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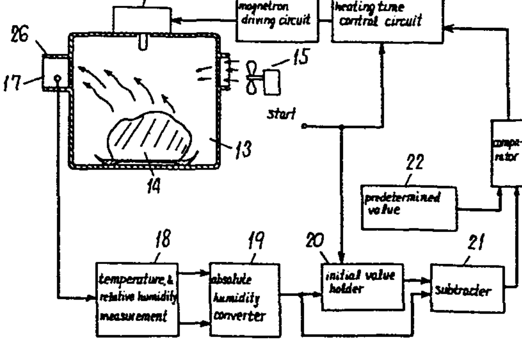
(54) **HIGH FREQUENCY HEATING DEVICE.**

(57) A high frequency heating device which detects variations in moisture and temperature in the vapor produced by heating food (14) in a heating chamber (13) by using a temperature and relative humidity detector (17), converts them into relative and absolute humidities to determine whether the variation in the absolute humidity has reached a predetermined level, thereby automatically heating or cooling the food. Since this device has a single detector, it produces less error due to detecting errors and changes with time, thereby performing an accurate detection.

Fig. 8



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SPECIFICATION

TITLE MODIFIED see front page

TITLE: Microwave heating device

TECHNICAL FIELD

The invention relates to a microwave heating device which automatically controls cooking of food by sensing the humidity variation within its heating chamber due to heating of the food. More particularly, it relates to a microwave heating device which automatically controls heating time by sensing relative humidity and temperature with a single sensor and converting them to absolute humidity to detect the variation of absolute humidity, thereby performing cooking with controlled heat.

BACKGROUND ART

Recently, electronic ovens or ranges capable of cooking food automatically have appeared with the development of microcomputers and the reduction of low cost thereof and the development of various kinds of sensors, and have been in the limelight. Particularly, an electronic range has been proposed which senses the vapor produced from food and cooks automatically. The electronic range provided with a temperature sensor and a humidity sensor senses with the temperature sensor the temperature in the heating chamber or in the exhaust port thereof, and controls in response to the detection signal a heater for maintaining the temperature of the air entering into the heating chamber constant, thereby maintaining the temperature of the air in the heating chamber constant. While, at the same time, it senses with the humidity sensor the varying amount of the vapor produced from the food and controls the output of a magnetron in response to the signal.

The general automatic heating control principle of the microwave heating device which performs such an automatic cooking will be explained with reference to Figs. 1 and 2.

Referring to (a), (b) and (c) of Fig. 1, R_h is a variation of relative humidity due to heating; T is a temperature increase; A_h is a variation of absolute humidity based on R_h and T; t is a time for heating.

Generally, the amount of water vapor produced from a food gradually increases when the latter is heated. After the food has been heated to 100°C, the amount of water vapor produced therefrom is determined by the quantity of heat applied. This reason is as follows.

Referring to Fig. 2 , O is a heating chamber; Y is a container; W is water; Q is an amount of air current; P is a quantity of applied heat; Q_E is latent heat; Q_C is an amount of dissipated heat. The container Y containing water W therein is placed in the heating chamber O through which the amount of air Q is forcibly passed. When the quantity of heat P is applied, the water W boils before long.

The relationship of the quantity of heat in this case is given as follows:

$$P = Q_E + Q_C$$

Assuming that the equation is approximately represented as $P \fallingdotseq Q_E$, the amount of water vapor G produced from water W is given as follows:

P [KWatt] x 860 [kcal]

= latent heat at 100°C [kcal/Kg] x G [Kg/h]

$\therefore$ G = 860 x P/539 [Kg/h]

= 860 x P/539 x 60 [Kg/min.]

For example, if a quantity of applied heat is 700 W, the amount of water vapor becomes 0.0186 Kg/min., and if the quantity of applied heat is 500 W, the amount of the vapor becomes 0.0133 Kg/min. Hence, if the quantity of applied heat is constant, the amount of water vapor produced per unit time is also constant.

Therefore, referring to Fig. 1, the relative humidity R_h is converted to the absolute humidity A_h based on R_h and T obtained by the relative humidity sensor and the temperature sensor disposed in the vicinity of an exhaust port. The absolute humidity A_h' at the start of heating is stored. Similarly, the relative humidity R_h is converted to the absolute humidity based on the relative humidity R_h and temperature T which vary with the heating. A time T_1 is measured which is from the start of heating to an instant at which the difference between the absolute humidity at the start of heating and the varying absolute humidity reaches a predetermined value ΔA_h of absolute humidity which is determined by the quantity of applied heat and the kind of food. The measured time T_1 from the start of heating to the instant at which ΔA_h is reached is multiplied by a heating coefficient K which is inherent in the food. The heating operation is further continued for the time of the product KT_1 after the time T_1 elapses. Since the time T_1 is considered to be approximately proportional to the amount of the food, the food is automatically heated irrespective of the amount of the food. If the time T_1 is measured based on the relative humidity only, a measurement error is likely to occur owing to the heat generated when quantity of heat is supplied (by a magnetron, a high voltage transformer or the like in the case of an electronic range).

This is because the amount of increase of the relative humidity greatly differs depending on different temperatures in the environment, even if the vapor is increased by the same amount, as apparant from the air diagram (not shown).

According to the principle explained above, automatic heating is performed by sensing absolute humidity. With this arrangement, the performance of the device depends much on the accuracy, reliability and durability of the sensors. Prior art devices have the following drawbacks, as separate sensors are incorporated therein:

(1) Since the varying amount of humidity is obtained based on relative humidity and temperature, the respective sensors with high precision are required, thereby making the device costly.

(2) Since two components having a sensing function are required, the incidence rate of troubles in the sensor units have been increased.

(3) Since the secular change of the relative humidity sensor is not related at all to that of the temperature sensor, the measured absolute humidity after a long time of use is inaccurate.

(4) The flow of air through an exhaust passageway is considered to be turbulent. Hence, the temperature differs greatly with various positions in the exhaust passageway. Since the temperature sensor and relative humidity sensor cannot be disposed at the same position, the absolute humidity has not been measured correctly.

DISCLOSURE OF THE INVENTION

An object of this invention is to provide a microwave heating device which senses the temperature and humidity in an exhaust gas and is capable of accurately measuring a time till the change of humidity due to the water vapor from the food reaches a predetermined value, and which performs automatic cooking or reconstitution.

Another object of this invention is to provide a microwave heating device which contributes to a decreased incidence rate of troubles by incorporating a temperature sensor and a humidity sensor as a single element.

Another further object of this invention is to provide a microwave heating device of high cooking performance which eliminates sensing errors for both temperature and humidity by disposing the sensing positions of a temperature sensor and a humidity sensor very close to each other.

In order to achieve the foregoing objects, the microwave heating device according to this invention comprises a heating chamber for accommodating a heating load, a high frequency oscillator for supplying microwave energy to the heating chamber, a control circuit including a microcomputer for controlling said high frequency oscillator, and a temperature and humidity sensor which comprises a single sensing element for sensing both temperature and humidity and which is disposed in the heating chamber or at a location communicating with the heating chamber, said temperature and humidity sensor sensing the temperature and relative humidity in the heating chamber or at said location communicating with the heating chamber, the relative humidity thus sensed being converted to an absolute humidity value, the time till this absolute humidity value reaches a predetermined amount of change being measured, and said control circuit controlling the high frequency oscillator using said time as a function, whereby making automatic cooking and automatic reconstitution possible and ensuring a high cooking performance.

BRIEF DFESCRIPTION OF THE DRAWINGS

Fig. 1(a), (b) and (c) are characteristic curves for some parameters for showing the principle of an automatic heating control method in response to sensed absolute humidity;

Fig. 2 is an explanatory sectioned diagram for explaining the principle;

Fig. 3 is a perspective view of the sensing element used in a microwave heating device according to this invention;

Fig. 4 is an equivalent circuit for the sensing element;

Fig. 5 is a temperature characteristic of the sensing element;

Fig. 6 is a humidity characteristic of the sensing element;

Fig. 7 is a schematic block diagram of a circuit for measuring temperature and relative humidity based on the temperature characteristic of the sensing element and the humidity characteristic thereof;

Fig. 8 is a block diagram of the control circuit of a microwave heating device according to an embodiment of this invention;

Fig. 9(a) through (g) are output wave forms produced from the respective blocks shown in Fig. 8;

Fig. 10 is a perspective view of a temperature and relative humidity sensor used in the microwave heating device;

Fig. 11 is a perspective view of a temperature and relative humidity sensor according to another embodiment;

Fig. 12 is a block diagram of the control circuit of a microwave heating device according to another embodiment of this invention; and

Fig. 13(a) through (g) are output wave forms produced by the respective blocks shown in Fig. 12.

BEST MODE FOR CARRYING OUT THE INVENTION

In the first embodiment of this invention which is described below, a porous dielectric strontium-barium titanate metal oxide is used as a sensor material.

Referring to Fig. 3, a sensing element 1 is constructed in such a way that both sides of a porous dielectric ceramic body are coated with electrodes 3, to which lead wires 4 are connected.

Referring to Fig. 4, the equivalent circuit of the sensing element 1 is shown. C is the electrostatic capacitance of the porous dielectric ceramic 2 as a bulk at a given temperature, which appears at a capacitor 5, and R is the electric resistance generated by the adsorption of water on the particles of said porous dielectric ceramic 2 in an atmosphere having a given relative humidity, which appears at a resistor 6. Fig. 5 shows a relationship between the temperature and the electrostatic capacity, i.e. a temperature characteristic. Fig. 6 shows a relationship between the relative humidity and the electric resistance R, i.e. a humidity characteristic. The temperature and relative humidity in the heating chamber can be obtained by the single sensing element 1 based on these relationships illustrated.

Fig. 7 is a block diagram of a temperature and relative humidity sensing circuit including a micro-computer. A pulse of voltage produced from a pulse controller 8 is applied to the sensing element 1 and a reference resistor R_s connected in series 7. Hence, a division voltage and a time constant can be obtained. The division voltage V_1 is given as follows:

$$V_1 = \frac{R_s}{R_s + R} \cdot V_{CC}$$

where, R_s: resistor connected in series

R : the resistance of the sensing element 1

V_{CC}: applied voltage

Therefore, the resistance R of the sensing element 1 is obtained based on the divisional voltage V_1.

The time constant is obtained by measuring the time period till the divisional voltage V_1 reaches a predetermined reference voltage V_{ref}. Thus, upon application of said pulse voltage, a counter 10 starts counting the clock signals from a clock signal generator 9, and a comparator 11 judges if the divisional voltage V_1 has reached the reference voltage V_{ref}. The counting is stopped as the judgement signal is fed to the counter segment 10. The time constant is thus determined and the electrostatic capacitance C of the sensing element is determined.

The divisional voltage and time constant data are supplied to a computing section 12 where the relative humidity and temperature are calculated.

Referring to Fig. 8, an electronic range including the aforementioned temperature and humidity measuring unit is shown. The electronic range comprises a heating chamber 13, a food 14 to be heated, a fan 15, a magnetron 16, a temperature and relative humidity sensor 17, the temperature and relative humidity measuring unit 18 as illustrated in Fig. 7, a relative absolute humidity converter 19, an initial value holder 20, a subtracter 21, a predetermined value generator 22, a comparator 23, a heating time control circuit 24, a magnetron driving circuit 25 and an exhaust port 26.

Fig. 9(a) and (b) show the temperature output curve and the relative humidity output curve from the temperature and relative humidity measuring unit 18, respectively. Fig. 9(c) shows the output curve from the relative absolute humidity converter 19. Fig. 9(d) shows the output from the initial value holder 20. Fig. 9(e) shows the output from the subtractor 21. Fig. 9(f) shows the output from the comparator 23. And Fig. 9(g) shows the output from the heating time control circuit 24.

Next, the operation will be explained. When a heating start signal is applied, the heating time control circuit 24 starts to measure time. The heating time control circuit 24 causes the magnetron driving circuit 25 to operate, thereby driving the magnetron to start heating. At the same time, relative humidity is converted to absolute humidity in response to the temperature and relative humidity obtained at the time. The resultant absolute humidity V'_{Ah} is held in the initial value holder 20 (Fig. 9-d). In the course of the heating operation, the temperature and relative humidity gradually vary (Fig. 9a, b), and are converted to the absolute humidity (Fig. 9-c). The relationship between the relative humidity and temperature and the absolute humidity is given as follows:

$$V_{Ah}\ [Kg/Kg] = \frac{0.622\phi\ P_s}{P - \phi\ P_s}$$

Where, ϕ : relative humidity (%)

P_s: saturated water vapor pressure at a given temperature [Kg/cm²]

P : standard atmospheric pressure (usually P = 1) [Kg/cm²]

The initial absolute humidity V'_{Ah} is subtracted by the subtracter 21 from the converted absolute humidity V_{Ah} (Fig. 9-e). The resultant output $(V_{Ah} - V'_{Ah})$ from the subtracter 21 is compared with a predetermined value ΔV_{Ah} produced from the predetermined value generator 22. The predetermined value is selected from many values depending on quantity of radiant heat and food. When the increased amount of the absolute humidity (V_{Ah} - V'_{Ah}) becomes equal to the predetermined value ΔV_{Ah}, an output signal V_f from the comparator 23 is produced (Fig. 9-f). After receiving the signal from the comparator 23, the heating time control circuit 24 further operates the magnetron driving circuit 25 during the time as long as KT_1 (Fig. 9-g). KT_1 is obtained by multiplying the measured time T_1 from the start of the heating to the instant of the production of the output V_f by a heating time coefficient K predetermined according to a kind of food and a kind of cooking methods. After the time KT_1 elapses, the heating time control circuit 24 stops the magnetron driving circuit 25, thereby stopping the oscillation of the magnetron and thus terminating the heating.

Cooking is performed in the manner as aforementioned. The temperature and relative humidity sensor according to an embodiment of this invention is constructed as in the following in order to perform a more accurate measurement. The temperature and relative humidity sensor 17 is always exposed to the water vapor, oil and oil smoke produced by a heating load 14 when it is heated, so that the surface of the sensing element 1 is soiled and thus the surface area thereof for sensing humidity is narrowed. The soil is dissolved when the sensing element 1 is heated to a temperature more than 400°C, and the sensing element 1 is restored to the initial condition. In order to make this possible, the temperature and relative humidity sensor 17 according to an embodiment of this invention is constructed as illustrated in Fig. 10. The sensor 17 comprises the sensing element 1, a heater 27, heater electrodes 28 and sensing element electrodes 29, which are all fixedly maintained by a supporting plate 30. The sensing element 1 is surrounded by the heater 27. The temperature and relative humidity sensor 17 according to another embodiment is shown in Fig. 11. The sensor 17 comprises the sensing element 1, a plate heater 31, heater electrodes 32 and a sensing element electrode 33, which are fixedly held by a supporting plate 34. The plate heater 31 is attached to one side of the sensing element 1. The heater electrode 32 is also used as the other electrode of the sensing element 1. The supporting plate 34 is earthed by an earth terminal 35.

The following effects are produced by the aforementioned embodiments.

(1) Since the temperature and relative humidity sensor comprises a single sensing element 1,

measurement errors owing to sensing positions can be almost eliminated, thereby making more accurate cooking possible.

(2) Since a porous dielectric ceramic 2 is employed, the water vapor is readily adsorbed deep inside the sensing element 1 through the minute voids therein so that an equilibrium of adsorption and desorption is established in a short time. Therefore, a very responsive clear-cut change of electric conductivity is ensured.

(3) The sensing element 1 is surrounded by the heater 27. If the sensing element 1 is heated by radiant heat therefrom to a temperature of about 450°C, the soil on the surface of the sensor element 1 is dissolved into carbon dioxide and water, so that the temperature and humidity are accurately sensed at all times.

(4) Since the sensing element 1 and the plate heater 31 are formed as a unit, the sensing element 1 is heated with conduction heat. As a result, the sensing element 1 can be heated by less electric power than it is the case with radiant heat.

(5) Since the vapor produced by the heating load 14 is concentrated in the vicinity of the exhaust port 26, the temperature and relative himidity sensor 17 is disposed at the exhaust port so that the variation of relative humidity due to the vapor from the food 14 to

be heated is accurately sensed.

(6) Since the temperature and relative humidity sensor 17 is disposed in the exhaust port 26, the sensor 17 is sufficiently shielded from the electromagnetic waves and the vapor produced from the food 14 to be heated necessarily goes out through the exhaust port 26 so that the variation of relative humidity caused by the vapor produced from the food 14 to be heated is accurately sensed.

(7) The amount of the vapor produced from the food 14 to be heated is varied by the quantity of radiant heat controlled in accordance with the kind of the food 14 to be heated and the kind of cooking method. Hence, more preferable cooking can be performed by changing the predetermined value ΔV_{Ah} depending on the kind of food 14 to be heated and the kind of cooking method.

Next, the microwave heating device according to another embodiment of this invention will be explained with reference to Fig. 12 and Fig. 13(a) through (g).

With this embodiment, the variation of absolute humidity is sensed to control the output of the magnetron, while the temperature in the heating chamber is controlled to be maintained at a temperature. This embodiment is different from the aforementioned embodiment in that the temperature is controlled to be at a given temperature.

Referring to Fig. 12, numeral 13 is the heating chamber; numeral 14 is the food to be heated; numeral 15 is the fan; numeral 16 is the magnetron; numeral 17 is the temperature and relative humidity sensor; numeral 18 is the temperature and relative humidity measuring unit; numeral 19 is the absolute humidity converter; numeral 20 is the initial value holder; numeral 21 is the subtractor; numeral 22 is the predetermined value generator; numeral 23 is the comparator; numeral 24 is the heating time control circuit; numeral 25 is the magnetron driving circuit; numeral 26 is the exhaust port; numeral 38 is an inlet port; numeral 37 is a resistor; numeral 36 is a heater controller.

Fig. 13(a) through (g) show output waveforms from the respective units illustrated in Fig. 12. Fig. 13(a) and (b) are the outputs from the temperature and relative humidity measuring unit 18. Fig. 13(a) shows temperature and Fig. 13(b) shows relative humidity. Fig. 13(c) shows the output from the absolute humidity converter; Fig. 13(d) shows the output from the initial value holder 20; Fig. 13(e) shows the output from the subtractor 21; Fig. 13(f) shows the output from the comparator 23; Fig. 13(g) shows the output from the heating time control circuit 24.

The heater controller 36 controls the resistor 37 to make it "on" or "off" in response to the input signal, thereby controlling the temperature in the heating chamber or of the exhaust air to be at a predetermined value. At the same time, a signal is transmitted to the initial value holder 20 and the heating time control circuit 24. Hence, the absolute humidity V'_{Ah} at an initial stage is obtained by the absolute humidity converter 19 based on the relative humidity at the start of the heating and the predetermined temperature, and is held by the initial value holder 20 (Fig. 13-d). In the course of the heating, the relative humidity gradually varies and is converted to absolute humidity V_{Ah} successively (Fig. 13-c). The initial value V'_{Ah} is subtracted by the subtractor 21 from the converted absolute humidity V_{Ah}. The output from the subtractor 21 is compared with a predetermined value ΔV_{Ah} produced from the predetermined value generator 22 (Fig. 13-e). The predetermined value is selected from many values depending on quantity of radiant heat and food. When the increased amount of the absolute humidity (V_{Ah} - V'_{Ah}) becomes equal to the value ΔV_{Ah}, an output signal V_f from the comparator 23 is produced (Fig. 13-f). After receiving the signal V_f from the comparator 23, the heating time control circuit 24 further continuously operates the magnetron driving circuit 25 during the time as long as KT_1 (Fig. 13-g). The time KT_1 is obtained by multiplying the measured time T_1 from the start of the heating to the instant of the production of the output V_f by a heating time coefficient K predetermined according to the kind of food and the kind of cooking method. After the time KT_1 elapses, the heating time control circuit 24 stops the magnetron driving circuit 25, thereby stopping the oscillation of the magnetron and thus terminating the automatic heating.

The following effects are produced by the second embodiment as mentioned above.

(1) Absolute humidity is related to temperature and relative humidity as aforementioned. Hence, in order to calculate the absolute humidity, saturated steam pressure corresponding to each temperature must be first obtained. The saturated steam pressure and the relative humidity must be used in the equation to obtain the absolute humidity. Thus in order to calculate the absolute humidity, each saturated steam pressure corresponding to each temperature must be obtained. In order to do so, all saturated steam pressures corresponding to the temperatures must be stored. It is apparant that a great number of storing elements are required to store them. If the temperature in the vicinity of the temperature and relative humidity sensor 17 is controlled to be maintained at a constant temperature, only the saturated steam pressure corresponding to the predetermined temperature must be

stored. Thus the number of the storing elements can be considerably decreased, thereby making the control circuit a very simple and compact one.

(2) Since the resistor is disposed in the inlet port, the temperature in the vicinity of the temperature and relative humidity sensor 17 is controlled and thus the temperature in the heating chamber 13 is also controlled. On the other hand, assuming that the microwave heating device is used in an environment of a high humidity, for example at a relative humidity of 95%, when vapor is produced from the food 14 to be heated which is heated by microwave energy, the humidity of the heating chamber is saturated in a short time. Thereafter, even if much vapor is produced from the food 14 to be heated, only water drops appear on the wall of the heating chamber, and it is impossible to sense the variation of the relative humidity. But as mentioned above, even if the microwave heating device is used in the environment of the relative humidity of 95%, the heating chamber is maintained at a much higher temperature so that the relative humidity is lowered. Hence, it takes a longer time until the humidity of the heating chamber is saturated by the vapor produced from the food 14 to be heated, so that the variation of the relative humidity is sensed with certainty. Therefore, the invention is capable of providing a

device which is hardly affected by weather or the environment in which it is used.

As a modification of the second embodiment, the resistor 37 may be disposed in the heating chamber so that the surface of the food 14 to be heated is directly heated by the heat radiated from the resistor. This arrangement is capable of appropriately drying or burning the surface of the food 14 to be heated. For example, roast beef is cooked with the microwave heating in the same manner as with the heating by a heater.

An infrared lamp may be used in place of the resistor 37 to control the temperature. The infrared lamp sufficiently lightens the heating chamber, thereby removing a lamp for illumination. Infrared rays are absorbed by the food so that the food is heated. The infrared rays bring about a similar effect in cooking the roast beef as mentioned above.

Further, in the second embodiment, the cooling air for the magnetron 16 and the amount of the air flow outside of the microwave heating device are controlled, thereby adjusting the temperature in the vicinity of the temperature and relative humidity sensor 17. Thus, the energy having been wasted in conventional devices can be utilized so that the device according to this invention is driven by less energy and is constructed inexpensively.

Further, in the second embodiment, the sensing element 1 and the resistor 37 may be disposed close to each other, and the heat radiated by the resistor 37 may be controlled to adjust the temperature. According to this arrangement, the temperature is controlled with less electric power, and the resistor 37 is used as the heater for heating the sensing element 1 to clean it, thus making the device operate with less energy and constructing the device inexpensively.

INDUSTRIAL APPLICABILITY

As explained above, the microwave heating device according to this invention senses temperature and relative humidity with a single sensor, thus making it possible to measure the temperature and the relative humidity in the heating chamber more accurately. In the case of measuring the temperature and relative humidity with two separate sensing elements, measurement errors made owing to sensing positions cannot be eliminated, even if the two sensing elements are disposed as close as possible to each other. This is because there is still a distance therebetween which cannot be shortened. With the single sensing element, the measurement error is scarcely produced. In the case of measuring the temperature and relative humidity with the separate sensing elements, the secular change of each of the sensing elements has inherent characteristic, which causes a large measurement error to be produced when the temperature and relative humidity are measured and are converted to the absolute humidity. But the single sensing element brings about an excellent effect, since the secular change characteristic vary with a certain relationship therebetween so that a large error is scarecely produced.

CLAIMS:

1. A microwave heating device comprising a heating chamber for accommodating a heating load, a high frequency oscillator for supplying microwave energy to the heating chamber, a control circuit including a microcomputer for controlling said high frequency oscillator, and a temperature and humidity sensor which comprises a single sensing element for sensing both temperature and humidity and which is disposed in the heating chamber or at a location communicating with the heating chamber, said temperature and humidity sensor sensing the temperature and relative humidity in the heating chamber or at said location cammunicating with said heating chamber, the relative humidity thus sensed being converted to an absolute humidity value, the time till this absolute humidity value reaches a predetermined amount of change being measured, and said control circuit controlling the high frequency oscillator using said time as a function.

2. A microwave heating device as defined in Claim 1 wherein the temperature in the heating chamber is controlled by the detection signal from the temperature and humidity sensor at a predetermined temperature.

3. A microwave heating device as defined in Claim 1 wherein the temperature and humidity sensor senses the

relative humidity with the resistance of the sensing element and senses the temperature with the electrostatic capacitance of the sensing element.

4. A microwave heating device as defined in Claim 1, wherein the sensor element of said temperature and humidity sensor is made of a porous dielectric ceramic material in the metal oxide series.

5. A microwave heating device as defined in Claim 1, wherein a heater for cleaning the sensing element of said temperature and humidity sensor is disposed near to or integrally with the sensor.

6. A microwave heating device as defined in Claim 2, further including a resistance element adapted to be controlled by the detection signal from the temperature and humidity sensor for controlling the temperature within the heating chamber at a predetermined constant temperature.

7. A microwave heating device as defined in Claim 1 or 2, wherein the temperature and humidity sensor is disposed in an exhaust region within the heating chamber.

8. A microwave heating device as defined in Claim 1 or 2, wherein cooking control is effected by using KT_1 which is the product of the time T_1 till the difference between the absolute humidity value at the start of heating and the absolute humidity value after the start of heating reaches a preset time value as

multiplied by the heating time coefficient K dependent on the kind of food and kind of cooking as an addition to said time T_1.

Fig. 1

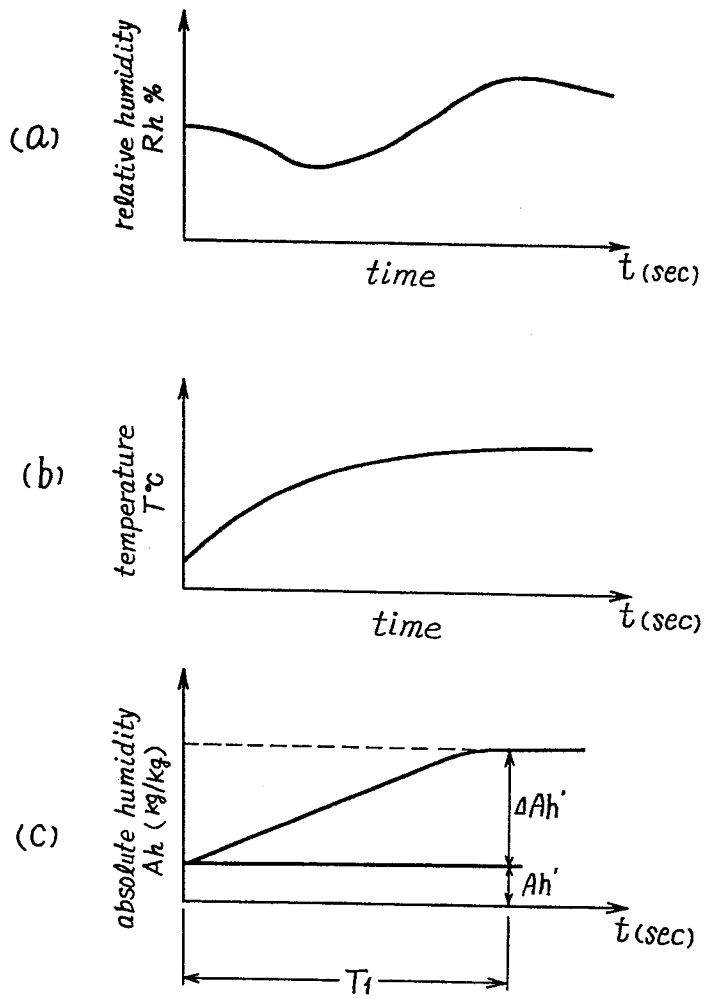
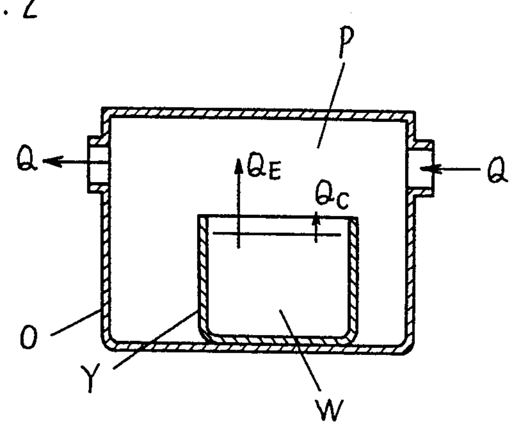

(a)
relative humidity Rh %
time
t (sec)
(b)
temperature T°C
time
t (sec)
(c)
absolute humidity Ah (kg/kg)
ΔAh'
Ah'
t (sec)
T1

Fig. 2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Q
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Fig. 3

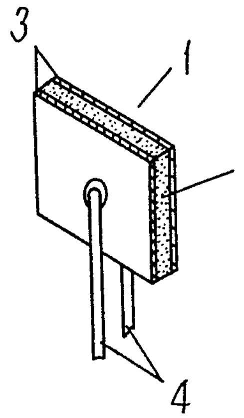


Fig. 4

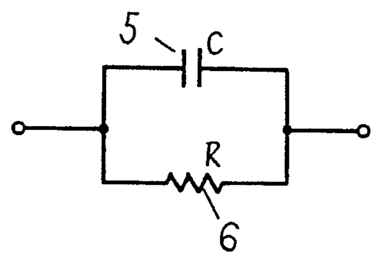


Fig. 5

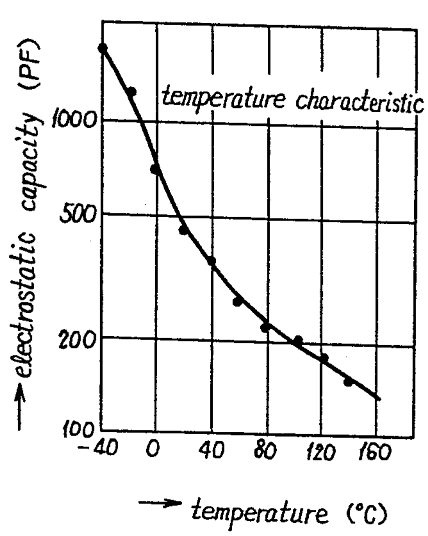


Fig. 6

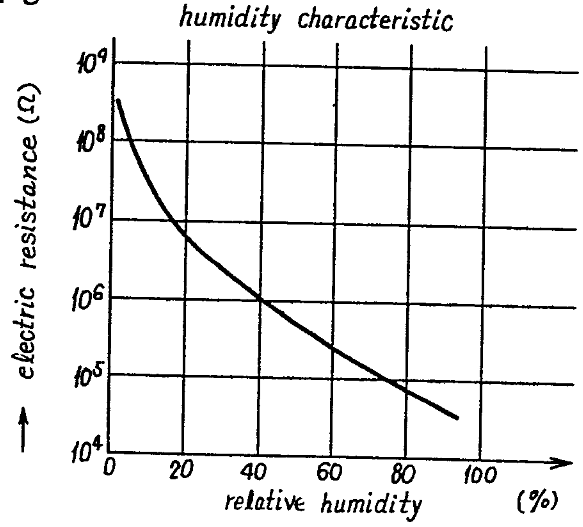


Fig. 7

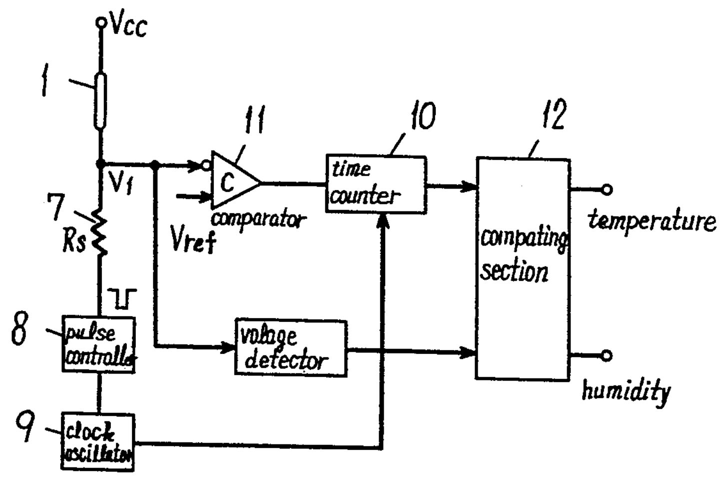


Fig. 8

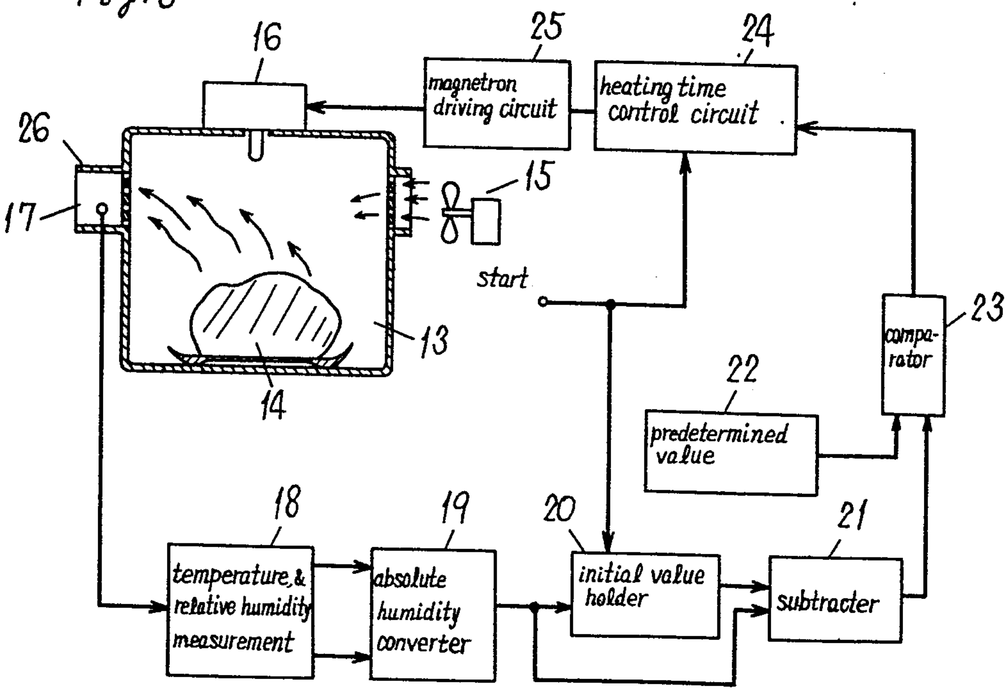
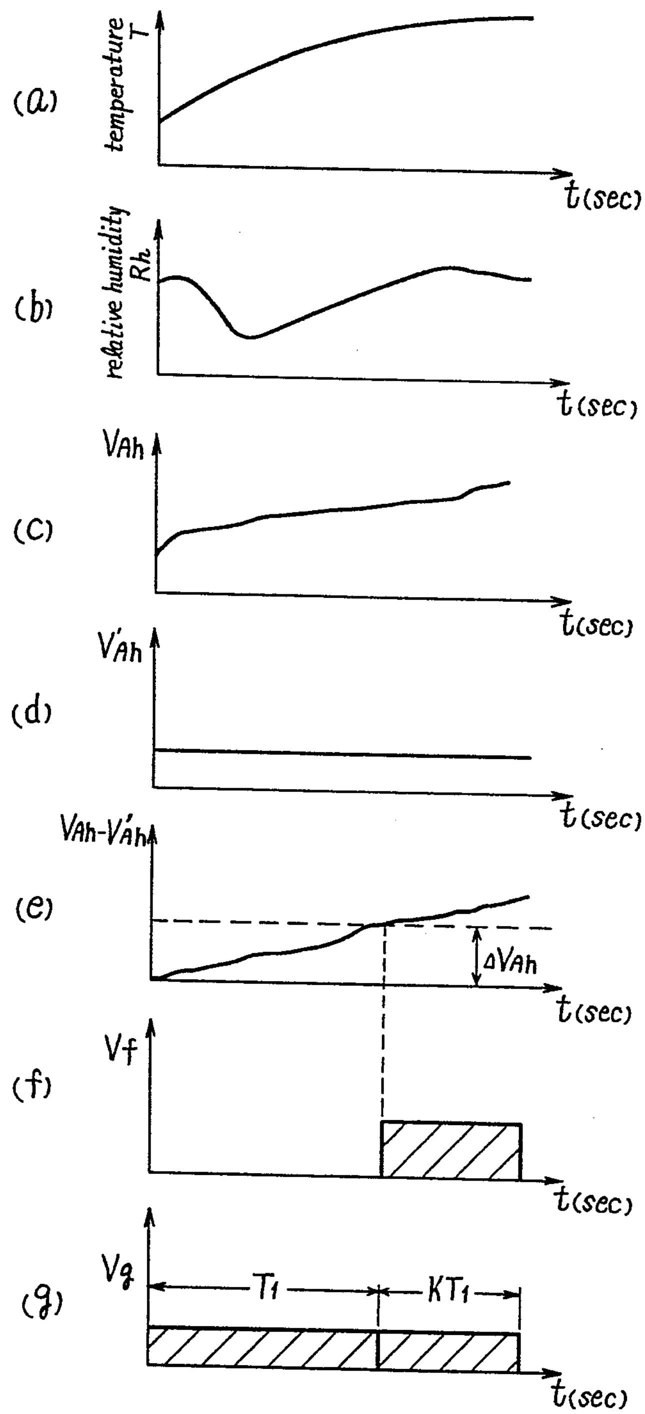


Fig. 9



(a)
temperature T
t(sec)
(b)
relative humidity Rh
t(sec)
(c)
VAh
t(sec)
(d)
V'Ah
t(sec)
(e)
VAh-V'Ah
ΔVAh
t(sec)
(f)
Vf
t(sec)
(g)
Vg
T1
KT1
t(sec)

Fig. 10

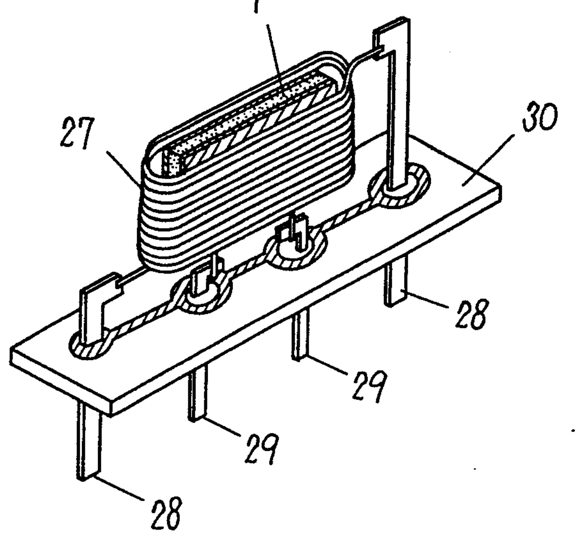


Fig. 11

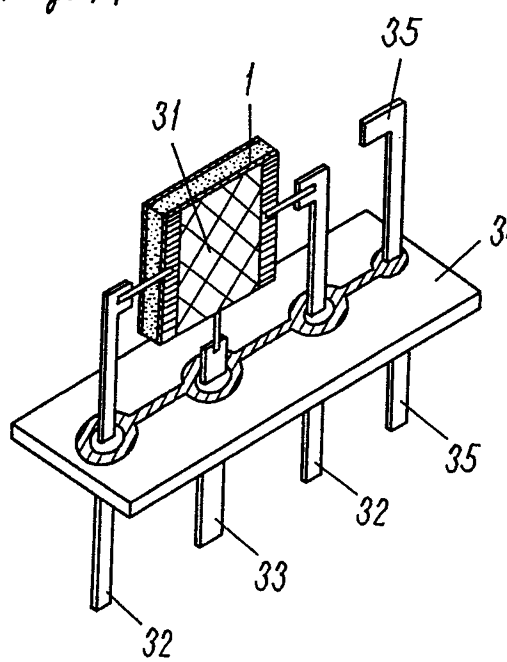


Fig. 12

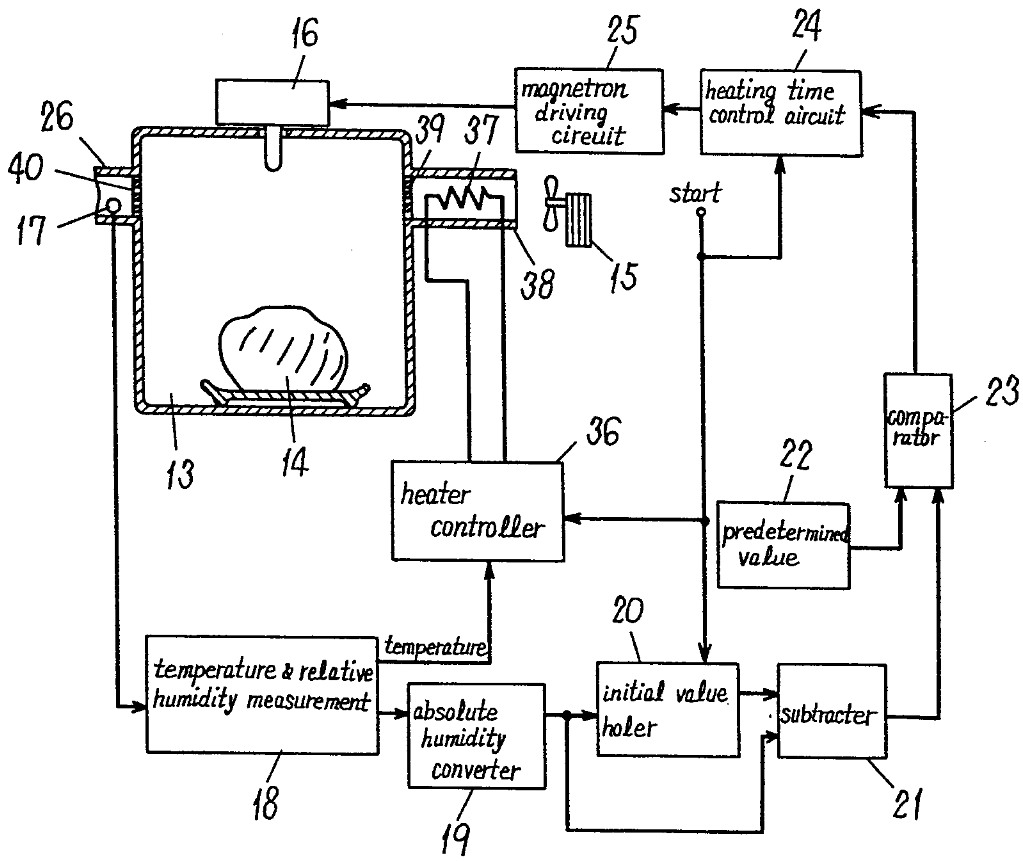
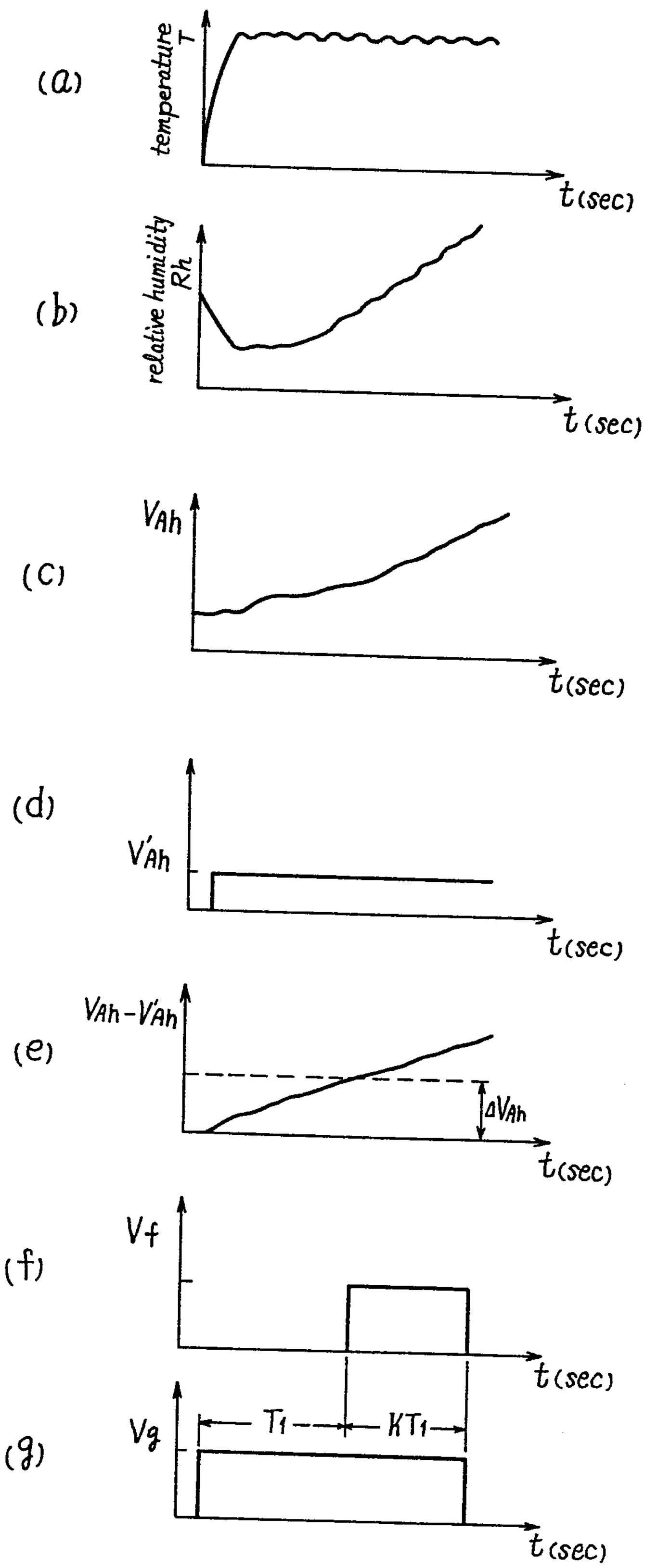

16
25
magnetron driving circuit
24
heating time control aircuit
26
40
17
39
37
38
15
start
13
14
36
heater controller
23
compa-rator
22
predetermined value
temperature
temperature & relative humidity measurement
18
absolute humidity converter
19
20
initial value holer
subtracter
21

Fig. 13


(a)
temperature T
t (sec)
(b)
relative humidity Rh
t (sec)
(c)
VAh
t (sec)
(d)
V'Ah
t (sec)
(e)
VAh-V'Ah
ΔVAh
t (sec)
(f)
Vf
t (sec)
(g)
Vg
T1
KT1
t (sec)

LIST OF REFERENCE NUMBERS IN THE DRAWINGS

1...sensing element

2...porous dielectric ceramic

3...electrodes

4...lead wires

5...capacitor

6...resistor

7...series

8...pulse controller

9...clock signal generator

10...counter

11...comparator

12...computing section

13...heating chamber

14...food to be heated

15...fan

16...magnetron

17...temperature and relative humidity sensor

18...temperature and relative humidity measuring unit

19...relative absolute humidity converter

20...initial value holder

21...subtracter

22...predetermined value generator

23...comparator

24...heating time control circuit

25...magnetron driving circuit

26...exhaust port

27...heater

28...heater electrodes

29...sensing element electrodes

30...supporting plate

31...plate heater

32...heater electrode

33...sensing element electrode

34...supporting plate

35...earth terminal

36...heater controller

37...resistor

38...inlet port

0093173

INTERNATIONAL SEARCH REPORT

International Application No. PCT/JP82/00165

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.[3] F24C 7/08, H05B 6/68

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
I P C	F24C 7/08, F24C 1/00, H05B 6/68, G01N 27/00

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

Jitsuyo Shinan Koho	1926 - 1981
Kokai Jitsuyo Shinan Koho	1971 - 1981

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category*	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
Y	National Technical Report, Vol. 26, No. 3 (June 1980) Matsushita Electric Industrial Co., Ltd., Terada Jiro and three others "Takino Sensor "Ceramic Ondo·Shitsudo Sensor" "Humiserum II"", P. 433-441	1,3-5, 7-8
Y	JP,A, 54-83148 (Matsushita Electric Industrial Co., Ltd.) 3. July. 1979 (03.07.79)	1,3-5,7-8
A	JP,A, 53-69940 (Matsushita Electric Industrial Co., Ltd.) 21. June. 1978 (21.06.78)	2,6-8

* Special categories of cited documents: [15]

"A" document defining the general state of the art which is not considered to be of particular relevance

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
August 5, 1982 (05.08.82)	August 16, 1982 (16.08.82)
International Searching Authority [1]	**Signature of Authorized Officer** [20]
Japanese Patent Office	