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London WC2A 3LS (GB)(54) **Microwave oven and method of determining food.**

(57) Gaseous alcohol and steam emanating from food being heated are detected by an alcohol sensor (11) and a steam sensor (12) respectively. A control circuit (16) obtains maximum values V_{Amax} and V_{Gmax} serving as reference values from detection voltages generated by the alcohol and steam sensors (11, 12). Change rates ΔA (V_A/V_{Amax}) and ΔG (V_G/V_{Gmax}) are obtained on the basis of detection voltages V_A and V_G detected a predetermined time (40 seconds, for example) after initiation of the heating and a ratio r of the change rates is obtained from the expression, $r = (1 - \Delta A)/(1 - \Delta G)$. The control circuit (16) compares a value of the ratio r with a threshold set for each kind of food to discriminate the kind of the food, thereby setting a subsequent heating time to execute the heating. Since the ratios r vary largely depending upon presence of an alcoholic component contained in the food, the kind of the food can be reliably discriminated.

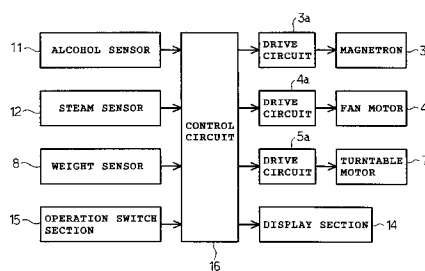


FIG.1

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The present invention relates to microwave ovens wherein food is heated by means of high-frequency waves, and more particularly, to such a microwave oven wherein the food is determined by discrimination of the kind of food on the basis of data of detected volumes of gaseous alcohol and steam each emanating from the food and a method of determining the food.

5 Microwave ovens have been provided with a weight sensor, a gas sensor and the like, for example. The weight of food to be heated is detected by the weight sensor and a volume of steam emanating from the food during the heating operation is detected by the gas sensor so that detection data is obtained. Heating conditions for the food are set on the basis of the detection data, or a degree of the heating is determined on the basis of the detection data so that an automatic cooking is executed.

10 The prior art has recently proposed a microwave oven wherein a volume of gaseous alcohol emanating from the food is detected so that the kind of the food is determined. A volume of steam emanating per weight is very small in different kinds of foods. Accordingly, there are some cases where the kind of food cannot be determined only on the basis of detection results of the weight sensor and gas sensor. Even in these cases, however, a volume of gaseous alcohol emanating from the food differs from food to food, so that the volume of gaseous alcohol is detected for the purpose of discrimination of the kind of food. For example, Japanese boiled rice and miso soup are sometimes warmed by the microwave oven when they become cold. In this case, the discrimination between the boiled rice and the miso soup is made on the basis of the detection result that a volume of gaseous alcohol emanating from the miso soup after initiation of the heating operation is larger than that of gaseous alcohol emanating from the boiled rice. More specifically, the gas sensor detects the volume of gaseous alcohol emanating from the food being heated a predetermined time after the initiation of the heating, for example, 40 seconds after that, thereby generating a detection signal. The detection signal generated by the gas sensor is compared with a reference value of the sensor output previously set for discrimination between the boiled rice and the miso soup so that the kind of food being heated is discriminated according to the magnitude of the detection signal.

25 Upon discrimination of the kind of food, a heating time suitable for the food is determined on the basis of previously set heating conditions. Consequently, an automatic cooking can be executed even when the food is either the boiled rice or the miso soup.

In the above-described prior art arrangement, however, there is a case where the difference between rates of change of volumes of alcohol detected by the alcohol sensor is small. Accordingly, a reliable discrimination level cannot be ensured when the food is discriminated on the basis of presence or absence of the alcoholic component. Consequently, an error determination may occur. When the error determination occurs, the food cannot be heated under an optimum condition.

30 Furthermore, the prior art has provided for another type of microwave oven wherein only a beverage warming key is operated when the food such as Japanese saké or milk is warmed. In this arrangement, the kind of the beverage is discriminated on the basis of the difference between the detection volumes of the alcohol and gas sensors. Either a saké warming course or a milk warming course is selected on the basis of the result of determination. Thus, the optimum heating time is obtained so that the automatic cooking is executed.

35 The Japanese saké is usually put in a particular ceramic liquor bottle called "tokkuri" in Japanese when warmed. The "tokkuri" usually has a top opening and an upper slender neck portion. The "tokkuri" will hereinafter be referred to as "bottle" throughout the specification. When the saké contained in the bottle is heated by the microwave oven, an upper part of saké in the bottle is warmed relatively rapidly. Accordingly, even though the whole saké in the bottle is not sufficiently warm, the volume of gaseous alcohol emanating from the top opening reaches a predetermined value and then, the heating operation is completed. To prevent this drawback, a piece of aluminum foil is wound around the neck portion of the bottle to cover the top opening, so that the saké contained in the bottle is uniformly warmed. Thus, in the prior art, the aluminum foil is wound around the upper neck portion of the bottle so that the warming of the part of the bottle contained saké in the vicinity of the top opening is retarded. The other part of the saké in the bottle is heated and that of the saké in the vicinity of the bottle neck portion is heated by application of heat transferred by convection, so that the whole saké in the bottle is uniformly heated.

40 However, a large volume of alcoholic component does not emanate from the upper opening of the bottle covered by the aluminum foil during a short period of time from the initiation of the heating to the discrimination of the kind of food. Consequently, the discrimination between the saké and milk cannot be reliably made, which results in the following inconvenience. That is, the milk warming course is selected in error where the saké warming course should be selected. In this case, too much heat is applied to the sake.

55 Therefore, an object of the present invention is to provide a microwave oven wherein the kind of food to be heated can be precisely discriminated on the basis of the detection outputs of the alcohol and gas sensors.

In one aspect, the present invention provides a microwave oven comprising heating means high-frequency heating food, a first gas sensor detecting gaseous alcohol emanating from the food, a second gas sensor detecting steam emanating from the food, and determining means for determining the kind of the food on the basis of outputs of the respective sensors, characterized in that the determining means
 5 comprises change rate operating means for operating a rate of change in the gaseous alcohol on the basis of data of a volume of gaseous alcohol detected by the first gas sensor and a rate of change in the steam on the basis of data of a volume of steam detected by the second gas sensor, ratio operating means operating a ratio of the change rate of the gaseous alcohol and the change rate of the steam each obtained by the change rate operating means, and discriminating means for discriminating the kind of the food on
 10 the basis of a value of the ratio obtained by the ratio operating means.

According to the above-described arrangement, the change rate operating means obtains the change rate of the gaseous alcohol on the basis of data of the volume of gaseous alcohol detected by the first gas sensor and the change rate of the steam on the basis of data of the volume of steam detected by the second gas sensor. The ratio of these obtained change rates is obtained by the ratio operating means. The
 15 kind of the food to be heated is determined by the determining means on the basis of the obtained ratio. Accordingly, the difference between the values of the ratios can be increased even though the volume of alcohol contained in the food to be heated is small. Even when the value of the change rate of the volume of gaseous alcohol detected by the gas sensor is small, that small value can be used for discrimination of the kind of food as the ratio of the change rates taking a large value. Consequently, the food to be heated
 20 can be reliably determined without error determination.

In a preferred form, the discriminating means includes comparing means for comparing the value of the ratio obtained by the ratio operating means with a reference value set for each kind of food, and the discriminating means discriminates the kind of the food to be heated on the basis of results of comparison performed by the comparing means. Consequently, the kind of the food to be heated can be reliably
 25 discriminated by the discriminating means with a simplified arrangement.

In another preferred form, the microwave oven is further characterized by a weight sensor detecting the weight of the food and setting means for setting a heating time of the food on the basis of both the weight of the food detected by the weight sensor and the results of determination of the determining means. In this arrangement, an appropriate heating time can be determined on the basis of both the weight and the kind of
 30 the food.

In further another preferred form, the microwave oven is further characterized by a weight sensor detecting the weight of the food and detection time setting means for setting a detection time on the basis of the weight detected by the weight sensor and is characterized in that the change rate operating means performs the operation on the basis of data of the volume of gaseous alcohol detected by the first gas
 35 sensor and data of the volume of steam detected by the second gas sensor, both said data being detected by the respective gas sensors upon lapse of the detection time set by the detection time setting means after initiation of the heating operation. Consequently, the kind of the food can be discriminated at an appropriate time according to the weight of the food on the basis of the ratio of the change rates of the gaseous alcohol and the steam detected by the first and second gas sensors respectively. In this
 40 arrangement, the microwave oven may be further characterized by heating time setting means for setting a heating time of the food on the basis of both the weight of the food detected by the weight sensor and the results of determination of the determining means. In this case, an appropriate heating time can be determined on the basis of both the weight and the kind of the food.

In another aspect, the invention provides a method of determining food contained in a heating chamber
 45 of a microwave oven by discriminating the kind of the food on the basis of data of volumes of gaseous alcohol and steam detected by first and second gas sensors respectively during a high frequency heating operation by heating means, characterized by the steps of operating a rate of change in the gaseous alcohol on the basis of data of the volume of gaseous alcohol detected by the first gas sensor and a rate of change in the steam on the basis of data of the volume of steam detected by the second gas sensor,
 50 operating a ratio of the obtained change rate of the gaseous alcohol and the obtained change rate of the steam, and discriminating the kind of the food on the basis of a value of the obtained ratio.

The step of discriminating the kind of the food may include steps of comparing the value of the obtained ratio of the change rate of the gaseous alcohol and the change rate of the steam with a reference value set for each kind of food and of discriminating the kind of the food to be heated.

55 The invention may be further characterized by steps of detecting the weight of the food by a weight sensor and of setting a detection time on the basis of the weight detected by the weight sensor and characterized in that in the change rate operating step, the operation is performed on the basis of data of the volume of gaseous alcohol detected by the first gas sensor and data of the volume of steam detected

by the second gas sensor, both said data being detected by the respective gas sensors upon lapse of the set detection time after initiation of the heating operation.

The invention will be described, merely by way of example, with reference to the accompanying drawings, in which:

- 5 FIG. 1 is a block diagram showing an electrical arrangement of the microwave oven of a first embodiment in accordance with the present invention;
- FIG. 2 is a front view of the microwave oven with a door of the heating chamber eliminated;
- FIG. 3 illustrates an alcohol sensor and a steam sensor provided in an exhaust path;
- FIG. 4 is a graph showing variations in the rate of change of the detection signal generated by the
- 10 alcohol sensor with lapse of time;
- FIG. 5 is a graph showing variations in the rate of change of the detection signal generated by the steam sensor with lapse of time;
- FIG. 6 is a graph showing variations in the ratio of the change rates with lapse of time;
- FIG. 7 is a flowchart of a heating program employed in the microwave oven of a second embodiment;
- 15 FIG. 8 is also a flowchart of the heating program continuing from FIG. 7;
- FIG. 9 is a graph showing variations in the rate of change of the volume of detected alcohol emanating from the food where its weight W is below 450 g;
- FIG. 10 is also a graph showing variations in the rate of change of the volume of detected alcohol emanating from the food where $450 \leq W < 680$ g;
- 20 FIG. 11 is a graph showing the results of determination on the basis of the ratio of the change rates; and
- FIG. 12 is also a graph showing the results of determination on the basis of the difference between the change rates.

A first embodiment of the invention will be described with reference to FIGS. 1 to 6. Referring first to FIG. 2 showing the appearance of the microwave oven, an outer cabinet 1 defines a heating chamber 2 in its left-hand interior and a component chamber (not shown) in its right-hand interior, as viewed in FIG. 2. A magnetron 3 (see FIG. 1), a cooling fan unit (not shown) and the like are provided in the component chamber. The magnetron 3 is energized to supply microwaves into the heating chamber 2, so that food contained in it is heated. The cooling fan unit comprises a cooling fan and a fan motor (see FIG. 1).

The heating chamber 2 has a front opening and a door (not shown) closing and opening the front opening. A rotational shaft 5 projects upwardly from the inner bottom of the heating chamber 2. A turntable 6 on which the food to be heated is placed is detachably mounted on the upper portion of the shaft 5. A turntable motor 7 (see FIG. 2) is provided for rotating the shaft 5.

A weight sensor 8 is provided in the lower interior of the heating chamber 2 for detecting, via the shaft 5, the weight of the food placed on the turntable 6. A rear wall of the heating chamber has on its upper left-hand end an air exit 9 composed of a number of through apertures. An exhaust path 10 extends from the air exit 9, communicating with the outside of the outer casing 1. A first gas sensor or alcohol sensor 11 highly sensitive to gaseous alcohol and a second gas sensor or steam sensor 12 highly sensitive to steam are disposed in the exhaust path 10, as shown in FIG. 3. The alcohol sensor 11 detects the gaseous alcohol and produces a detection voltage V_A , and the steam sensor 12 detects the steam and produces a detection

40 voltage V_G .

An operation panel 13 is provided on the front right-hand side of the outer casing 2, as viewed in FIG. 2. The operation panel 13 includes a display section 14 (see FIG. 1) for displaying a heating time period, a heating mode, a cooking menu and the like and an operation switch section 15 (see FIG. 1) having various switches for entering the heating time period, heating mode, cooking menu, a heating start time and the like. Each switch of the operation switch section 15 generates an operation input signal when operated.

Referring now to FIG. 1 showing an electrical arrangement of the microwave oven, a control circuit 16 comprises a microcomputer, memories and the like. A control program for execution of the heating operation is previously stored in one of the memories. The control circuit 16 serves as determining means, change rate operating means, ratio operating means, comparing means, discriminating means and heating time setting means, which means will be described later. The control circuit 16 has input terminals to which the alcohol sensor 11, the steam sensor 12, the weight sensor 8 and the operation switch section 15 are connected so that the detection signals and the operation input signals are supplied to the control circuit 16. The control circuit 16 further has output terminals connected to the display section 14 and drive circuits 3a, 4a and 5a further connected to the magnetron 3, the fan motor 4 and the turntable motor 7 respectively, so that the magnetron 3, the fan motor 4, the turntable motor 7 and the display section 14 are controlled by the control circuit 16.

The operation of the microwave oven will now be described with reference to FIGS. 4-6. In the following description, Japanese miso soup and boiled rice are employed as food to be heated. The miso soup

contains an alcoholic component while the boiled rice contains no alcoholic component.

The user puts either miso soup or boiled rice into the heating chamber 2 and then closes the door of the heating chamber in the condition that power has been applied to the microwave oven. Then, the control circuit 16 stands by for supply of the input regarding selection of one cooking menu. When the cooking menu of "WARMING" is selected, for example, the control circuit 16 supplies a display signal to the display section 14 so that an indication of the selected cooking menu is displayed. Furthermore, the control circuit 16 operates to energize the magnetron 3, the fan motor 4 and the turntable motor 7 via the respective drive circuits 3a, 4a, 5a. The control circuit 16 further detects the weight of the food on the basis of the detection signal generated by the weight sensor 8 and stores data of the detected weight in the memory. Based on the detection voltages V_A and V_G produced by the respective alcohol and steam sensors 11, 12, the control circuit 16 obtains the respective maximum values V_{Amax} and V_{Gmax} while 40 seconds elapses after the initiation of the heating, and stores data of these maximum values. These maximum values V_{Amax} , V_{Gmax} represent the condition that the detected volume of gas is the smallest.

Upon lapse of 40 seconds after the initiation of the heating, the control circuit 16 again inputs the data of the detection voltages V_A , V_G from the respective alcohol and steam sensors 11, 12. Based on the detection voltage V_A and the maximum value V_{Amax} , the control circuit 16 obtains a change rate ΔA of the alcohol from the following expression (1):

$$\Delta A = V_A / V_{Amax} \quad (1)$$

Also, based on the detection voltage V_G and the maximum value V_{Gmax} , the control circuit 16 obtains a change rate ΔG of the steam from the following expression (2):

$$\Delta G = V_G / V_{Gmax} \quad (2)$$

FIGS. 4 and 5 show variations in the values of the obtained change rates ΔA and ΔG of the alcohol and the steam with lapse of time respectively.

The control circuit 16 then obtains a ratio r of the change rates ΔA and ΔG from the following expression (3):

$$r = (1 - \Delta A) / (1 - \Delta G) \quad (3)$$

FIG. 6 shows variations in the obtained ratio r with lapse of time after the initiation of the heating.

The ratio r obtained 40 seconds after the initiation of the heating is compared with a threshold or a reference value whose data is previously stored in the memory so that the determination is made as to which the food is, the miso soup or the boiled rice. In this regard, since the difference between the ratios r in the cases of the miso soup and the boiled rice is large, the discrimination between them can be reliably made. More specifically, as understood from FIG. 6, the differences between the values of the ratios r varying with laps of time with respect to the respective miso soup and boiled rice are larger than those between the values of the change rates ΔA and ΔG (see FIGS. 4 and 5) obtained on the basis of the detection voltages V_A , V_G produced by the alcohol and steam sensors 11, 12 respectively. Consequently, the determination of the cooking menu can be reliably made without error determination when the threshold is set at a medium value between the variations in the values of the ratios r with respect to the respective miso soup and boiled rice.

Upon discrimination between the miso soup or the boiled rice in the manner as described above, the control circuit 16 sets the heating time at 70 seconds in the case of the miso soup while setting it at 35 seconds in the case of the boiled rice. The heating operation is continued until each set heating time elapses. Upon lapse of the set heating time, the control circuit 16 deenergizes the magnetron 3 and the turntable motor 7, thereby completing the heating. At the same time, the control circuit 16 operates to display on the display section an indication indicative of completion of the heating and to activate a buzzer (not shown) so that the user is informed of completion of the heating. Subsequently, the control circuit 16 deenergizes the fan motor 4 upon lapse of a period of time previously determined according to the heating condition for the food, thereby completing the heating program.

According to the above-described embodiment, the ratios r of the change rates are obtained and then compared with the threshold when the food is discriminated. Consequently, since the threshold can be set readily and the food can be reliably discriminated, the food can be cooked under an optimum heating condition.

FIGS. 7-12 illustrate a second embodiment of the invention. Difference between the first and second embodiments will be described. FIGS. 7 and 8 show flowcharts explaining a program for warming beverage. In the embodiment, Japanese saké and milk are warmed. The control circuit 16 is provided with a function of setting a detection time on the basis of the weight detected by the weight sensor 8, as will be described later. The control circuit 16 obtains the heating time and executes the heating operation in a manner as will be described later.

Upon application of the electric power to the microwave oven, the control circuit 16 executes an initializing process for initializing control data, flags and the like (step S1). In this state, when the user puts the food into the heating chamber 2 and closes its door, the control circuit 16 determines in the affirmative at step S2, standing by for operation of any one of the cooking menu selecting key (step S3).

When the key for the beverage warming operation has been operated, the control circuit 16 advances to step S4 and then to step S5 where the indication of UNDER COOKING is displayed on the display section 14, the chamber lamp is turned on, and the fan motor 4 and the turntable motor 7 are energized. Additionally, the control circuit 16 inputs the detection signal indicative of the detection weight W of the food detected by the weight sensor 8, storing the data of the detection weight W.

The control circuit 16 then starts to drive the magnetron 3 and sets at a built-in timer a detection time according to the detection weight W, starting the timing operation. For example, the timer is set at 45 seconds when the detection weight W is below 450 g while being set at 90 seconds when the detection weight W is 450 g or above. Thus, the control circuit 16 sets at the built-in timer the detection time differentiated according to the weight W of the food to be heated. The control circuit 16 inputs the data of the volume of gaseous alcohol detected by the alcohol sensor 11 and the data of the volume of steam detected by the steam sensor 12, each data being detected upon lapse of the detection time set at the built-in timer. Subsequently, the control circuit 16 obtains the maximum values V_{Gmax} and V_{Amax} of the detection voltages V_G and V_A produced by the steam sensors 12 and the alcohol sensor 11 respectively and stores the data of these values until the time period set at the built-in timer elapses (steps S7 to S10). When the door of the heating chamber 2 is opened before the time period set at the timer elapses, the control circuit 16 determines in the affirmative at step S7, resetting the display state of the display section 14 and then, driving the fan motor 4 for 90 seconds (step S11). Subsequently, the control circuit 16 returns to step S1.

The control circuit 16 then obtains by calculation the change rate ΔA of the gaseous alcohol from the expression (1) on the basis of the detection voltage V_A produced by the alcohol sensor 11 and its maximum value V_{Amax} in the same manner as in the foregoing embodiment and further obtains the change rate ΔG of the steam from the expression (2) on the basis of the detection voltage V_G produced by the steam sensor 12 and its maximum value V_{Gmax} . Based on the obtained change rates, the control circuit 16 obtains the ratio r of the change rates from the expression (3). Then, the control circuit 16 advances to step S13 where it determines whether or not the value of the obtained ratio r is larger than "12." When the value of the ratio r is larger than "12," the control circuit 16 determines in the affirmative at step S13, selecting the saké warming course and operating the display section 14 to display the indication for the selected course (step S14). The control circuit 16 obtains and sets the heating time for the saké warming course in accordance with the detection weight W (step S15). On the other hand, when determining in the negative at step S13, the control circuit 16 selects the milk warming course and operates the display section 14 to display the indication of the selected course (step S16). The control circuit 16 then advances to step S17 where the heating time for the selected course is obtained in accordance with the detection weight W and is set. The heating time T (second) for the sake warming course is obtained from the following expression (4):

$$T = 0.18 \times W + 12 \quad (4)$$

and the heating time T (second) for the milk warming course is obtained from the following expression (5):

$$T = 0.23 \times W + 15. \quad (5)$$

Subsequently, the control circuit 16 subtracts the time currently indicated by the built-in timer from the obtained heating time T to thereby obtain a remaining heating time Ta (step S18). Further at step S18, the control circuit 16 sets a subtracting timer (not shown) to the remaining heating time Ta and starts its timing operation. The heating operation is executed until the remaining time Ta elapses (step S20). When the door of the heating chamber 2 is opened in the middle of the heating operation, the control circuit 16 determines in the affirmative at step S19 and interrupts the timing operation of the subtracting timer and the operation of the magnetron 3 (step S21). Thereafter, when the door is reclosed and the beverage warming key is

operated, the control circuit 16 determines in the affirmative at step S22, returning to step S20, where the heating operation is restarted.

Upon completion of the timing operation of the subtracting timer, the control circuit 16 advances to step S20 where it determines in the affirmative, further advancing to step S23. At step S23, the magnetron 3 is deenergized and simultaneously, the buzzer for informing of completion of the heating is activated once and the chamber lamp is turned off. When the sake warming course has been executed, the control circuit 16 advances to steps S24 and S25 in turn. At step S25, the fan motor 4 is driven for 10 minutes and subsequently, the program is completed.

The reference value takes "12" in the embodiment, as described above. The value is based on the results of experiments made by the inventors. The inventors measured the transition of deviation ($1-\Delta A$) of the change rates ΔA of the detection voltages V_A generated by the alcohol sensor 11 with respect to one cup of saké, one bottle of saké, one bottle of saké with the bottle having an aluminum foil around its neck portion, and one glass of milk in the case where the weight W is below 450 g. FIG. 9 shows the results of the measurement. The inventors further measured the transition of deviation ($1-\Delta A$) of the change rates ΔA of the detection voltages V_A generated by the alcohol sensor 11 with respect to two cups of saké, two bottles of sake, two bottles of saké with each bottle having an aluminum foil around its neck portion, and two glasses of milk in the case where the weight W is 450 g or above and below 680 g.

As understood from FIG. 9, the volume of gaseous alcohol detected by the alcohol sensor 11 is small with respect to both of one bottle of saké with the bottle having the aluminum foil around its neck portion and of one glass of milk in the case where the weight W is below 450 g. Accordingly, discrimination cannot be exactly made between these cases even when the detection of gaseous alcohol is performed 50 seconds after the initiation of the heating, for example. On the other hand, the difference between the change rates ΔG in both cases is not so large even though there is a small difference between the volumes of steam in both cases. Consequently, when the change rate ΔG of the volume of steam detected by the steam sensor 12 is subtracted from the change rate A of the volume of gaseous alcohol detected by the alcohol sensor 11 and the kind of food is determined on the basis of the resultant difference, as in the prior art, there is only a slight difference between the resultant differences in the cases of one bottle of saké with the bottle having the aluminum foil around the neck portion and one glass of milk, as shown in TABLE 1, so that there is the possibility of an error determination.

In the embodiment, however, when the ratio r of the change rates is obtained from the expression (3), a large difference can be obtained between the cases of one bottle of saké with the bottle having the aluminum foil and one glass of milk though the deviation of the detection voltage V_G of the steam sensor 12 is small. TABLE 1 shows the differences obtained in this manner. FIG. 11 shows the case where the discrimination has been made on the basis of the ratio of the change rates with the discrimination reference value of "12" and FIG. 12 the case where the discrimination has been made on the basis of the difference between the change rates with the discrimination reference value of "6."

TABLE 1

	Kind of beverage (heating time)	Sensor	Detection data	$\Delta A - \Delta G$	r
5	One cup of saké (45 sec.)	Alcohol sensor Steam sensor	18.8 0.7	18.1	27.0
	Two cups of saké (90 sec.)	Alcohol sensor Steam sensor	49.9 2.6	47.3	19.0
10	One bottle of saké (45 sec.)	Alcohol sensor Steam sensor	12.05 0.35	11.7	34.0
	Two bottles of saké (90 sec.)	Alcohol sensor Steam sensor	27.5 1.2	26.3	22.0
15	One bottle of saké with aluminum foil (45 sec.)	Alcohol sensor Steam sensor	2.0 0.1	1.9	20.0
	Two bottles of saké with aluminum foil (90 sec.)	Alcohol sensor Steam sensor	21.6 0.5	21.1	43.2
20	One glass of milk (45 sec.)	Alcohol sensor Steam sensor	2.5 0.5	2.0	5.0
	Two glasses of milk (90 sec.)	Alcohol sensor Steam sensor	4.1 1.0	3.1	4.1

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According to the second embodiment, the rates of changes in the detection voltages V_A , V_G generated by the respective alcohol and steam sensors 11, 12 are obtained and then the ratio r of the change rates is obtained from the expression (3) in the same manner as in the first embodiment, so that the discrimination is made as to which the food to be heated is, saké or milk. Since either the saké warming course or the milk warming course is set on the basis of the discrimination, the determination of the course can be reliably made.

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Furthermore, the control circuit 16 is arranged to switch the detection time for input of the detection data from the alcohol and steam sensors 11, 12 between 45 and 90 seconds in the cases where the weight W detected by the weight sensor 8 is below 450 g and 450 g or above. Consequently, the food discriminating operation can be performed at a suitable time in accordance with the detected weight.

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Furthermore, the control circuit 16 is arranged to set the remaining heating time T_a on the basis of the results of discrimination of the food and the weight W detected by the weight sensor 8. Consequently, the appropriate heating time T can be set in accordance with the kind and weight of the food to be cooked, which can provide for an appropriate heating operation.

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The foregoing disclosure and drawings are merely illustrative of the principles of the present invention and are not to be interpreted in a limiting sense. The only limitation is to be determined from the scope of the appended claims.

Claims

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1. A microwave oven comprising heating means (3) high-frequency heating food, a first gas sensor (11) detecting gaseous alcohol emanating from the food, a second gas sensor (12) detecting steam emanating from the food, and determining means (16) for determining the kind of the food on the basis of outputs of the respective sensors (11, 12), characterized in that the determining means (16) comprises change rate operating means (16) for operating a rate of change in the gaseous alcohol on the basis of data of a volume of gaseous alcohol detected by the first gas sensor (11) and a rate of change in the steam on the basis of data of a volume of steam detected by the second gas sensor (12), ratio operating means (16) operating a ratio of the change rate of the gaseous alcohol and the change rate of the steam each obtained by the change rate operating means (16), and discriminating means (16) for discriminating the kind of the food on the basis of a value of the ratio obtained by the ratio operating means (16).

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2. A microwave oven according to claim 1, characterized in that the discriminating means (16) includes comparing means (16) for comparing the value of the ratio obtained by the ratio operating means (16) with a reference value set for each kind of food and in that the discriminating means (16) discriminates the kind of the food to be heated on the basis of results of comparison performed by the comparing means (16).
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3. A microwave oven according to claim 1 or 2, characterized by a weight sensor (8) detecting the weight of the food and setting means (16) for setting a heating time of the food on the basis of both the weight of the food detected by the weight sensor (8) and the results of determination of the determining means (16).
10
4. A microwave oven according to claim 1 or 2, characterized by a weight sensor (8) detecting the weight of the food and detection time setting means (16) for setting a detection time on the basis of the weight detected by the weight sensor (8) and characterized in that the change rate operating means (16) performs the operation on the basis of data of the volume of gaseous alcohol detected by the first gas sensor (11) and data of the volume of steam detected by the second gas sensor (12), both said data being detected by the respective gas sensors (11, 12) upon lapse of the detection time set by the detection time setting means (16) after initiation of the heating operation.
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5. A microwave oven according to claim 4, characterized by heating time setting means (16) for setting a heating time of the food on the basis of both the weight of the food detected by the weight sensor (8) and the results of determination of the determining means (16).
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6. A method of determining food contained in a heating chamber (2) of a microwave oven by discriminating the kind of the food on the basis of data of volumes of gaseous alcohol and steam detected by first and second gas sensors (11, 12) respectively during a high frequency heating operation by heating means (3), characterized by the steps of operating a rate of change in the gaseous alcohol on the basis of data of the volume of gaseous alcohol detected by the first gas sensor (11) and a rate of change in the steam on the basis of data of the volume of steam detected by the second gas sensor (12), operating a ratio of the obtained change rate of the gaseous alcohol and the obtained change rate of the steam, and discriminating the kind of the food on the basis of a value of the obtained ratio.
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7. A method according to claim 6, characterized in that the step of discriminating the kind of the food includes steps of comparing the value of the obtained ratio of the change rate of the gaseous alcohol and the change rate of the steam with a reference value set for each kind of food and of discriminating the kind of the food to be heated.
35
8. A method according to claim 6 or 7, characterized by steps of detecting the weight of the food by a weight sensor (8) and of setting a detection time on the basis of the weight detected by the weight sensor (8) and characterized in that in the change rate operating step, the operation is performed on the basis of data of the volume of gaseous alcohol detected by the first gas sensor (11) and data of the volume of steam detected by the second gas sensor (12), both said data being detected by the respective gas sensors (11, 12) upon lapse of the set detection time after initiation of the heating operation.
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45

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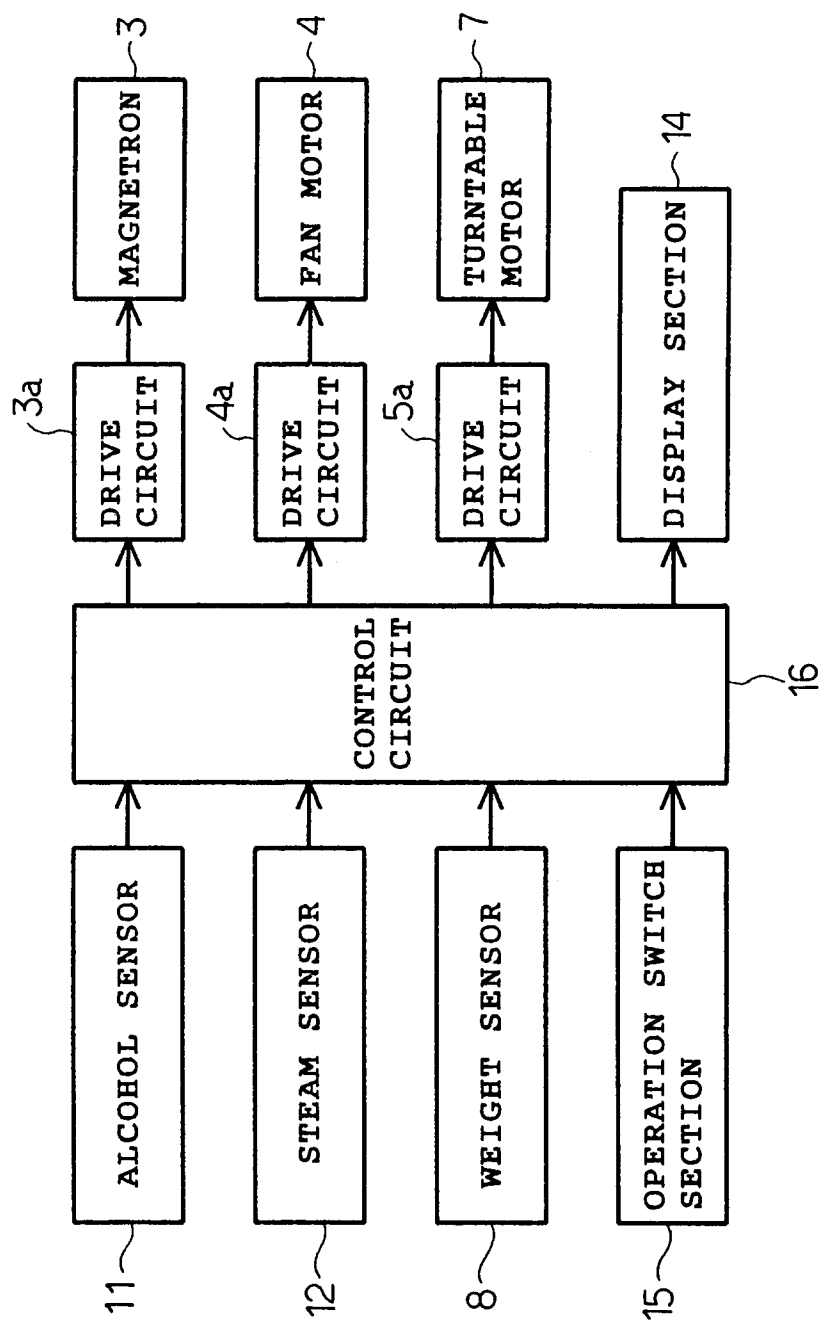


FIG.1

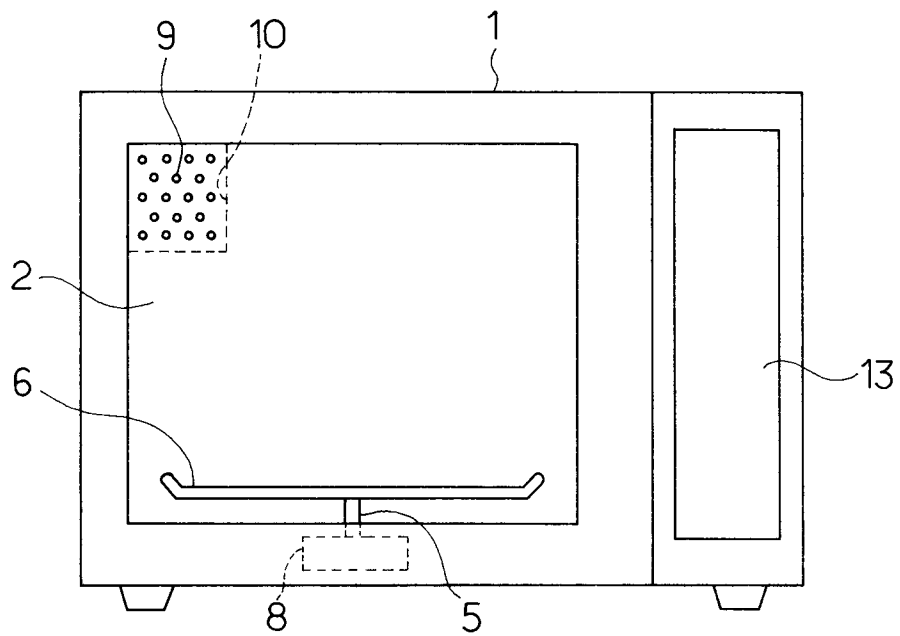


FIG. 2

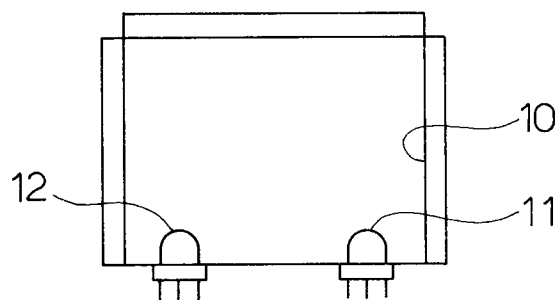


FIG. 3

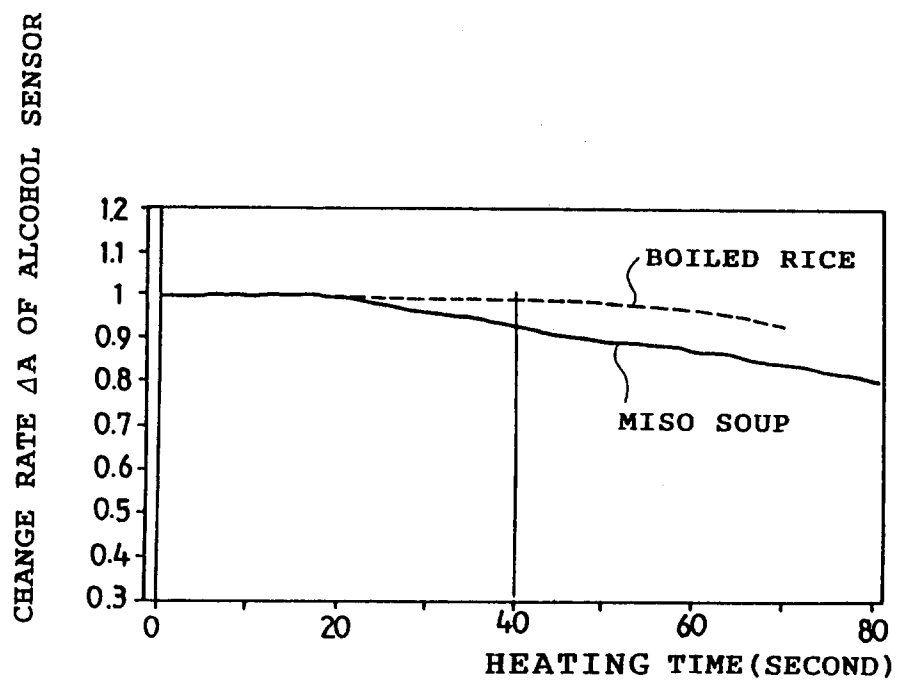


FIG.4

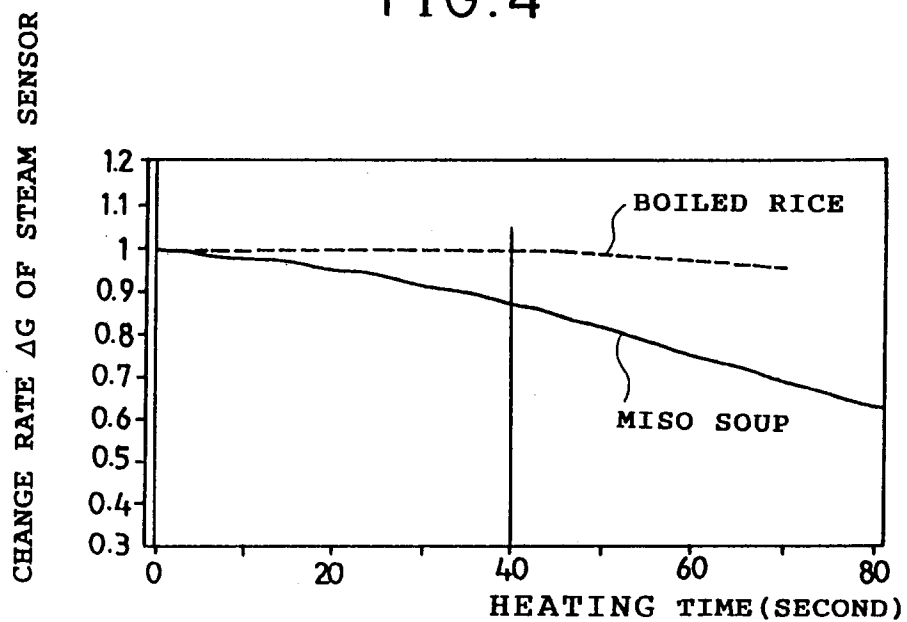


FIG.5

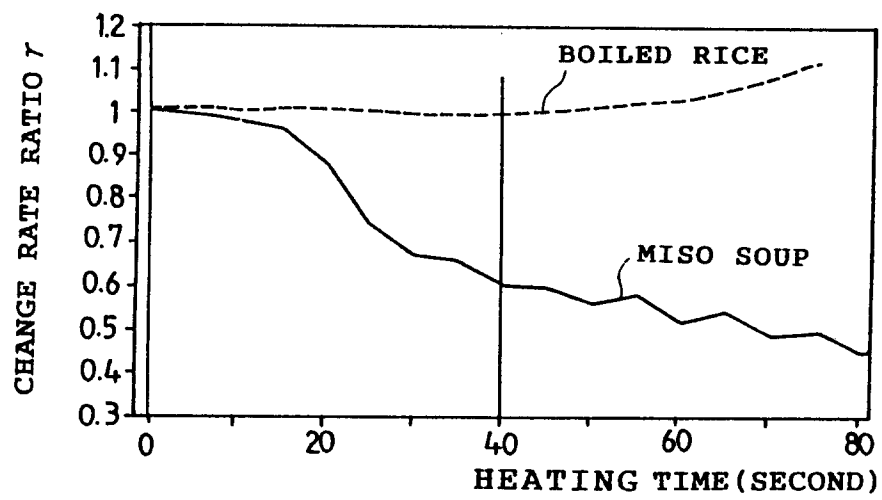


FIG. 6

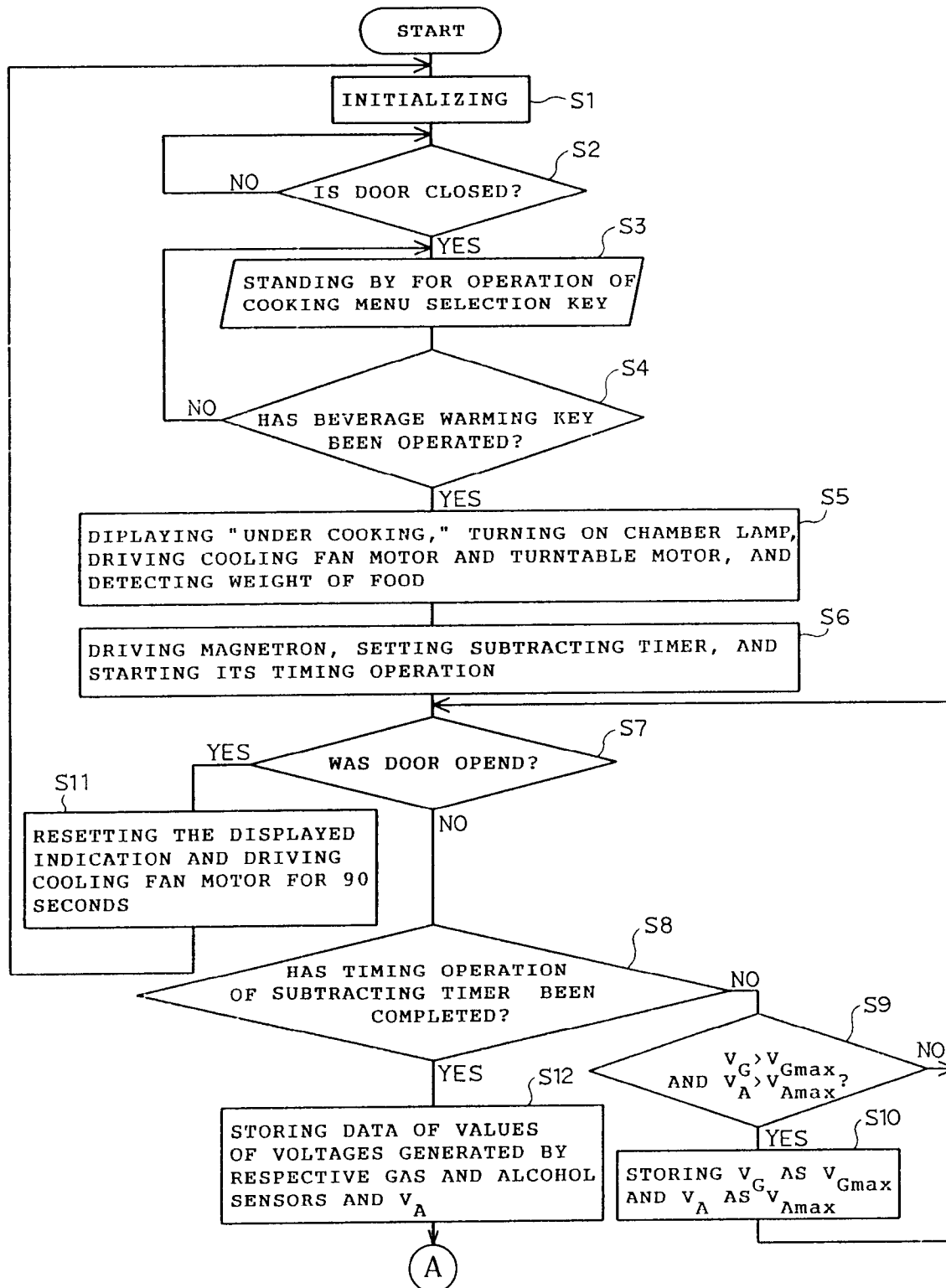


FIG. 7

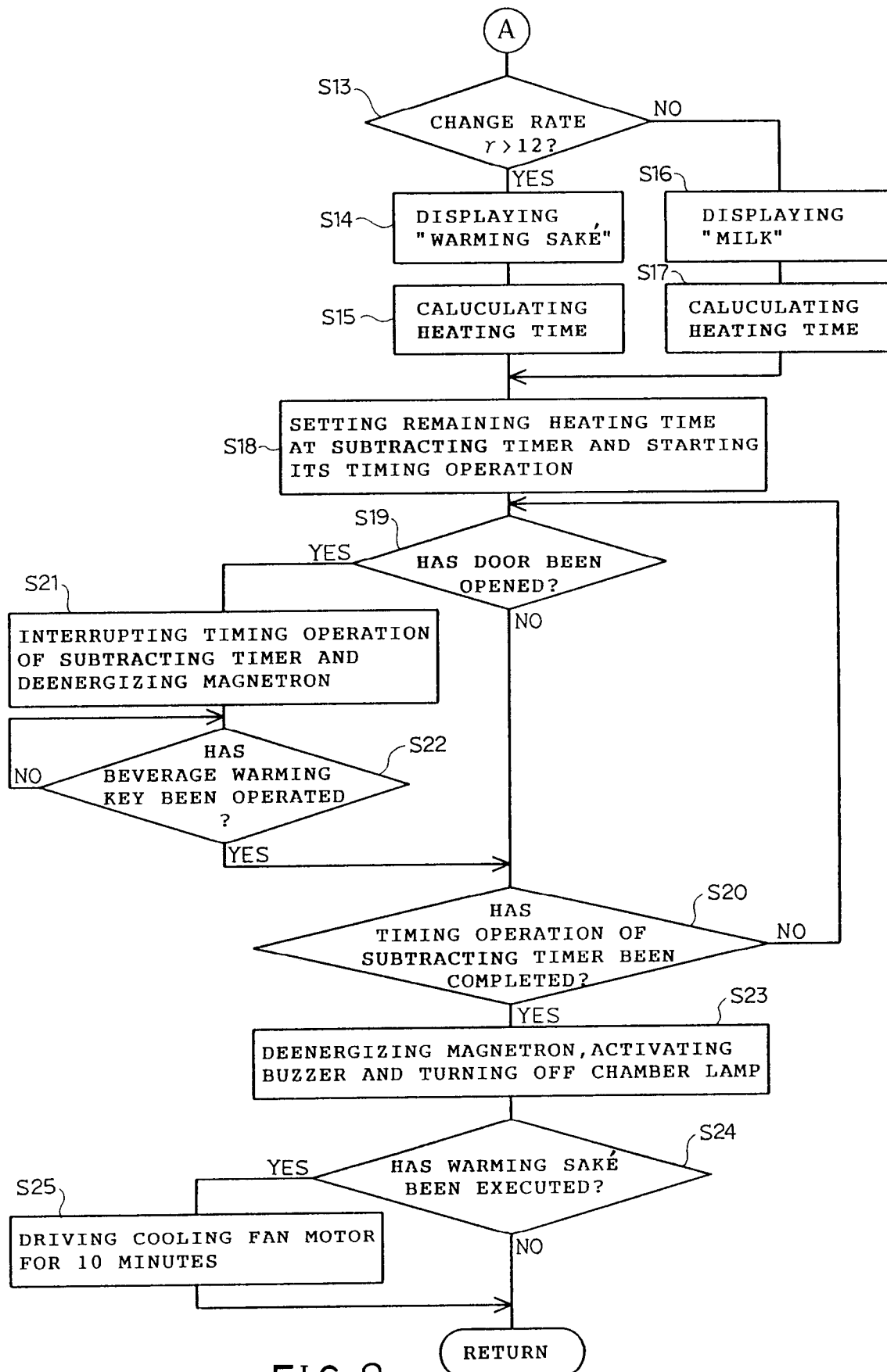


FIG. 8

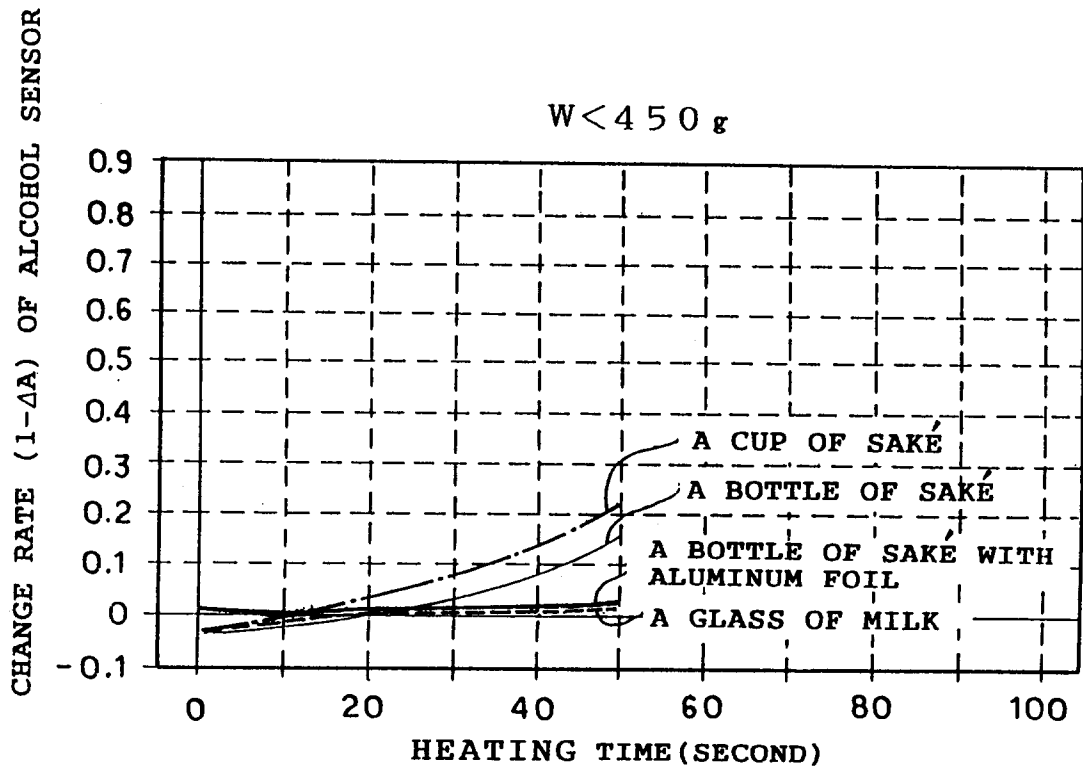


FIG.9

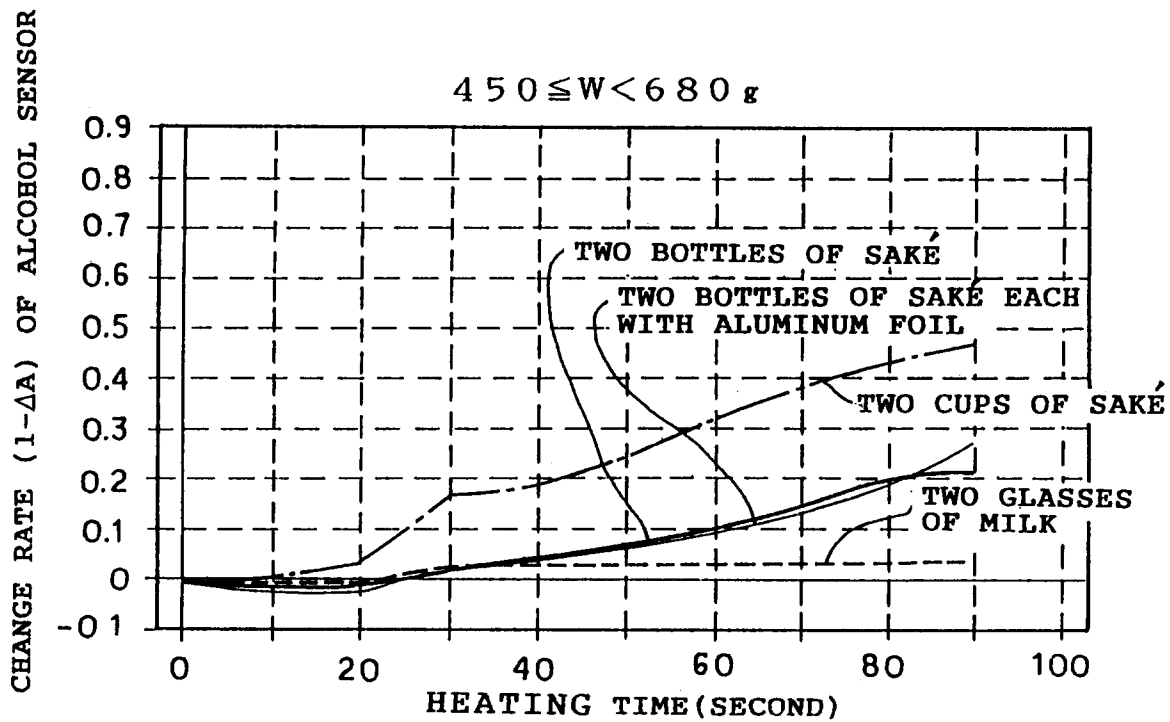


FIG.10

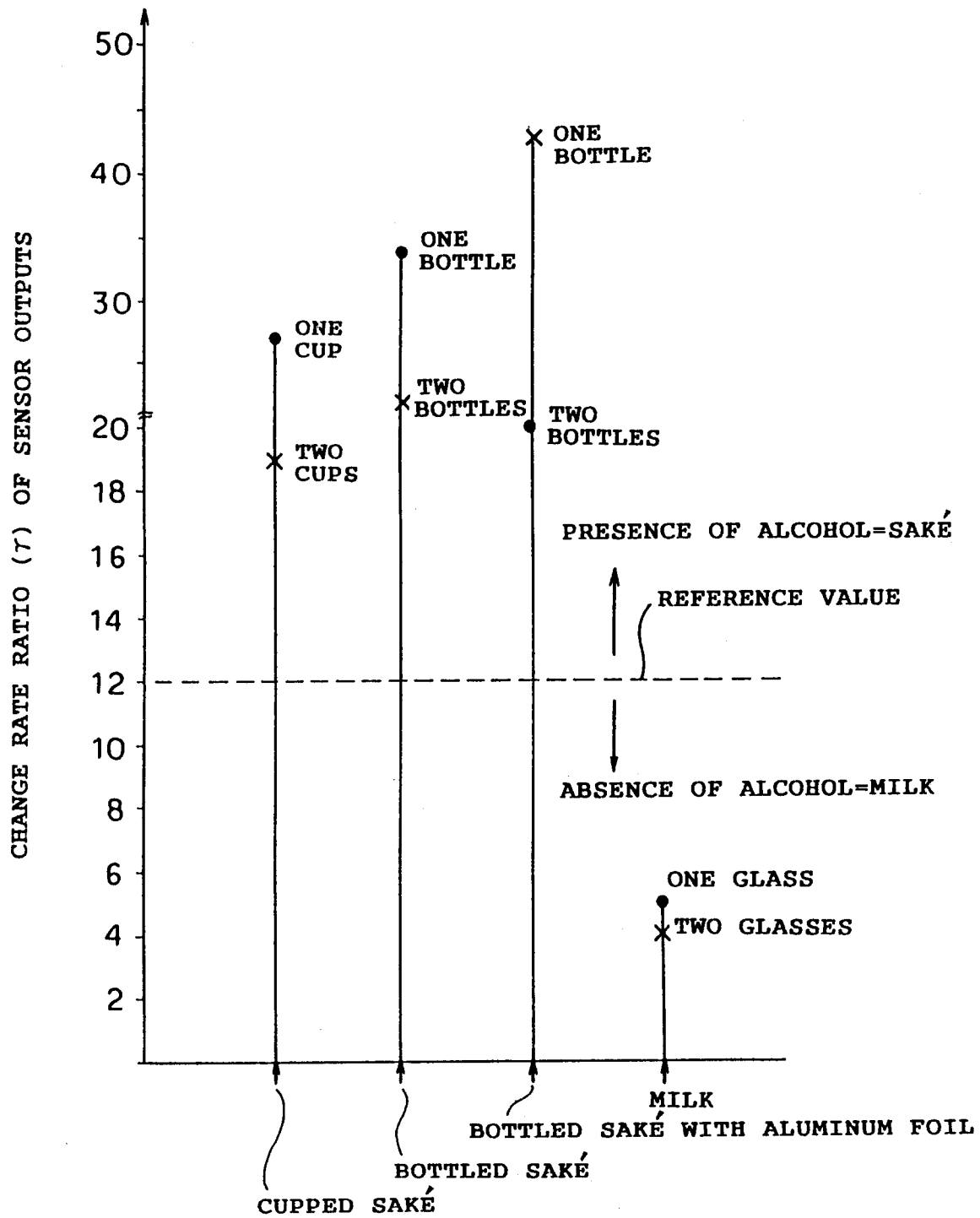


FIG.11

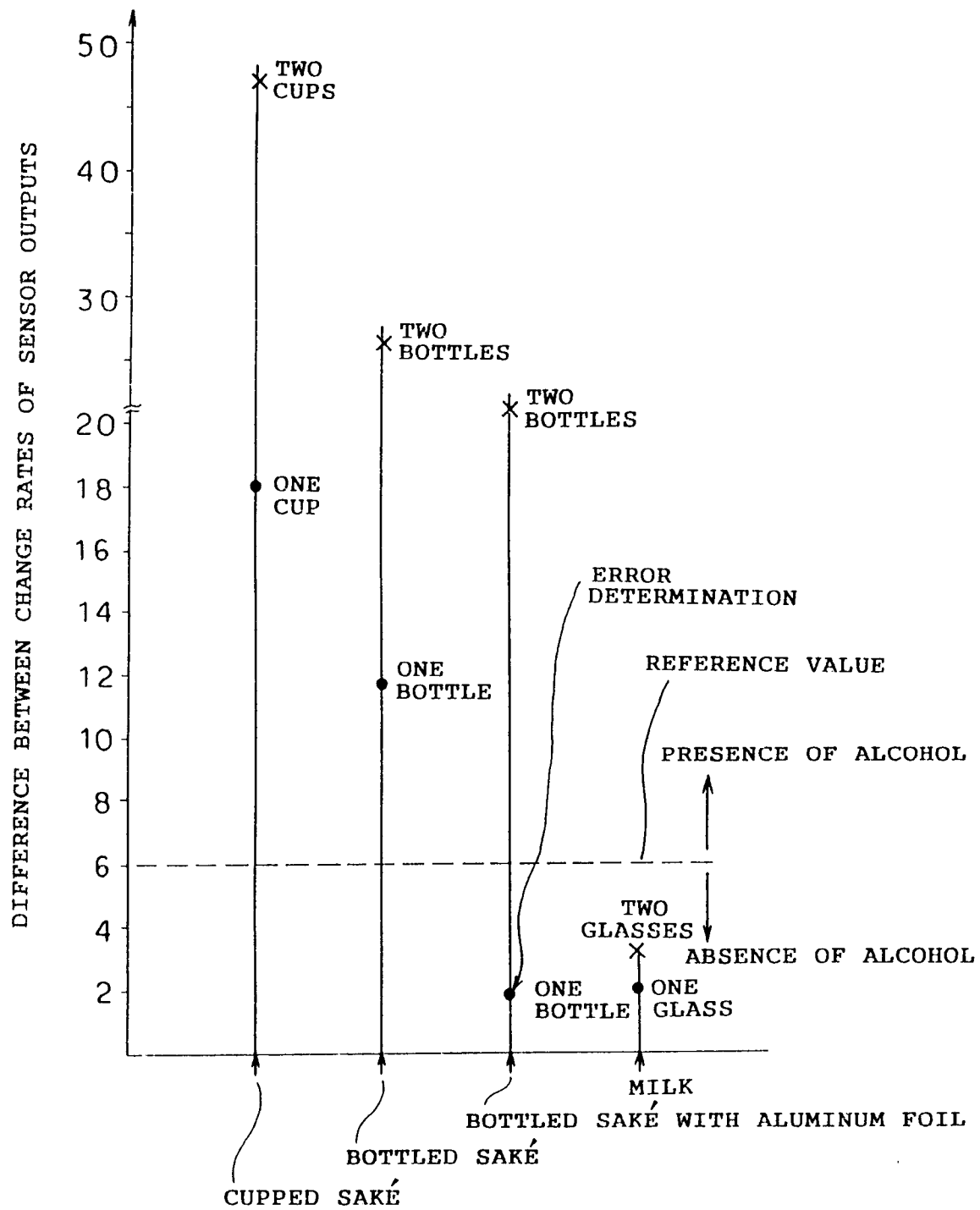


FIG.12