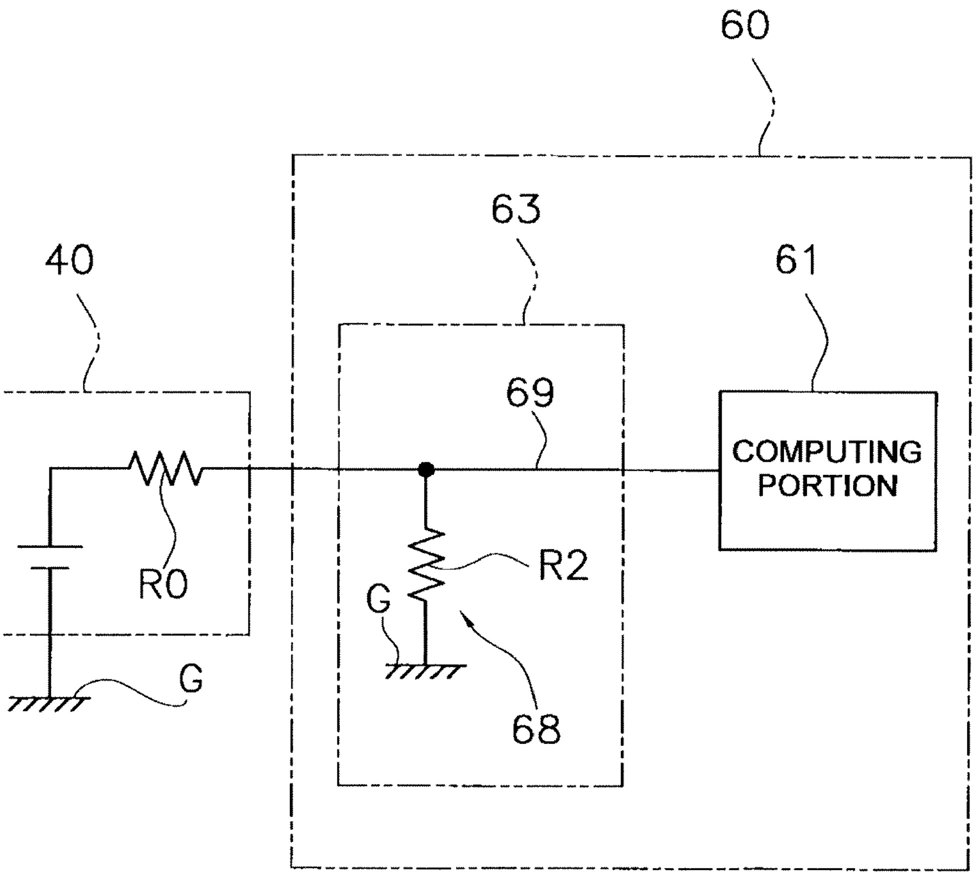

Fig. 11

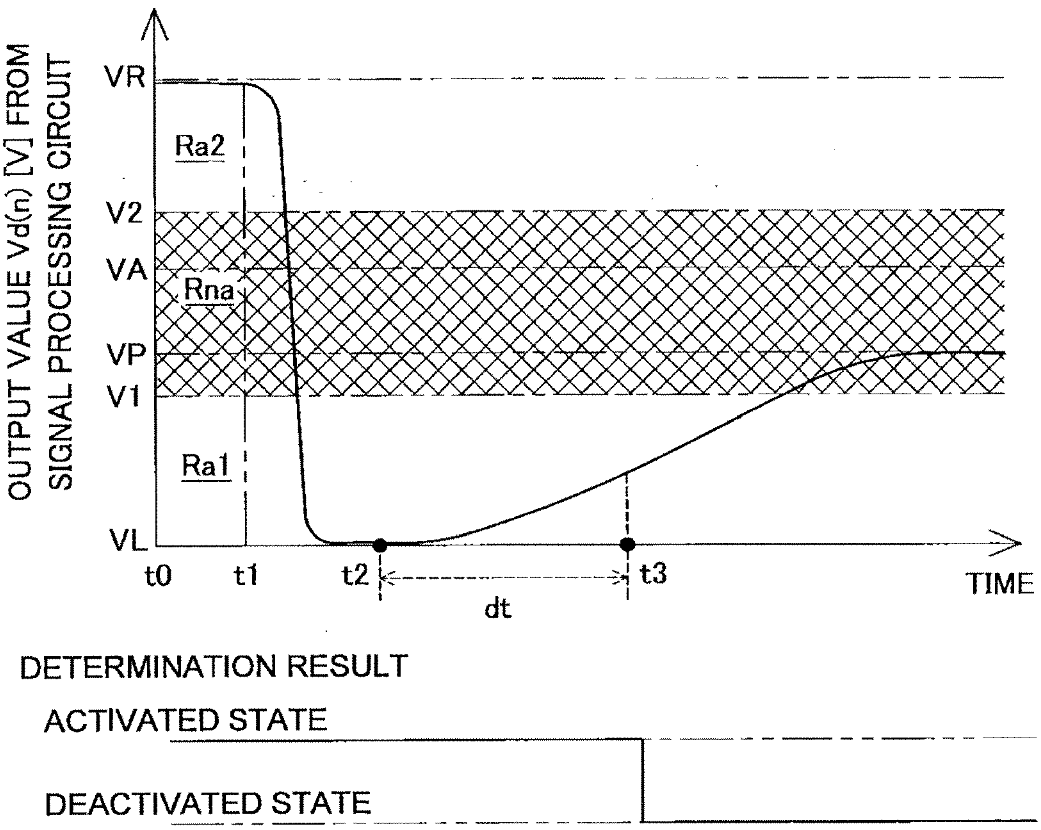
OUTPUT VALUE Vd(n) [V] FROM SIGNAL PROCESSING CIRCUIT
VR
Ra2
V2
VA
Rna
VP
V1
Ra1
VL
t0
t1
t2
t3
dt
TIME
DETERMINATION RESULT
ACTIVATED STATE
DEACTIVATED STATE

Fig. 12

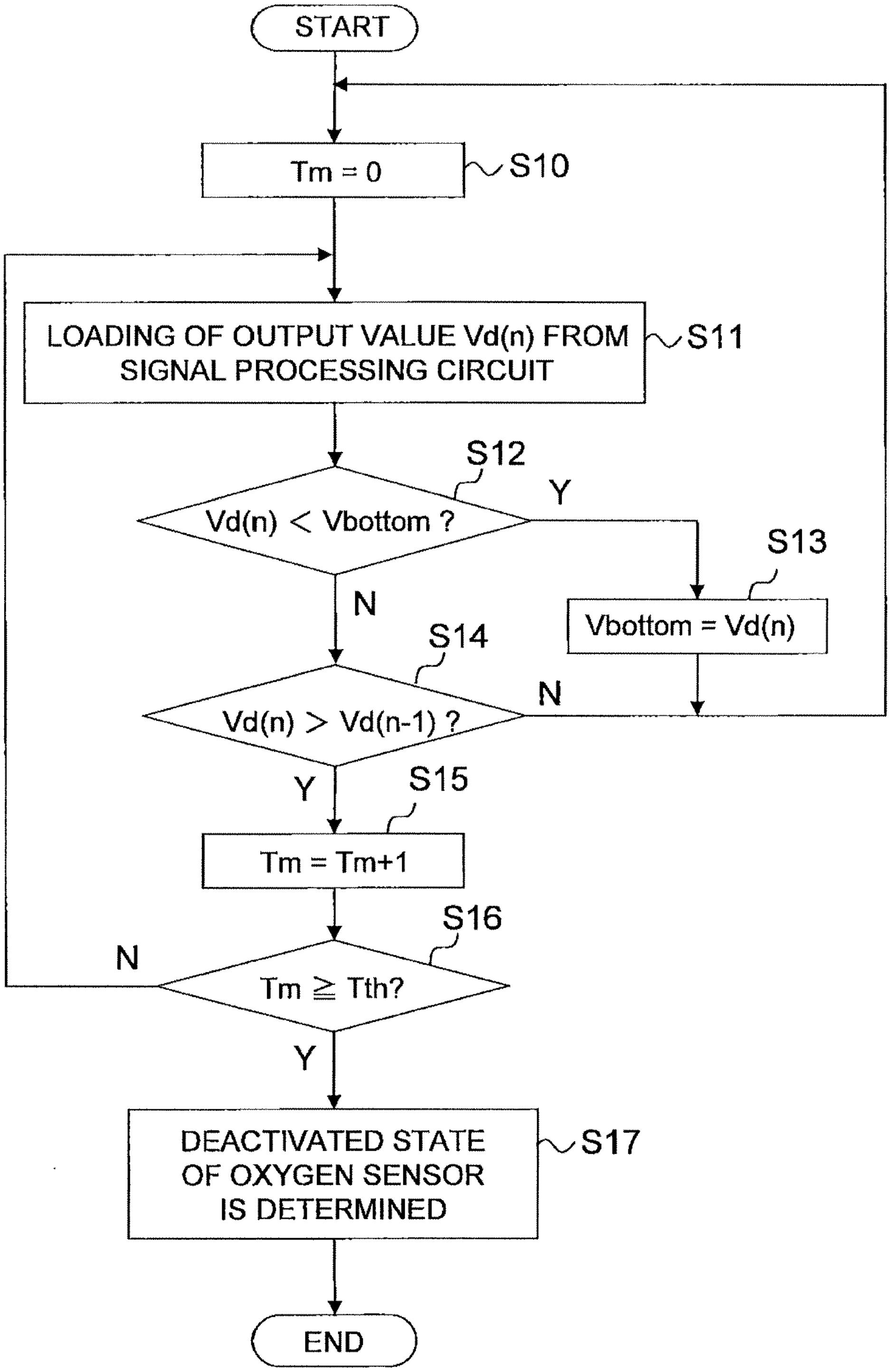
START
Tm = 0
S10
LOADING OF OUTPUT VALUE Vd(n) FROM SIGNAL PROCESSING CIRCUIT
S11
S12
Vd(n) < Vbottom ?
Y
N
S13
Vbottom = Vd(n)
S14
Vd(n) > Vd(n-1) ?
N
Y
S15
Tm = Tm+1
S16
Tm ≧ Tth?
N
Y
DEACTIVATED STATE OF OXYGEN SENSOR IS DETERMINED
S17
END

FIG. 13

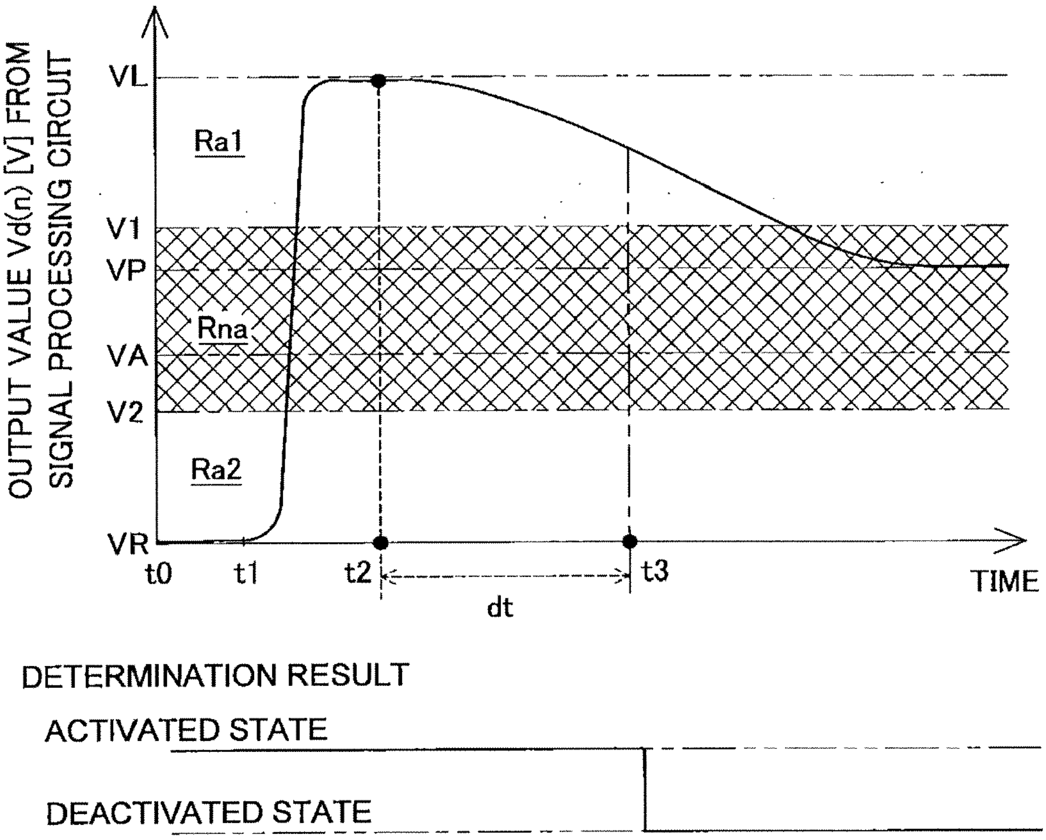
OUTPUT VALUE Vd(n) [V] FROM SIGNAL PROCESSING CIRCUIT
VL
Ra1
V1
VP
Rna
VA
V2
Ra2
VR
t0
t1
t2
t3
dt
TIME
DETERMINATION RESULT
ACTIVATED STATE
DEACTIVATED STATE

Fig. 14

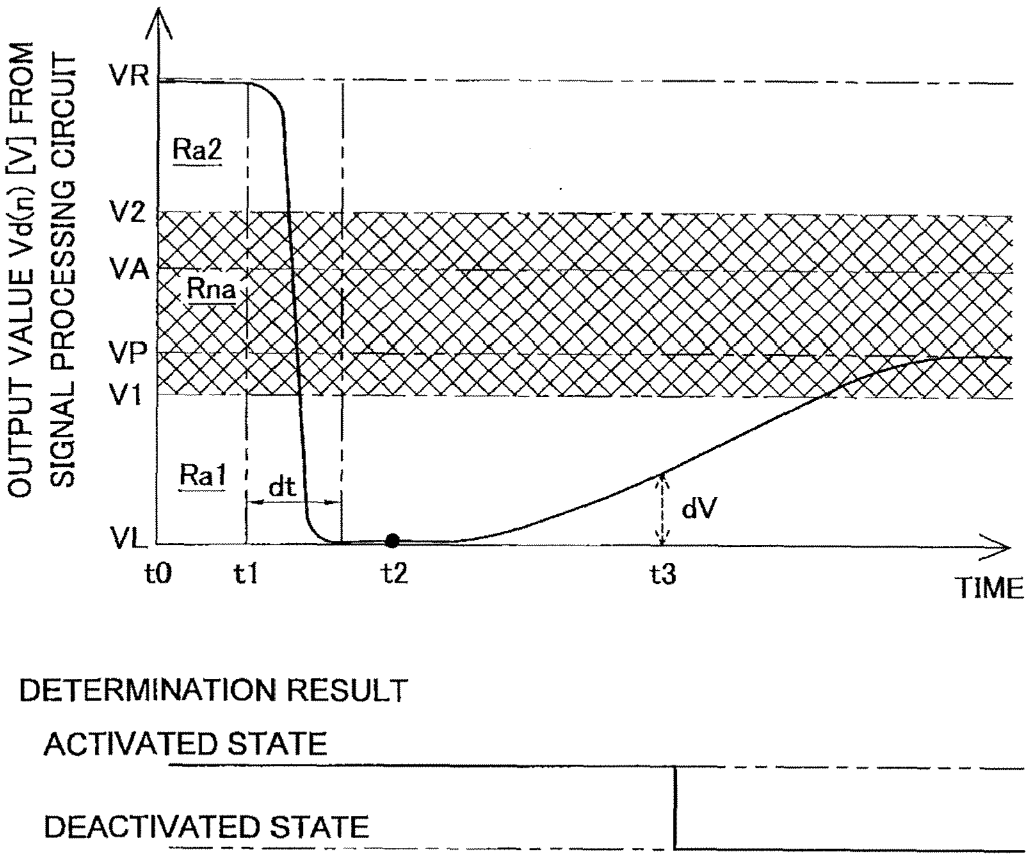
OUTPUT VALUE Vd(n) [V] FROM SIGNAL PROCESSING CIRCUIT
VR
Ra2
V2
VA
Rna
VP
V1
Ra1
dt
dV
VL
t0
t1
t2
t3
TIME
DETERMINATION RESULT
ACTIVATED STATE
DEACTIVATED STATE

Fig. 15

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2006170938 A **[0002]**