



(12) **EUROPEAN PATENT APPLICATION**

(21) Application number : **92302032.5**

(51) Int. Cl.⁵ : **H05B 6/68**

(22) Date of filing : **10.03.92**

(30) Priority : **15.03.91 JP 76939/91**

(43) Date of publication of application :
16.09.92 Bulletin 92/38

(84) Designated Contracting States :
DE FR GB

(71) Applicant : **KABUSHIKI KAISHA TOSHIBA**
72, Horikawa-cho Saiwai-ku
Kawasaki-shi Kanagawa-ken 210 (JP)

(72) Inventor : **Takei, Tamotsu, Nagoya Works**
K.K. Toshiba, 21, Yoshihara-cho 4-chome
Nishi-ku, Nagoya (JP)
Inventor : **Nishimura, Nobuichi, Nagoya Works**
K.K. Toshiba, 21, Yoshihara-cho 4-chome
Nishi-ku, Nagoya (JP)

(74) Representative : **Freed, Arthur Woolf et al**
MARKS & CLERK 57-60 Lincoln's Inn Fields
London WC2A 3LS (GB)

(54) **Heating apparatus.**

(57) A heating apparatus such as microwave ovens includes an electric heater (15), a magnetron (16), a thermistor (8) sensing the atmospheric temperature in a cooking chamber (6) and generating a voltage signal and a control device including CPU (11). The voltage signal is read from the thermistor (8) by the control device at predetermined intervals in the condition that both of the electric heater (15) and the magnetron (16) are deenergized. A read temperature corresponding to the read voltage signal is stored in a first memory (14a). When the difference between the temperature stored in the first memory (14a) and the temperature read by the control device is within a predetermined range, the temperature read by the control device is stored in a second memory (14b). Heating constants set by a user are compensated for based on the read temperature stored in the second memory (14b). The control device controls the output of the magnetron (16) based on the compensated heating constants.

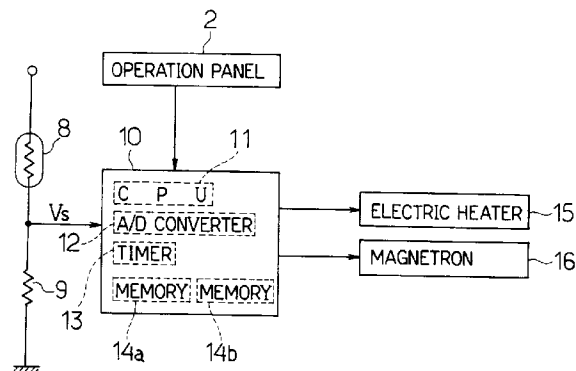


FIG.1

This invention relates to a heating apparatus wherein heating is executed based on heating constants such as a heating value, heating time period and the like set by a user.

A microwave oven with an oven function is generally provided with a temperature sensor sensing an atmospheric temperature in a cooking chamber. A heating temperature and a time period of the heating operation are set by the user in the case of an oven cooking mode. A control device of the microwave oven controls the output of an electric heater so that the temperature sensed by the temperature sensor reaches the set temperature.

In the case of a range cooking mode by the use of a magnetron, a magnetron output and the heating operation time period are set by the user. In this case the temperature of food heated does not agree with the atmospheric temperature in the cooking chamber since food placed in the cooking chamber is directly heated by high frequency waves. Accordingly, the cooking chamber atmospheric temperature need not generally be set in the case of execution of range cooking mode.

On the other hand, the degree of heating of the food is influenced by an atmospheric temperature in a room where the microwave oven is disposed, as well as by an output value of and an operation period of the heating source. Accordingly, in the case of a microwave oven with a thawing function, not only heat by the magnetron but also heat due to the ambient temperature are applied to the food when the magnetron output is set to a small value with the ambient temperature high. As a result, the finishing of the thawing varies from case to case. Furthermore, in the case of a microwave oven with a fermenting function, the temperature at which the bread dough is fermented is affected by the room atmospheric temperature, which worsens the finishing of the bread.

In order to solve the above-described problems, it is desirable that a temperature sensor should be provided for sensing the room atmospheric temperature and that the thawing period or fermenting period in the range cooking mode should be compensated for based on the temperature sensed by the temperature sensor. More specifically, when the room atmospheric temperature is high, the actual thawing or fermenting period is rendered shorter than the period set by the user so that the influence by the room atmospheric temperature is canceled, thereby preventing variations in the finishing of the food.

However, when the temperature sensor for sensing the room atmospheric temperature is newly provided in the microwave oven, addition of the temperature sensor increases the production cost of the microwave oven and complicates the circuit arrangement.

Therefore, an object of the present invention is to provide a heating apparatus wherein the heating is

executed based on the heating constants set by the user and an arrangement for sensing the ambient temperature and compensating for the heating constants can be actualized without the increase in the production cost and complication of the circuit arrangement.

Another object of the invention is to provide a heating apparatus wherein the oven cooking by the use of the electric heater and the range cooking by the use of the magnetron are executed based on the heating constants set by the user and the arrangement for sensing the ambient temperature to compensate for the heating constants can be attained without the increase in the production cost and a complicated circuit arrangement.

In one aspect, the present invention provides a heating apparatus comprising a cooking chamber, first heating means for heating food accommodated in the cooking chamber, second heating means for heating the food accommodated in the cooking chamber, a temperature sensor sensing an atmospheric temperature in the cooking chamber to thereby generate a voltage signal according to the sensed temperature, and first heating execution means for controlling an output of the first heating means based on the voltage signal supplied thereto from the temperature sensor upon receipt of a start command, thereby executing the heating, characterized by temperature reading means for reading the voltage signal from the temperature sensor at predetermined intervals in the condition that both of the first and second heating means are deenergized, first storage means for storing data of read temperature corresponding to the voltage signal read by the temperature reading means, temperature determining means for calculating the difference between the temperature whose data is stored in the first storage means and the temperature read by the temperature reading means, second storage means for storing data of the temperature read by the temperature reading means when the temperature difference calculated by the temperature determining means is with a predetermined range, heating constant setting means for setting heating constants determining a volume of output of the second heating means, and second heating execution means for compensating for the heating constants set by the heating constant setting means based on the temperature whose data is stored in the second storage means upon receipt of a start command, and controlling the output of the second heating means based on the result of compensation, thereby executing the heating.

In another aspect, the invention provides a heating apparatus comprising a cooking chamber, first heating means for heating food accommodated in the cooking chamber, second heating means for heating the food accommodated in the cooking chamber, a temperature sensor sensing an atmospheric tempera-

ture in the cooking chamber to thereby generate a voltage signal according to the sensed temperature, and first heating execution means for controlling an output of the first heating means based on the voltage signal supplied thereto from the temperature sensor upon receipt of a start command, thereby executing the heating, characterized by temperature gradient determining means for differentiating the voltage signal from the temperature sensor to thereby generate a differentiation signal, first storage means, temperature determining means storing, in the first storage means, read data of the temperature corresponding to the temperature signal from the temperature sensor when the rate of change of the temperature corresponding to the differentiation signal from the temperature differentiating means is smaller than a predetermined value in the condition that both of the first and second heating means are deenergized, heating constant setting means for setting heating constants determining a volume of output of the second heating means, and second heating execution means for compensating for the heating constants set by the heating constant setting means based on the temperature whose data is stored in the first storage means upon receipt of a start command, and controlling the output of the second heating means based on the result of compensation, thereby executing the heating.

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

FIG. 1 is a block diagram showing an electrical arrangement of a microwave oven in accordance with the present invention;

FIG. 2 is a perspective view of the microwave oven;

FIG. 3 is a flowchart showing the operation of a control device of the microwave oven;

FIG. 4 is a flowchart showing the operation of the control device following the operation shown in FIG. 3;

FIG. 5 is a flowchart showing the operation of the control device following the operation showing in FIG. 3;

FIG. 6 is a flowchart showing the operation of the control device in a range cooking routine;

FIG. 7 is a flowchart showing the operation of the control device in an oven cooking routine; and

FIG. 8 is a graph showing the change in the atmospheric temperature in the cooking chamber of the microwave oven.

An embodiment in which the invention is applied to a microwave oven will be described with reference to the accompanying drawings. Referring first to FIG. 2, a door 1a is mounted on the front side of an outer casing 1 of the microwave oven. An operation panel 2 is also mounted on the front side of the outer casing 1. The operation panel 2 comprises a plurality of oper-

ation switches 3 including an oven cooking start button, a range cooking start button, a cancel button, a heating constant setting switch and the like, a time adjusting knob 4 and a display 5. A cooking chamber 6 defined in the outer casing 1 is closed and opened by the door 1a. A turntable 7 is rotatably mounted in the cooking chamber 6. A thermistor 8 serving as a temperature sensor is mounted on an inner side wall of the cooking chamber 6.

Referring now to FIG. 1, the thermistor 8 is connected at one of two ends to a DC power line and is grounded at the other end via a resistance 9. The common node of the thermistor 8 and the resistance 9 is connected to an input terminal of a control device 10. The thermistor 8 has a negative characteristic that the resistance value is reduced with the raise of the temperature and accordingly, the signal level of a voltage signal V_s generated by the thermistor 8 is raised with the raise of the atmospheric temperature in the cooking chamber 6.

The control device 10 comprises a central processing unit (CPU) 11, an analog-to-digital (A/D) converter 12, a timer 13, a first memory 14a serving as first storage means, a second memory 14b serving as second storage means and the like. CPU 11 serves as first heating execution means, second heating execution means, temperature reading means and temperature determining means. The voltage signal V_s from the thermistor 8 is supplied to the A/D converter 12. The analog voltage signal V_s is converted to a corresponding digital signal by the A/D converter 12 and the digital signal is delivered to CPU 11. A time interval is set in the timer 13. The timer 13 operates to inform CPU 11 that it has been timed up every time the set time interval is timed up. The time interval set in the timer 13 is a time factor for determining the gradient of the cooking chamber 6 atmospheric temperature from the temperature sensed by the thermistor 8.

CPU 11 reads the voltage signal V_s from the A/D converter 12 at the timing that the timer 13 is timed up. CPU 11 then operates so that the read temperature T_a corresponding to the voltage signal V_s read by CPU 11 is stored in the first memory 14a. When a predetermined condition is met, CPU 11 operates so that the read temperature is stored in the second memory 14b. The temperature stored in the first memory 14a will be referred to as "stored temperature T_b " and the temperature stored in the second memory 14b will be referred to as "stored temperature T_c ."

The operation of the above-described arrangement will be described. Referring to FIGS. 3 through 7, when the microwave oven is connected to the commercial power supply (step S1), CPU 11 operates to set the time interval in the timer 13 (step S2). CPU 11 then operates to read the voltage signal V_s from the thermistor 8 through the A/D converter 12 (step S3) and to store the read temperature T_a corresponding to the read voltage signal V_s in the first memory 14a

(step S4).

CPU 11 then determines whether or not the range cooking start command or the oven cooking start command has been inputted from the operation panel 2 (steps S5 and S6). When neither command has been inputted, CPU 11 determines whether the cooking has been completed or not (step S7). Since it is not the timing that the cooking is completed, CPU 11 advances from step S7 to step S11 where it is determined that the cooking is not being performed. Subsequently, CPU 11 advances to step S12 where it is determined whether the timer 13 has been timed up or not. When the timer 13 is not timed up, CPU 11 returns to step S5.

The above-described operation is repeated and then, CPU 11 advances from step S12 to step S13 when the timer 13 is timed up. CPU 11 reads the voltage signal V_s from the thermistor 8 at step S13. CPU 11 then reads the stored temperature T_b from the first memory 14a (step S14) and operates to subtract the stored temperature T_b from the read temperature T_a corresponding to the read voltage signal V_s (step S15) and determines whether or not the temperature difference between the read temperature T_a and the stored temperature T_b is within ΔT (step S16). In step S16, it is determined whether or not the cooking chamber 6 atmospheric temperature corresponds to the room atmospheric temperature. It is determined that the cooking chamber atmospheric temperature corresponds to the room atmospheric temperature when $T_b - T_a > \Delta T$, and the read temperature T_a is stored as the room temperature data in the second memory 14b. Since the atmospheric temperature in the cooking chamber 6 agrees approximately to the room atmospheric temperature and does not change immediately after power supply, CPU 11 advances from step S16 to step S17 where the read temperature T_b is stored in the second memory 14b. Then, the read temperature T_a is stored in the first memory 14a at step S18 and CPU 11 returns to step S5. Consequently, the room atmospheric temperature taking the approximately same value as the read temperature T_a is stored in the first and second memories 14a, 14b.

Upon operation of a start button (not shown) for the thawing which is included in the range cooking mode, CPU 11 answers in the affirmative (step S5) to execute a range cooking routine as shown in FIG. 6. More specifically, the stored temperature T_c is read from the second memory 14b (step S101) and the heating constants such as the heating level, heating period and the like externally set via the operation panel 2 are read (step S102). CPU 11 then operates to compensate for the read heating constants based on the stored temperature T_c (step S103) and to control the output of the magnetron 16 based on the compensated heating constants (step S104). In this case the heating constants are compensated for so that the output of the magnetron 16 is reduced as the stored

temperature T_c or the room atmospheric temperature becomes higher.

On the other hand, upon operation of the oven cooking start button on the operation panel 2, CPU 11 answers in the affirmative at step S6 and executes an oven cooking routine as shown in FIG. 7. More specifically, the heating constants such as the heating temperature, heating period and the like externally set via the operation panel 2 are read (step S201) and the voltage signal V_s from the thermistor 8 is read (step S202). CPU 11 then operates to control the output of the electric heater 15 so that the cooking chamber atmospheric temperature sensed by the thermistor 8 reaches the heating temperature set by the user (step S203).

During execution of the cooking as described above, CPU 11 advances from step S11 to step S19 where it is determined whether the cancel button on the operation panel 2 has been operated or not. When the cancel button is operated, CPU 11 advances from step S19 to step S20 where the voltage signal V_s from the thermistor 8 is read. CPU 11 then operates to store the read temperature T_a corresponding to the read voltage signal V_s in the first memory 14a (step S21). Subsequently, CPU 11 operates to clear the heating constants read from the operation panel 2 (step S22) and returns to step S5.

Upon completion of the heating based on the heating constants set as described above, CPU 11 advances from step S7 to step S8 where the voltage signal V_s from the thermistor 8 is read and the read temperature T_a corresponding to the read voltage signal V_s is stored in the first memory 14a (step S9). CPU 11 then operates to clear the heating constants set by the user (step S10) and advances to step S11. Since the cooking has been completed, CPU 11 advances from step S11 to step S12 where it is determined whether the timer 13 has been timed up or not. CPU 11 returns to step S5 when the timer 13 is not timed up.

FIG. 8 shows the change in the atmospheric temperature in the cooking chamber (the temperature sensed by the thermistor 8) 6 when the heating is executed. In accordance with FIG. 8, the atmospheric temperature in the cooking chamber 6 agrees approximately with the room atmospheric temperature since the microwave oven remains in the condition of stop of the heating operation for a long period until the heating is initiated. Upon initiation of the heating, the atmospheric temperature in the cooking chamber 6 is rapidly raised to be maintained at the set temperature. Upon completion of the heating, the atmospheric temperature in the cooking chamber 6 begins to rapidly drop and the degree of temperature drop becomes gentle with lapse of time. In the condition after a sufficient time has elapsed from the completion of the heating, the atmospheric temperature in the cooking chamber 6 agrees approximately with the

room atmospheric temperature. Accordingly, when the condition of the stop of the heating operation continues after completion of the cooking, the gradient of the atmospheric temperature in the cooking chamber 6 becomes smaller and at last, the difference between the read temperature T_a and the stored temperature T_b is within ΔT . Consequently, CPU 11 advances from step S16 to step S17 where the read temperature T_a is stored in the second memory 14b and the read temperature T_a is stored in the first memory 14a (step S18). CPU 11 then returns to step S5. Accordingly, when the condition of the stop of the heating operation continues for a sufficient period of time, the room atmospheric temperature is stored in the second memory 14b and the heating constants are compensated for based on the room atmospheric temperature stored in the second memory 14b when the next range cooking is to be executed.

In accordance with the above-described embodiment, when the change of the read temperature T_a sensed by the thermistor 8 or the atmospheric temperature in the cooking chamber 6 is within a predetermined value or ΔT in the condition of stop of the cooking operation, the read temperature T_a is assumed to be the room atmospheric temperature and stored in the second memory 14b. When the thawing included in the range cooking mode is executed, the heating constants set by the user is compensated for based on the stored temperature T_c stored in the second memory 14b. As a result, the range cooking can be executed without influence of the ambient temperature. Accordingly, since the room atmospheric temperature can be sensed by use of the thermistor 8 provided for sensing the atmospheric temperature in the cooking chamber 6. Consequently, the electrical arrangement of the microwave oven can be simplified as compared with the conventional arrangement that an additional temperature sensor is provided for sensing the room atmospheric temperature.

Although the room atmospheric temperature is sensed based on the voltage signal V_s supplied from the thermistor 8 at predetermined intervals which are factors determining the temperature gradient, in the foregoing embodiment, a differentiation circuit may be provided for generating a differentiation signal of the voltage signal V_s from the thermistor 8, instead and the atmospheric temperature in the cooking chamber 6 may be looked upon as the room atmospheric temperature when the signal level of the differentiation signal from the differentiation circuit takes a predetermined value or below.

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

1. A heating apparatus comprising a cooking chamber (6), first heating means (15) for heating food accommodated in the cooking chamber (6), second heating means (16) for heating the food accommodated in the cooking chamber (6), a temperature sensor (8) sensing an atmospheric temperature in the cooking chamber (6) to thereby generate a voltage signal according to the sensed temperature, and first heating execution means (11) for controlling an output of the first heating means (15) based on the voltage signal supplied thereto from the temperature sensor (8) upon receipt of a start command, thereby executing the heating, characterized by temperature reading means (11) for reading the voltage signal from the temperature sensor (8) at predetermined intervals in the condition that both of the first and second heating means (15, 16) are deenergized, first storage means (14a) for storing data of read temperature corresponding to the voltage signal read by the temperature reading means (11), temperature determining means (11) for calculating the difference between the temperature whose data is stored in the first storage means (14a) and the temperature read by the temperature reading means (11), second storage means (14b) for storing data of the temperature read by the temperature reading means (11) when the temperature difference calculated by the temperature determining means (11) is within a predetermined range, heating constant setting means (2) for setting heating constants determining a volume of output of the second heating means (16), and second heating execution means (11) for compensating for the heating constants set by the heating constant setting means (2) based on the temperature whose data is stored in the second storage means (14b) upon receipt of a start command, and controlling the output of the second heating means (16) based on the result of compensation, thereby executing the heating.
2. A heating apparatus comprising a cooking chamber (6), first heating means (15) for heating food accommodated in the cooking chamber (6), second heating means (16) for heating the food accommodated in the cooking chamber (6), a temperature sensor (8) sensing an atmospheric temperature in the cooking chamber (6) to thereby generate a voltage signal according to the sensed temperature, and first heating execution means (11) for controlling an output of the first heating means (15) based on the voltage signal supplied thereto from the temperature sensor (8) upon receipt of a start command, thereby

executing the heating, characterized by temperature gradient determining means (11) for differentiating the voltage signal from the temperature sensor (8) to thereby generate a differentiation signal, first storage means (14a), temperature determining means (11) storing, in the first storage means, read data of the temperature corresponding to the temperature signal from the temperature sensor (8) when the rate of change of the temperature corresponding to the differentiation signal from the temperature differentiating means (11) is smaller than a predetermined value in the condition that both of the first and second heating means (15, 16) are deenergized, heating constant setting means (2) for setting heating constants determining a volume of output of the second heating means (16), and second heating execution means (11) for compensating for the heating constants set by the heating constant setting means (2) based on the temperature whose data is stored in the first storage means (14b) upon receipt of a start command, and controlling the output of the second heating means (16) based on the result of compensation, thereby executing the heating.

3. A heating apparatus according to claim 1, characterized in that the first heating means (15) comprises an electric heater and the second heating means (16) comprises a magnetron.
4. A heating apparatus according to claim 2, characterized in that the first heating means (15) comprises an electric heater and the second heating means (16) comprises a magnetron.

40

45

50

55

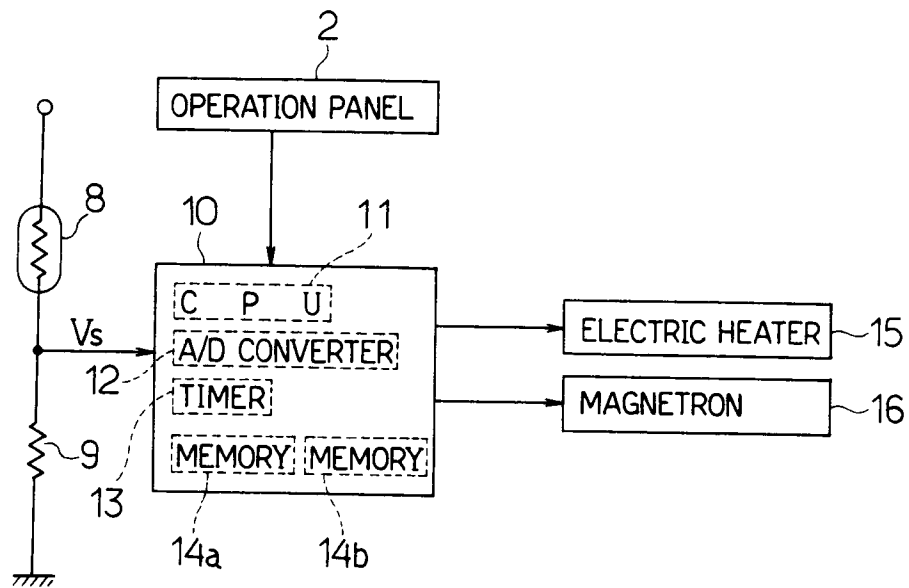


FIG.1

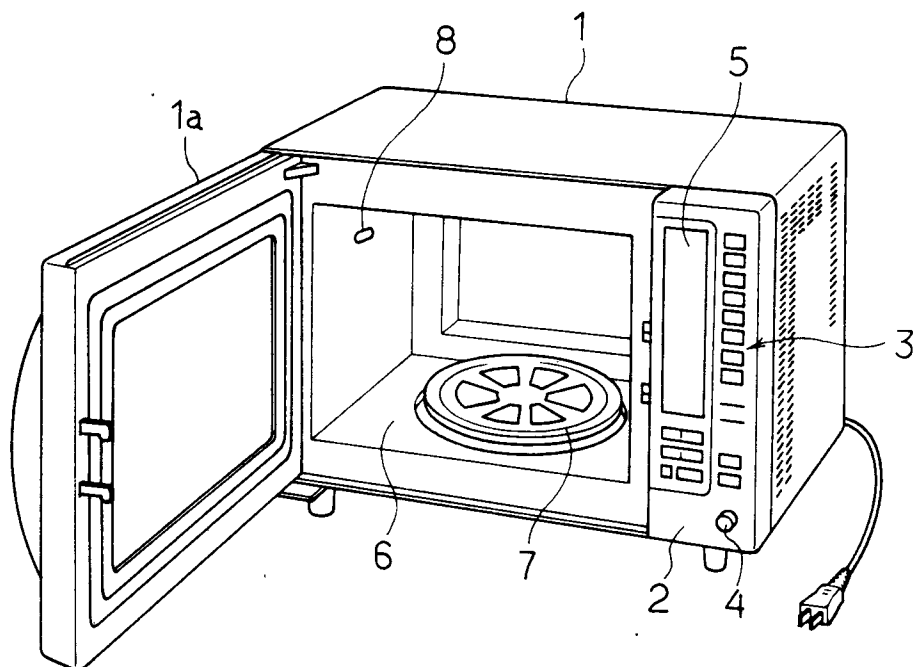


FIG.2

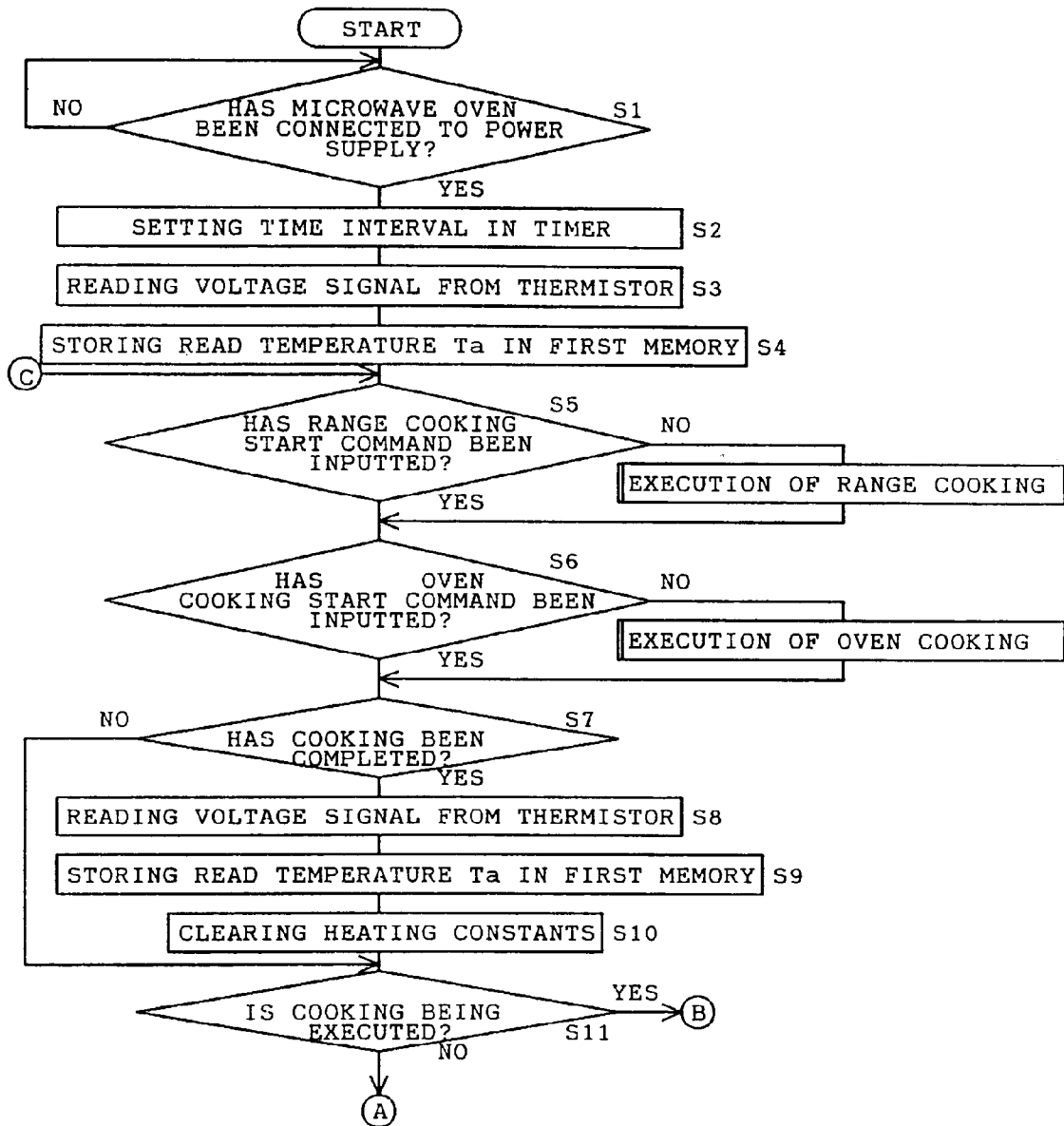


FIG. 3

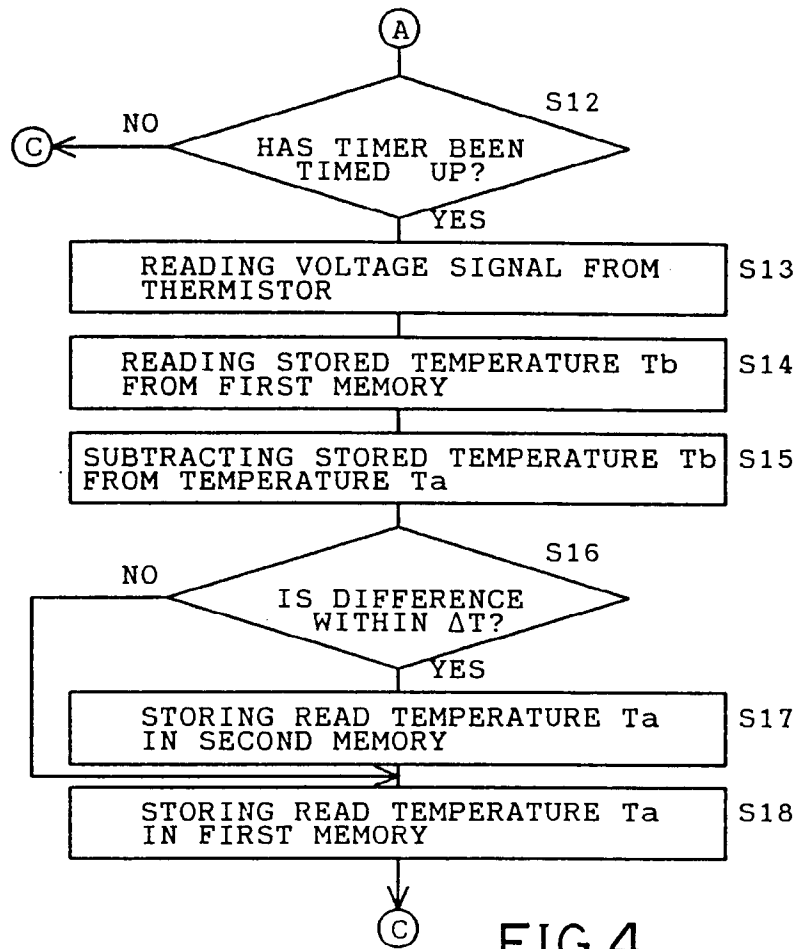


FIG.4

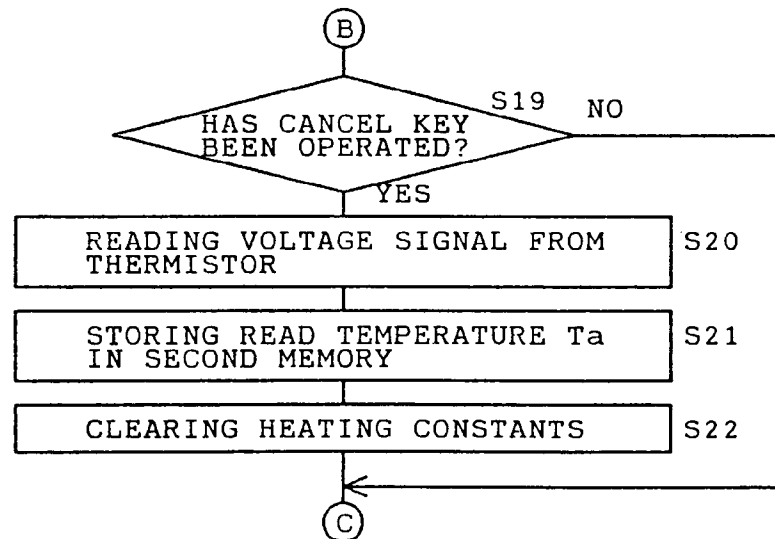


FIG.5

RANGE COOKING ROUTINE

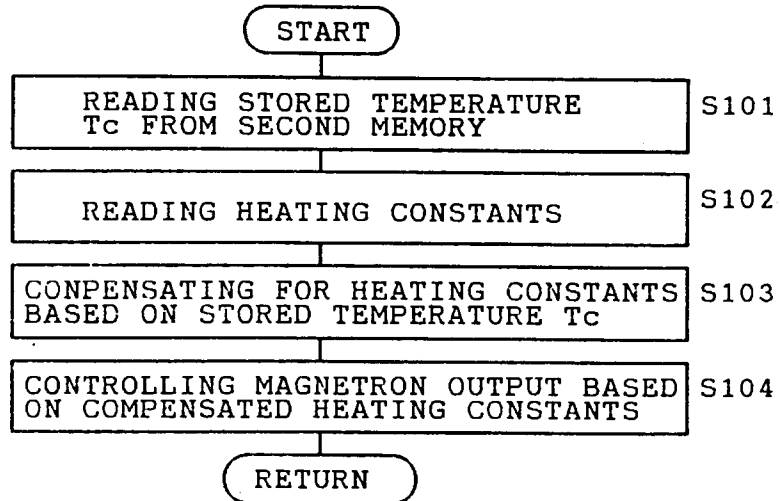


FIG.6

OVEN COOKING ROUTINE

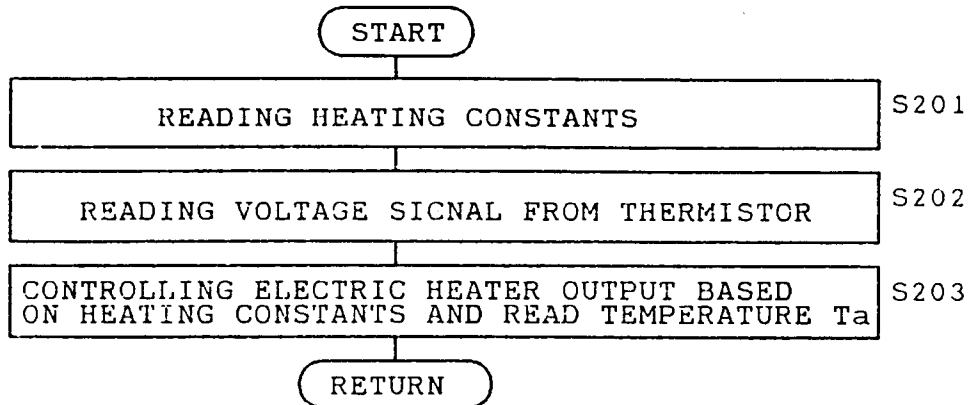


FIG.7

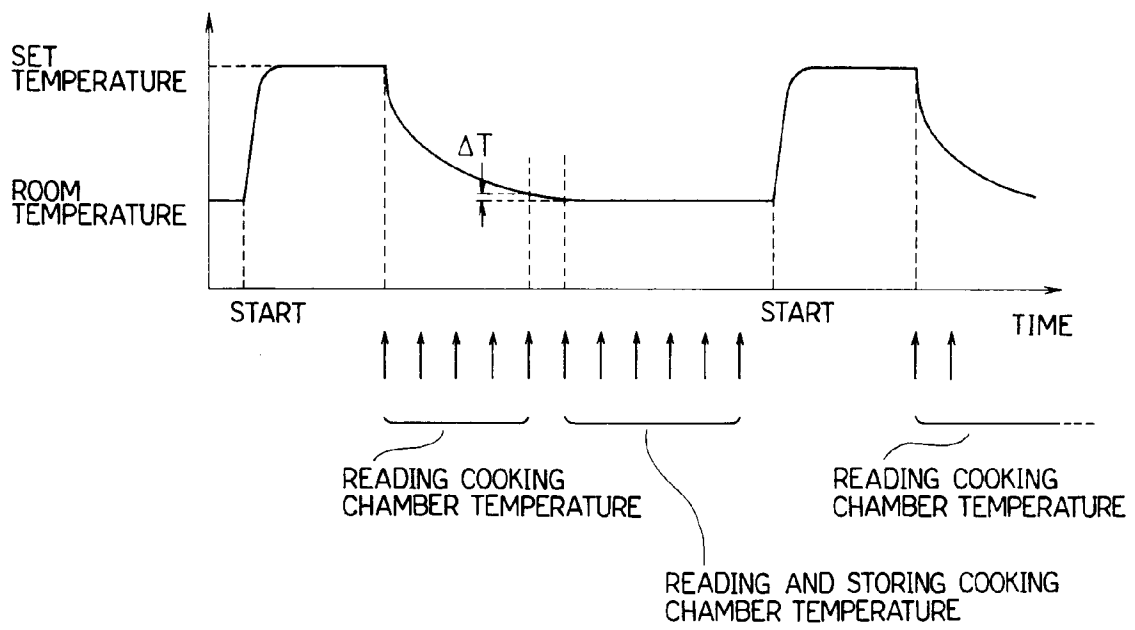


FIG.8



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 30 2032

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	GB-A-2 200 805 (SHARP KABUSHIKI KAISHA) * page 6, line 2 - page 8, line 8; figure 2 * ---	1-4	H05B6/68
A	EP-A-0 394 009 (MATSUSHITA ELECTRONICS CORPORATION) * page 4, line 48 - page 5, line 13; figure 3 * ---	1,2	
A	EP-A-0 274 904 (SHARP KABUSHIKI KAISHA) ---		
A	EP-A-0 213 442 (BOSCH-SIEMENS HAUSGERATE GMBH) -----		
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			H05B
Place of search THE HAGUE		Date of completion of the search 25 MAY 1992	Examiner RAUSCH R. G.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P0401)