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GAS SENSOR

Abstract

Disclosed herein is a gas sensor that includes: first and second thermistors connected in series; first and second heaters configured to heat the first and second thermistors, respectively; and a control circuit configured to control the first and second heaters and apply a power supply to the first and second thermistors In a first period, the control circuit is configured to: start heating the first and second heaters; start applying the power supply to the first and second thermistors after a start of heating the first and second heaters; and generate an output signal indicating a concentration of a gas to be measured based on a detection signal appearing at a connection point between the first and second thermistors in a state where the first and second heaters are heated and the power supply is applied to the first and second thermistors.

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Background/Summary

BACKGROUND OF THE ART
Field of the Art
[0001] The present disclosure relates to a gas sensor.
Description of Related Art
[0002] International Publication WO 2020/031517 discloses a gas sensor that detects the concentration of a gas to be measured based on the level of a detection signal appearing at the connection point between two thermistors connected in series between a power supply and a ground. The gas sensor described in International Publication WO 2020/031517 heats a thermistor constituting a detection element and a thermistor constituting a reference element to 150° C. and 300° C., respectively, to acquire a detection signal.
[0003] In the gas sensor described in International Publication WO 2020/031517, power consumption occurs during current flow through the two series-connected thermistors.
SUMMARY
[0004] A gas sensor according to the present disclosure includes: first and second thermistors connected in series; first and second heaters for heating the first and second thermistors, respectively; and a control circuit configured to control the first and second heaters and apply a power supply to the first and second thermistors. In a first period, the control circuit is configured to: start heating the first and second heaters; start applying the power supply to the first and second thermistors after a start of heating the first and second heaters; and generate an output signal indicating a concentration of a gas to be measured based on a detection signal appearing at a connection point between the first and second thermistors in a state where the first and second heaters are heated and the power supply is applied to the first and second thermistors.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0005] The above features and advantages of the present disclosure will be more apparent from the following description of some embodiments taken in conjunction with the accompanying drawings, in which:
[0006] FIG. **1** is a circuit diagram illustrating the configuration of a gas sensor **1** according to a first embodiment of the technology described herein;
[0007] FIG. **2** is a timing chart for explaining a first operation example of the gas sensor **1**;
[0008] FIG. **3** is a graph illustrating the temperature characteristics of the thermistors Rd**1** and Rd**2**;
[0009] FIG. **4** is a graph illustrating the relation between the temperature of the thermistors Rd**1**, Rd**2** and their sensitivity to CO.sub.2 gas;
[0010] FIG. **5** is a graph for explaining a temporal change of the heating time of the thermistors Rd**1** and Rd**2** in period T**1**;
[0011] FIG. **6** is a timing chart for explaining a second operation example of the gas sensor **1**;
[0012] FIG. **7** is a circuit diagram illustrating the configuration of the gas sensor **2** according to the second embodiment of the technology described herein;
[0013] FIGS. **8**A and **8**B are circuit diagrams showing examples of the resistance measurement circuit **11**; and
[0014] FIG. **9** is a timing chart for explaining the operation of the gas sensor **2**.
DETAILED DESCRIPTION OF THE EMBODIMENTS
[0015] The present disclosure describes a technology for reducing power consumption in a gas sensor having two series-connected thermistors.

[0016] Some embodiments of the present disclosure will be explained below in detail with reference the accompanying drawings.

[0017] FIG. **1** is a circuit diagram illustrating the configuration of a gas sensor **1** according to a first embodiment of the technology described herein.

[0018] As illustrated in FIG. **1**, the gas sensor **1** according to the first embodiment includes thermistors Rd**1** and Rd**2**, heater resistors MH**1** and MH**2** for heating the thermistors Rd**1** and Rd**2**, respectively, and a control circuit **20** for controlling the heater resistors MH**1** and MH**2**. Although not particularly limited, the gas sensor **1** according to the present embodiment is a thermal conduction type gas sensor for detecting the concentration of CO.sub.2 gas in the atmosphere.

[0019] The thermistors Rd**1** and Rd**2** are detection elements made of a material having a negative temperature coefficient of resistance, such as a composite metal oxide, amorphous silicon, polysilicon, or germanium. Both the thermistors Rd**1** and Rd**2** detect the concentration of CO.sub.2 gas, but have different operating temperatures, as described below. Here, the thermistor Rd**1** constitutes a detection element, and the thermistor Rd**2** constitutes a reference element. The thermistors Rd**1** and Rd**2** are connected in series between a power supply **25** for supplying a power supply potential VDDS and a ground, and a detection signal Vco**2** appearing at the connection point between the thermistors Rd**1** and Rd**2** is supplied to the control circuit **20**.

[0020] The control circuit **20** includes an AD converter (ADC) **21**, DA converters (DAC) **22** and **23**, an MPU **24**, and the power supply **25**. The AD converter **21** AD-converts the detection signal Vco**2** appearing at the connection point between the thermistors Rd**1** and Rd**2** and supplies an obtained digital value to the MPU **24**. The MPU **24** generates an output signal OUT indicating the concentration of CO.sub.2 gas based on the AD-converted detection signal. The DA converters **22** and **23** DA-convert the digital value supplied from the MPU **24** to apply predetermined voltages to the heater resistors MH**1** and MH**2**, respectively. In other words, the heating temperatures of the heater resistors MH**1** and MH**2** are controlled by the MPU **24**.

[0021] The following describes the operation of the gas sensor **1** according to the present embodiment.

[0022] FIG. **2** is a timing chart for explaining a first operation example of the gas sensor **1** according to the present embodiment.

[0023] In the first operation example illustrated in FIG. **2**, gas measurement operation is performed in period T**1**. In the gas measurement operation, the heater resistors MH**1** and MH**2** are heated to 150° C. and 300° C., respectively, under the control of the MPU **24**. The heater resistor MH**1** and thermistor Rd**1** are disposed in close proximity to each other and thus, the temperature of the heater resistor MH**1** can be regarded as substantially the esame as the temperature of the thermistor Rd**1**. Similarly, the heater resistor MH**2** and thermistor Rd**2** are disposed in close proximity to each other and thus, the temperature of the heater resistor MH**2** can be regarded as substantially the same as the temperature of the thermistor Rd**2**.

[0024] As illustrated in FIG. **3**, the temperature characteristics of the thermistors Rd**1** and Rd**2** are mutually different and designed such that the resistance value of the thermistor Rd**1** heated to 150° C. and the resistance value of the thermistor Rd**2** heated to 300° C. are close to each other. In the example illustrated in FIG. **3**, the resistance value of the thermistor Rd**1** heated to 150° C. is 5.1 kΩ, and the resistance value of the thermistor Rd**2** heated to 300° C. is 4.0 kΩ. The resistance value of the thermistor Rd**1** heated to 150° C. and the resistance value of the thermistor Rd**2** heated to 300° C. may be approximately the same.

[0025] FIG. **4** is a graph illustrating the relation between the temperature of the thermistors Rd**1**, Rd**2** and their sensitivity to CO.sub.2 gas. As can be seen from the graph of FIG. **4**, the sensitivity of the thermistors Rd**1** and Rd**2** to CO.sub.2 gas varies significantly depending on the temperature, and the sensitivity of the thermistors Rd**1**, Rd**2** to CO.sub.2 gas is almost zero in the temperature range below 40° C. or above 300° C. The sensitivity of the thermistors Rd**1**, Rd**2** to CO.sub.2 gas is maximum at about 150° C.

[0026] Thus, when CO.sub.2 gas is present in the measurement atmosphere with the thermistor Rd**1** as the detection element heated to 150° C., the heat dissipation characteristics of the thermistor Rd**1** change according to the concentration. Such a change appears as a change in the resistance value of the thermistor Rd**1**. On the other hand, even when CO.sub.2 gas is present in the measurement atmosphere with the thermistor Rd**2** as the reference element heated to 300° C., the heat dissipation characteristics of the thermistor Rd**2** hardly change according to the concentration. Therefore, the change in the resistance value of the thermistor Rd**2** heated to 300° C. due to the concentration of CO.sub.2 gas is sufficiently smaller than the change in the resistance value of the thermistor Rd**1** heated to 150° C. due to the concentration of CO.sub.2 gas. There is no problem if the resistance value of the thermistor Rd**2** heated to 300° C. due to the concentration of CO.sub.2 gas hardly changes.
[0027] As a result, the level of the detection signal Vco**2** appearing at the connection point between the thermistors Rd**1** and Rd**2** changes according to the concentration of CO.sub.2 gas in the measurement atmosphere. The detection signal Vco**2** is supplied to the MPU **24** through the AD converter **21**, and the MPU **24** generates the output signal OUT indicating the concentration of CO.sub.2 gas based on the supplied detection signal Vco**2**.
[0028] During the gas measurement operation performed in period T**1**, the heating start timing of the heater resistors MH**1** and MH**2** is time t**11**, the power supply application start timing to the thermistors Rd**1** and Rd**2** by the power supply **25** is time t**12**, and the heating end timing of the heater resistors MH**1** and MH**2** and the power supply application end timing to the thermistors Rd**1** and Rd**2** by the power supply **25** are time t**13**. Thus, the heater resistors MH**1** and MH**2** are heated during a period from time t**11** to time t**13**, and the thermistors Rd**1** and Rd**2** are applied a power supply during a period from time t**12** to time t**13**. The power supply application time to the thermistors Rd**1** and Rd**2** is sufficiently shorter than the heating time of the heater resistors MH**1** and MH**2** and is about one-tenth thereof, for example. As described above, in the present embodiment, the power supply application timing to the thermistors Rd**1** and Rd**2** is made later than the heating start timing of the heater resistors MH**1** and MH**2**.
[0029] FIG. **5** is a graph for explaining a temporal change of the heating time of the thermistors Rd**1** and Rd**2** in period T**1**.
[0030] As illustrated in FIG. **5**, when the heating of the heater resistors MH**1** and MH**2** is started at time t**11**, the temperatures of the thermistors Rd**1** and Rd**2** rise. However, a predetermined time is required until the temperature of the thermistor Rd**1** reaches a target value of 150° C., and a predetermined time is required until the temperature of the thermistor Rd**2** reaches a target value of 300° C. In the example of FIG. **5**, the temperature of the thermistor Rd**1** reaches the target value of 150° C. at time t**1**, and the temperature of the thermistor Rd**2** reaches the target value of 300° C. at time t**2**. That is, even after the start of heating of the heater resistors MH**1** and MH**2**, the concentration of CO.sub.2 gas cannot be properly measured by the thermistors Rd**1** and Rd**2** until the time t**2** is reached. It is only after the time t**2** that the concentration of CO.sub.2 gas can be properly measured. Therefore, even when a power supply is applied to the thermistors Rd**1** and Rd**2** before time t**2**, the detection signal Vco**2** obtained before time t**2** cannot be sampled. Considering this, in the present embodiment, the power supply application start timing (time t**12**) to the thermistors Rd**1** and Rd**2** is delayed, whereby unnecessary power consumption is reduced.
[0031] Although time t**12** at which the power supply application to the thermistors Rd**1** and Rd**2** is started is not particularly limited provided that it is after time t**11** and before t**13**; however, by setting time t**12** to time t**2** when the concentration of CO.sub.2 gas can be properly measured or a time close to time t**2**, it is possible to make a time during which a power supply is applied to the thermistors Rd**1** and Rd**2** shortest. Then, the detection signal obtained between time t**12** and t**13** is sampled by the MPU **24**, and the output signal OUT indicating the concentration of CO.sub.2 gas is calculated based on the sampled detection signal.
[0032] The start and end of the power supply application to the thermistors Rd**1** and Rd**2** may be

performed by the MPU **24** in the following manner: controlling the operation of the power supply **25** that generates and terminates the power supply potential VDDS; or turning ON/OFF a switch provided at the output end of the power supply **25**. Further, the power supply **25** need not necessarily be a constant voltage source but may be a constant current source. Furthermore, the heating start timing of the heater resistor MH**1** and that of the heater resistor MH**2** need not necessarily be the same as each other, but the heating of the heater resistor MH**2** to be heated to a higher temperature may be started earlier than the heater resistor MH**1**.

[0033] Further, the timing of time t**12** is not particularly limited and may be timing when a predetermined period passes from time t**11** at which heating of the heater resistors MH**1** and MH**2** is started. Thus, the relation between the time t**11** and time t**12** is fixed, facilitating control by the MPU **24**. Alternatively, a period from time t**11** at which the heating of the heater resistors MH**1** and MH**2** is started to time t**12** at which the power supply application to the thermistors Rd**1** and Rd**2** is started may be made variable.

[0034] As described above, in the first operation example, the power supply application to the thermistors Rd**1** and Rd**2** is started after the start of heating of the heater resistors MH**1** and MH**2**, so that power consumption by the thermistors Rd**1** and Rd**2** can be reduced. In addition, the thermistors Rd**1** and Rd**2** are reduced also in self-heating amount and are thus suppressed in aging. Note that it is not necessary to make the heating end timing of the heater resistors MH**1** and MH**2** and power supply end timing to the thermistors Rd**1** and Rd**2** completely coincide with each other; however, by making them coincide with each other, the occurrence of unnecessary power consumption can be prevented.

[0035] FIG. **6** is a timing chart for explaining a second operation example of the gas sensor **1** according to the present embodiment.

[0036] In the second operation example illustrated in FIG. **6**, the gas measurement operation is performed in period T**1**, and dummy heating operation is performed in period T**2**. The gas measurement operation and dummy heating operation are alternately performed. The gas measurement operation performed in period T**1** is the same as that in the first operation example, so overlapping description will be omitted.

[0037] As illustrated in FIG. **6**, during the dummy heating operation performed in period T**2**, the heater resistors MH**1** and MH**2** are heated to 300° C. and 150° C., respectively, under the control of the MPU **24**. This eliminates the thermal history difference between the thermistors Rd**1** and Rd**2** generated during the gas measurement operation performed in period T**1**. To eliminate the thermal history difference more accurately, the lengths of periods T**1** and T**2** should be made to coincide with each other. Further, the detection signal Vco**2** is not sampled in period T**2**, so that the power supply application to the thermistors Rd**1** and Rd**2** may be stopped completely. This contributes to further reduction in power consumption. Alternatively, as illustrated in FIG. **6**, a configuration may be employed in which the heating of the heater resistors MH**1** and MH**2** is started at time t**21**, the power supply application to the thermistors Rd**1** and RD**2** is started at time t**22**, and the heating of the heater resistors MH**1** and MH**2** and the power supply application to the thermistors Rd**1** and Rd**2** by the power supply **25** are ended at time t**23**. As a result, the thermal history associated with the self-heating of the thermistors Rd**1** and Rd**2** in period T**1** and the thermal history associated with the self-heating of the thermistors Rd**1** and Rd**2** in period T**2** coincide with each other, making it possible to further reduce the thermal history difference between the thermistors Rd**1** and Rd**2**. In this case, the power consumption and power supply application time of the thermistors Rd**1** and Rd**2** in period T**1** and those in period T**2** may be made to coincide with each other.

[0038] FIG. **7** is a circuit diagram illustrating the configuration of the gas sensor **2** according to the second embodiment of the technology described herein.

[0039] As illustrated in FIG. **7**, the gas sensor **2** according to the second embodiment differs from the gas sensor **1** according to the first embodiment in that it additionally includes resistance measurement circuits **11**, **12** and switches SW**1** to SW**3**. Other basic configurations are the same as those of the gas sensor **1** according to the first embodiment, so the same reference numerals are given to the same elements, and overlapping description will be omitted.

[0040] The switch SW**1** is connected between the power supply **25** for supplying the power supply potential VDDS and the thermistor Rd**1**. The switches SW**2** and SW**3** are connected between the thermistors Rd**1** and Rd**2**. As a result, when the switches SW**1** to SW**3** are turned ON, the thermistors Rd**1** and Rd**2** are connected in series between the power supply **25** and the ground. The potential appearing between the switches SW**2** and SW**3** in this state, i.e., the detection signal Vco**2** appearing at the connection point between the thermistors Rd**1** and Rd**2** is supplied to the control circuit **20**. On the other hand, when the switches SW**1** to SW**3** are turned OFF, the series connection of the thermistors Rd**1** and Rd**2** is released, and the thermistors Rd**1** and Rd**2** are separated from each other. The resistance measurement circuits **11** and **12** measure the resistance values of the thermistors Rd**1** and Rd**2**, respectively, in a state where the switches SW**1** to SW**3** are turned OFF.

[0041] As illustrated in FIG. **8**A, the resistance measurement circuit **11** may have a configuration in which a constant current source **13** and a voltmeter **14** are connected in parallel between one end **11***a* and the other end **11***b*. With this configuration, when a constant current is made to flow from the constant current source **13** to the thermistor Rd**1** in a state where the thermistor Rd**1** is connected between the one end **11***a* and the other end **11***b*, a voltage to be generated between the one end **11***a* and the other end **11***b* is determined by the resistance value of the thermistor Rd**1**. This voltage is measured with the voltmeter **14** and supplied to the control circuit **20**. This allows the control circuit **20** to acquire the directly-measured resistance value of the thermistor Rd**1**.

[0042] Alternatively, as illustrated in FIG. **8**B, the resistance measurement circuit **11** may have a configuration in which a constant voltage source **15** and an ammeter **16** are connected in series between the one end **11***a* and the other end **11***b*. With this a configuration, when predetermined voltage is applied from the constant voltage source **15** to the thermistor Rd**1** in a state where the thermistor Rd**1** is connected between the one end **11***a* and the other end **11***b*, a current flowing between the one end **11***a* and the other end **11***b* is determined by the resistance value of the thermistor Rd**1**. This current is measured with the ammeter **16** and supplied to the control circuit **20**. This allows the control circuit **20** to acquire the directly-measured resistance value of the thermistor Rd**1**.

[0043] The same applies to the configuration of the resistance measurement circuit **12**, and the control circuit **20** can acquire the directly-measured resistance value of the thermistor Rd**2**.

[0044] FIG. **9** is a timing chart for explaining the operation of the gas sensor **2** according to the present embodiment.

[0045] As illustrated in FIG. **9**, in the present embodiment, the switches SW**1** to SW**3** are turned OFF at time t**11**, and thereby the MPU **24** monitors resistance values R**1** and R**2** of the respective thermistors Rd**1** and Rd**2** measured by the resistance measurement circuits **11** and **12**, respectively. Then, in response to the resistance value R**1** of the thermistor Rd**1** reaching a predetermined value R**1**th and the resistance value R**2** of the thermistor Rd**2** reaching a predetermined value R**2**th, the switches SW**1** to SW**3** are turned ON, and the power supply application to the thermistors Rd**1** and Rd**2** is started. The predetermined value R**1**th is a threshold value that the resistance value R**1** exceeds when the thermistor Rd**1** is heated to about 150° C. irrespective of the concentration of CO.sub.2 gas contained in the atmosphere. Similarly, the predetermined value R**2**th is a threshold value that the resistance value R**2** exceeds when the thermistor Rd**2** is heated to about 150° C. irrespective of the concentration of CO.sub.2 gas contained in the atmosphere. This allows the power supply application to the thermistors Rd**1** and Rd**2** to be started in a state where the concentration of CO.sub.2 gas can be properly measured by the thermistors Rd**1** and Rd**2**.

[0046] However, it is not essential to monitor both the resistance values R**1** and R**2** of the thermistors Rd**1** and Rd**2**, but it is only necessary to monitor one of the resistance values R**1** and R**2**. That is, in response to one of the resistance values R**1** and R**2** reaching a predetermined value, the switches SW**1** to SW**3** are turned ON, and the power supply application to the thermistors Rd**1** and Rd**2** is started. In this case, the resistance value of the thermistor Rd**2** heated to a higher temperature may be monitored in period T**1** during which the gas measurement operation is performed, and the resistance value of the thermistor Rd**1** heated to a higher temperature may be monitored in period T**2** during which the dummy heating operation is performed.

[0047] While some embodiments of the technology according to the present disclosure have been described, the technology according to the present disclosure is not limited to the above embodiments, and various modifications may be made within the scope of the present disclosure, and all such modifications are included in the technology according to the present disclosure.

[0048] For example, although the measurement target gas is CO_2 gas in the above embodiments, the present invention is not limited to this. Further, the sensor part used in the present invention need not necessarily be a thermal conduction type sensor, but may be a sensor of other types such as a catalytic combustion type. As an example, when the measurement target gas is CO gas, a catalytic combustion type sensor part can be used.

[0049] The technology according to the present disclosure includes the following configuration examples, but not limited thereto.

[0050] A gas sensor according to the present disclosure includes: first and second thermistors connected in series; first and second heaters for heating the first and second thermistors, respectively; and a control circuit configured to control the first and second heaters and apply a power supply to the first and second thermistors. In a first period, the control circuit is configured to: start heating the first and second heaters; start applying the power supply to the first and second thermistors after a start of heating the first and second heaters; and generate an output signal indicating a concentration of a gas to be measured based on a detection signal appearing at a connection point between the first and second thermistors in a state where the first and second heaters are heated and the power supply is applied to the first and second thermistors. This can reduce power consumed by the first and second thermistors.

[0051] In the above gas sensor, in the first period, the control circuit may be configured to start applying the power supply to the first and second thermistors after an elapse of a predetermined period from the start of heating the first and second heaters. This facilitates control by the control circuit.

[0052] In the above gas sensor, in the first period, the control circuit may be configured to control a period from the start of heating the first and second heaters to a start of applying the power supply to the first and second thermistors. This allows the power supply application to the first and second thermistors to be started at an optimum timing.

[0053] In the above gas sensor, in the first period, the control circuit may be configured to start applying the power supply to the first and second thermistors in response to a resistance value of the first or second thermistor reaching a predetermined value after the start of heating the first and second heaters. This allows the power supply application to the first and second thermistors to be started in a state where the concentration of a gas to be measured can be properly measured.

[0054] In the above gas sensor, in the first period, the control circuit may be configured to make a heating end timing of the first and second heaters and an applying end timing of the power supply to the first and second thermistors coincide with each other. This facilitates control and can prevent the occurrence of unnecessary power consumption.

[0055] In the above gas sensor, the control circuit may be configured to heat the second heater to a higher temperature than a heating temperature of the first heater in the first period, and the control circuit may be configured to heat the first heater to a higher temperature than a heating temperature of the second heater in a second period. This can reduce a difference in thermal history between the first and second thermistors.

[0056] In the above gas sensor, in the second period, the control circuit may be configured to start applying the power supply to the first and second thermistors after a start of heating the first and second heaters. This reduces also a difference in thermal history due to the self-heating of the first and second thermistors.

[0057] In the above gas sensor, the control circuit may be configured to: make a heating temperature and a heating time of the first heater in the first period and a heating temperature and a heating time of the second heater in the second period coincide with each other; make a heating temperature and a heating time of the second heater in the first period and a heating temperature and a heating time of the first heater in the second period coincide with each other; make a power consumption of the first and second thermistors in the first period and a power consumption of the first and second thermistors in the second period coincide with each other; and make an application time of the power supply to the first and second thermistors in the first period and an application time of the power supply to the first and second thermistors in the second period coincide with each other. This can reduce the thermal history difference between the first and second thermistors more accurately.

Claims

1. A gas sensor comprising: first and second thermistors connected in series; first and second heaters configured to heat the first and second thermistors, respectively; and a control circuit configured to control the first and second heaters and apply a power supply to the first and second thermistors, wherein, in a first period, the control circuit is configured to: start heating the first and second heaters; start applying the power supply to the first and second thermistors after a start of heating the first and second heaters; and generate an output signal indicating a concentration of a gas to be measured based on a detection signal appearing at a connection point between the first and second thermistors in a state where the first and second heaters are heated and the power supply is applied to the first and second thermistors.

2. The gas sensor as claimed in claim 1, wherein, in the first period, the control circuit is configured to start applying the power supply to the first and second thermistors after an elapse of a predetermined period from the start of heating the first and second heaters.

3. The gas sensor as claimed in claim 1, wherein, in the first period, the control circuit is configured to control a period from the start of heating the first and second heaters to a start of applying the power supply to the first and second thermistors.

4. The gas sensor as claimed in claim 3, wherein, in the first period, the control circuit is configured to start applying the power supply to the first and second thermistors in response to a resistance value of the first or second thermistor reaching a predetermined value after the start of heating the first and second heaters.

5. The gas sensor as claimed in claim 1, wherein, in the first period, the control circuit is configured to make a heating end timing of the first and second heaters and an applying end timing of the power supply to the first and second thermistors coincide with each other.

6. The gas sensor as claimed in claim 1, wherein the control circuit is configured to heat the second heater to a higher temperature than a heating temperature of the first heater in the first period, and wherein the control circuit is configured to heat the first heater to a higher temperature than a heating temperature of the second heater in a second period.

7. The gas sensor as claimed in claim 6, wherein, in the second period, the control circuit is configured to start applying the power supply to the first and second thermistors after a start of heating the first and second heaters.

8. The gas sensor as claimed in claim 7, wherein the control circuit is configured to: make a heating temperature and a heating time of the first heater in the first period and a heating temperature and a heating time of the second heater in the second period coincide with each other; make a heating temperature and a heating time of the second heater in the first period and a heating temperature and a heating time of the first heater in the second period coincide with each other; make a power consumption of the first and second thermistors in the first period and a power consumption of the first and second thermistors in the second period coincide with each other; and make an application time of the power supply to the first and second thermistors in the first period and an application time of the power supply to the first and second thermistors in the second period coincide with each other.