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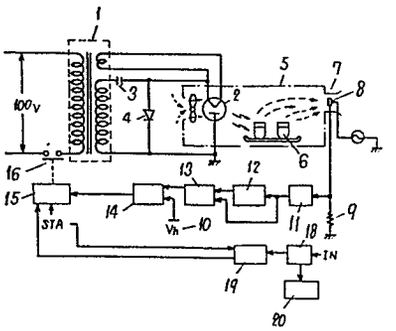
(54) **MICROWAVE HEATER.**

(57) An egg is heated at a weak power to between 70 to 85°C of the egg cooking temperature, and the detection signal of a detection sensor (8) detecting small amounts of steam, gas or odors produced from the egg being heated during the weak power operation is determined so as to set and control the full heating time, thereby realizing the automatic microwave cooking of the egg.

Fig.5



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SPECIFICATION

TITLE: High frequency heating appliance

TECHNICAL FIELD

This invention relates to an automatic high frequency heating appliance which cooks food by high frequency heating and especially senses state of food being cooked and automatically determines heating time.

BACKGROUND ART

The time length of high frequency heating of food is determined by various factors of food including initial temperature, amount, final temperature, specific heat, absorption factor of high frequency energy, etc. A conventional manner to preset heating time in microwave ovens is that the user presets time with a timer, based upon the kind and amount of food to be heated. In this case, since the initial temperature of food or the like is not taken into consideration, the user feels an increased fear of erroneous cooking and the inconvenience that he should calculate and preset heating time whenever the amount of the food is varied.

Automatic microwave ovens which automatically preset cooking time and complete cooking through the use of a control relying mainly upon a sensor or sensors monitoring the progress of food cooking and a microcomputer in an

attempt to overcome the above disadvantages have been developed and have been growing into the leading type of ovens in the industry of microwave ovens. The automtic microwave ovens are designed to trace variances in relative humidity, food temperature, odor, gas, etc. resulting from heating of food, using various kinds of sensors and achieves automatic cooking for only limited items of food. Those ovens are still unable to perform automatic cooking on some of food items which faced great difficulties as before with the conventional types of ovens, for example, eggs.

Figs. 1 through 4 will give a better understanding of the operating principle and the progress of cooking when a pot-steamed hotchpotch, a typical example of egg dishes, is prepared in the conventional type of automatic microwave oven. In Fig. 1, a transformer 1 is connected to energize a magnetron 1 together with a rectifying circuit consisitng of a capacitor 3 and a diode 4. Food 6 is received in a heating chamber 5. While the food is cooked with microwave radiations, moisture-ladden air from the food is discharged via an air outlet 7. A humidity sensor 8 of which characteristic is illustrated in Fig. 2 is disposed in an exhaust air passageway around the air outlet 7. A voltage variance across a resistor 9 in series with the humidity sensor is used as a humidity readout signal. There are further provided a standard signal source 10, a pre-amplifier 11, a minimum value holding circuit 12 and a subtractor 13 for

evaluating a humidity increase with regard to the mininum value and providing a signal C which is proportional to (A - B), where A is the varying humidity signal h, B is the minumum value h_{min} and C is the humidity variance Δh as shown in Fig. 3(a).

A voltage comparator 14 compares the difference signal C with a reference voltage Vh and provides an output signal when C is in excess of Vh. A switch circuit 15 responsive to the output signal from the voltage comparator 14 is provided for a contact 16 which switches on and off a power supply upon starting and discontinuing of cooking. The contact 16 is closed upon receipt of a cook start signal STA and opened upon passage of time T in Fig. 3(a). While the food 6 is heated with the microwave radiations from the magnetron 2, water vapor is generated and moisture-ladden air is discharged. The humidity sensor 8 senses this discharge air so that the control circuits 11, 12, 13, 14 and 15 place the contact 16 into open position and automatically ends cooking when an increase in the readout voltage from its minimum level exceeds Vh.

The progress of heating and cooking will now be discussed in more detail.

The food 6 hotchpotch material rises gradually in temperature after heating has been started. Because of the inherent tendency that microwave readiations would be absorbed by the peripheral portion of the food 6 first, the zone D in Fig. 3(c) demonstrates a temperature rise

earlier than the zone E due to rapid heating by the microwave radiations. With further advance of heating, the temperature in the zone D reaches up to 70°C to 90°C for time T_2 in Fig. 3(a) and water vapor begins generating gradually from the zone D as depicted in Fig. 3(b). However, the readout signal still continues falling during this period. This is because the microwave radiations continue being generated at a high output level and the relative humidity of the air passing through the air outlet 7 continues falling due to a temperature rise at the magnetron 2, the heating chamber 5, etc. The temperature in the zone D exhibits a sharp increase during the second half of the time T_2. This is a phenomenon peculiar to egg cooking. There is a trend for protein such as hovalbumin and lipovitellin, the predominant constituent of eggs to solidify at about 60°C to 70°C. In the case of pot-steamed hotchpotch, eggs and stock are generally mixed in the ratio 1:3 to 1:4 and heated together with seasoning. It is noted that the solidifying point of such mixture is between 75°C and 85°C. The egg-containing liquid in the zone D where the solidifying point is exceeded, becomes completely solidified so that convention within the bowl 17 is completely interrrupted with a resulting sharp rise in temperature.

No increase in the readout signal is viewed and heating is further advanced since the relative humidity does not rise though water vapor is slightly generated under

these circumstances. If heating is further kept on for a period T_3 of time, then the temperature in the zone D rises up to about 100°C and a large amount of water vapor is generated suddenly. This amount of water vapor overrides a decrease in the relative humidity originating from the temperature rise in the air within the heating chamber 5 and therefore is developed as the increase Δh in the readout signal, thus automatically discontinuing heating. At this moment the mixture 6 in the zone D contains lots of bubbles and becomes hard and solid and disagreeable to the taste. The mixture in the zone E, on the other hand, is still at 60°C to 70°C and fully in liquid phase. This section is therefore inedible. If "miso soup" is re-heated and the boiling point is approached, then good heat conduction is maintained throughout heating due to convention together with even heat distribution because of no possibility that "miso soup" may become solidified. No problem is entertained with "miso soup" additionally because it is usually mixed with something else when people drink it. In addition, if fresh vegetables are wrapped with a thin sheet and heated, then the spaces in the vegetables in the wrapping material are full of water vapor during heating and uniformly heated. For this reason the heating procedure and humidity decision as described previously present no problem with cooking of vegetables. As noted already, egg cooking especially pot-steamed hotchpotch has many outstanding problems: final cooking

temperature should be as low as possible because of the amount of water vapor or gas generated being relatively small; allowance of the final cooking temerature is very limited; convection is interruped with results in uneven temperature distribution because eggs become solidified at about 80°C, etc. The conventional types of automatic microwave ovens are unable to put automated processes of egg cooking into practice.

DISCLOSURE OF THE INVENTION

It is therefore an object of the present invention to provide a high frequency heating appliance which makes possible automated egg cooking which was considered as difficult to achieve in the past years, thanks to skillful design of heating patterns or sequences and a control circuit taking full advantage of the peculiar nature of egg cooking, the relation between water vapor and relative humidity, the relation between food temperature and generated gas and the operating characteristics of the high frequency heating appliance. Pursuant to the present invention, a heating output is switched between high and low levels during high frequency cooking of eggs and decision as to a readout signal from a sensor means is carried out to determine heating item while heating is kept on at the low output level. The present invention is usefull especially for pot-steamed hotchpotch or other egg cooking menus.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram of a conventional high frequency heating appliance;

Fig. 2 is a graph showing characteristics of a humidity sensor;

Figs. 3(a), 3(b), 3(c) and 3(d) are graphs for explaining operation of the conventional appliance;

Fig. 4 is a cross sectional view for explaining cooking state of food;

Fig. 5 is a block diagram of a high frequency heating appliance designed accordign to an embodiment of the present invention;

Figs. 6(a), 6(b), 6(c) and 6(d) are graphs for explaining operation of the illustrated embodiment;

Figs. 7(a), 7(b) and 7(c) are illustrations of heating sequences;

Fig. 8 is a front view of an operational panel; and

Fig. 9 is a front view of a modification in the panel illustrated in Fig. 8.

BEST MODE FOR CARRYING OUT THE INVENTION

Principal components 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 and 16 in Fig. 5 for sensing water vapor from food 6 are similar to those in the conventional appliance and detailed descriptions thereof are omitted herein. In Fig. 5, there are further provided a menu selector 18 for selection of an intended cooking item and

presetting food amounts and a heating sequence memory and selector 19 which also serves as a timer circuit. A menu selection and amount setting signal is designated IN and a display 20 is provided to display a menu and an amount selected.

Referring to Fig. 6, the progress of heating will now be described. When the user selects "pot-steamed hotchpotch" and presets the amount of food, the signal IN is fed to the menu selector. Immediately after a start signal STA has been fed to the menu selector 18 and the relay driver 15, high frequency energy of the maximum output level, i.e., 600 W, is radiated toward the food 6 for a length T_1 of time. The length T_1 of time is selected such that heating is completed before the food 6 or pot-steamed hotchpotch reaches the solidifying point or 75°C to 85°C. If the given time length T_1 contained in the time sequence memory and selector has gone by, then the relay driver 15 is supplied with a signal to switch on and off the contact 16 and permit heating to continue with an intermittent output level or a low output level.

Attention is invited to the amount of water vapor which the readout signal is developed and the temperature of the food. The readout signal h traces an abrupt decrease during heating T_1 with the high output level but settles down during heating with the low output level. This is because a temperature rise in the magnetron 2

and the heating chamber 5 is very small and minimized by the action of a cooling fan 21 and no variance in the relative humidity is viewed. Moreover, since the food 6 is not solidified and heated gradually with the low output level, satisfactory convention is maintained in the bowl 17 in Fig. 4 with a minimum of differential temperature between the zones D and E. If the temperature of the whole of the food 6 reaches 75°C to 80°C with further advance of heating, the food begins solidifying with generation of a slight amount of water vapor. Under these circumstances, the relative humidity in the heating chamber 5 in stable state starts increasing due to the slight amount of water vapor from the food 6 and such increase is detected as the increase Δh in the read-out signal which in turn provides a signal for the relay driver 15 to place the relay contact 16 in the full-open position for discontinuation of heating.

Fig. 7 illustrates heating sequences provided for different amounts of pot-steamed hotchpotch, in which sequences the maximum output length T_1 beginning with the start of heating is varied depending upon the amount of the food. The length T_1 is correlated as $T_1 < T_\alpha$ where T_α is the time at which the hotchpotch becomes solidified, whatever initial cooking temperature, surrounding atmosphere and other conditions. Though the amount of the food is varied, heating is effected automatically with the maximum output level before the given temperature

is reached and thereafter continued with the low output level to enalbe only a slightest amount of water vapor to be sensed. Eventually, the humidity sensor 8 automatically terminates heating. Furthermore, the cycle of intermittent delivery of the high frequency output is varied based upon the amount setting during heating with the low output level. By this method of control, it is possible to effect compensation so as to make the increase in the food temperature constant during the low output level heating as shown in Fig. 6(c) even if the amount of the food is varied. This makes possible automatic cooking with stability of final cooking temperature and uniformity of temperature distribution at all times.

Fig. 8 shows an operational panel on which cooking items can be selected and the amount of the food be preset at the same time through single operation to thereby ensure simplicity of manual operation. Fig. 9 shows an example by which the amount of the food is preset through rotation of a knob 22 and displayed on the display 21. The latter of examples demands only one key for each of the cooking items on the operational panel and permits a much more number of the item keys to be mounted on a limited space of the operational panel. Whereas the foregoing description has set forth humidity variance, the same effect is available when a gas sensor or an odor sensor is used.

INDUSTRIAL APPLICABILITY

As is clear from the foregoing description, it is possible to catch a slight amount of water vapor, gas or odor which is generated at a final cooking temperature ranging from 70°C to 85°C during egg cooking, as long as heating is carried out with an appropriate output level depending upon the amount of the food. Accordingly, the present invention makes readily possible automatic cooking of eggs which had great difficulties as experienced in the past years.

Furthermore, since the optimum condition during heating is switched between the high and low output levels automatically depending upon the amount of the food, egg cooking is completed in satisfactory and delicious state most promptly whatever amount of the food. It is obvious that almost all of the various control circuits used with the present invention may be implemented with a single microcomputer recently in wide-spread use and without no substantial money expenditures.

CLAIMS:

1. A high frequency heating appliance comprising a heating chamber in which food is received, a high frequency generator means for generating high frequency radiations for heating the food, a sensor means for sensing a variance in humidity, gas, odor or the like in said heating chamber, an output control means for controlling the output of the high frequency radiations in response to a signal from said sensor means and a cooking item presetting means, wherein heating sequences as defined by high frequency output level settings for individual cooking items are selectable and wherein decision as to said sensor output signal is carried out to control a total of heating time during egg cooking with an output level lower than the maximum level of the high frequency radiations.

2. A high frequency heating appliance as set forth in Claim 1 further including a control means for conducting heating with the maximum output level at least at the initial phase thereof during egg cooking.

3. A high frequency heating appliance as set forth in Claim 1 further including an amount presetting means and a control means for selecting and controlling the heating sequences depending upon the amount presetting, wherein heating is patterned with the high output level during the first half of heating and with the low output level during the second half of heating for egg cooking and the

length of time where the high output level heating is carried out is determined automatically depending upon said amount presetting, and wherein the end of heating is determined automatically by the output from said sensor means.

4. A high frequency heating appliance as set forth in Claim 3 wherein the low output level during the second half of heating is selected and controlled automatically depending upon said amount presetting.

5. A high frequency heating appliance as set forth in Claim 3 further including a display for displaying cooking items and so forth, said amount presetting being displayed on said display.

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Fig. 1

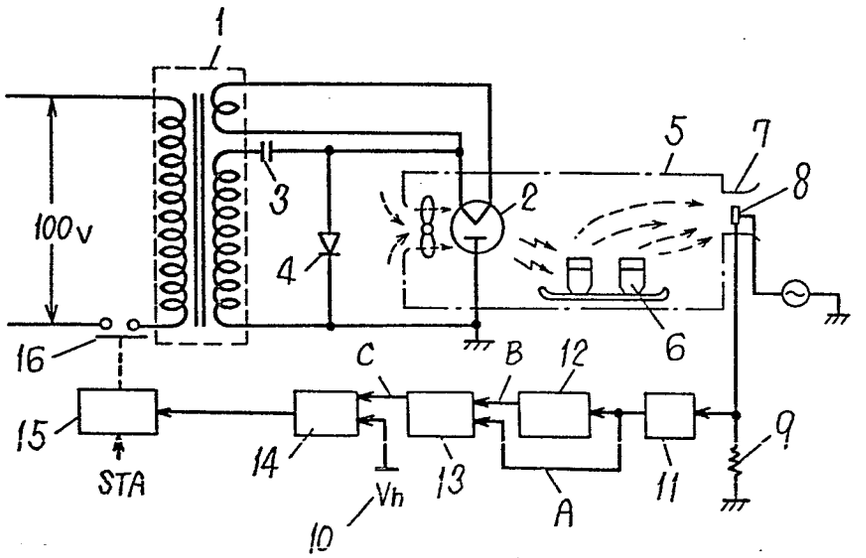


Fig. 2

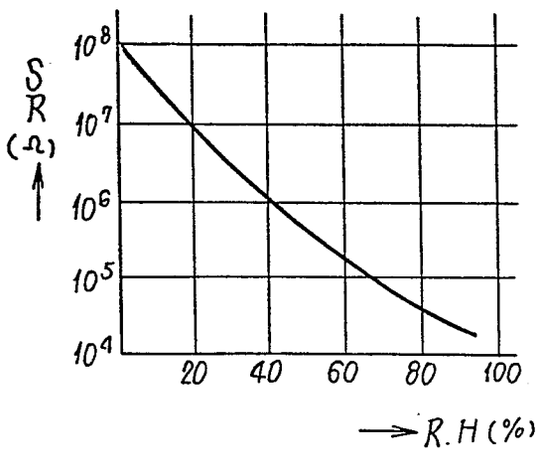


Fig. 3

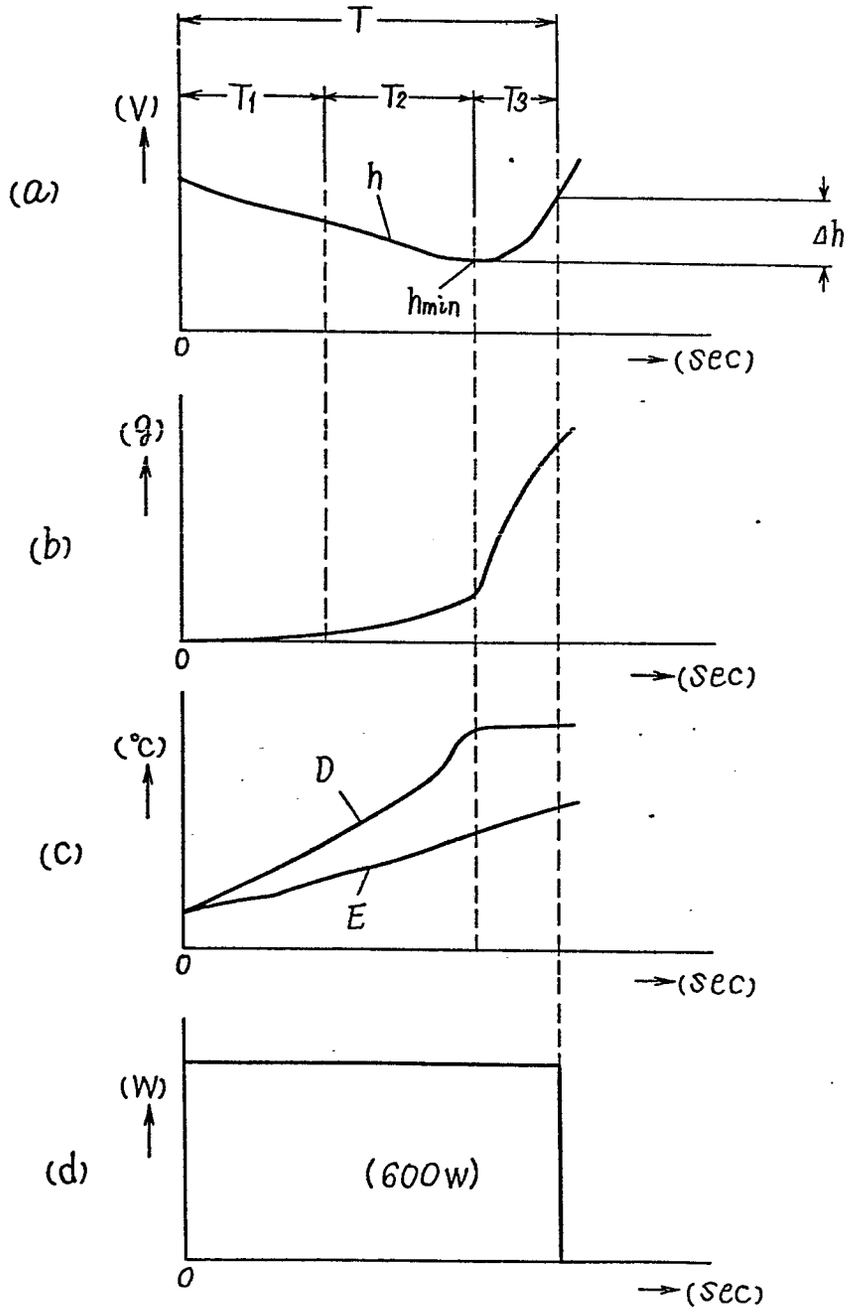


Fig.4

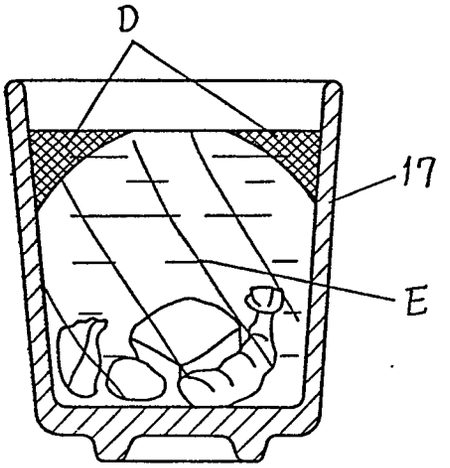


Fig.5

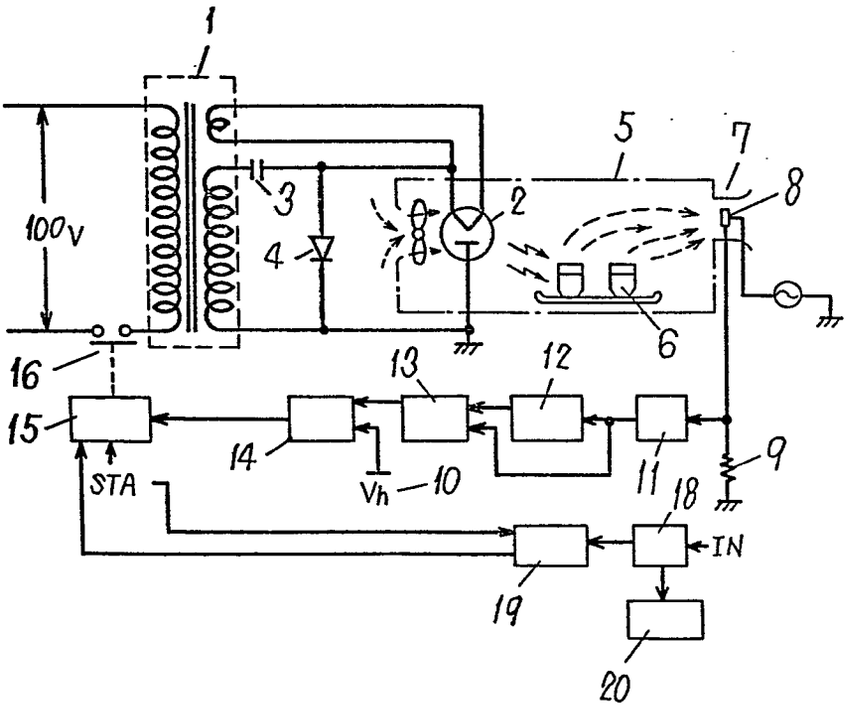


Fig.6

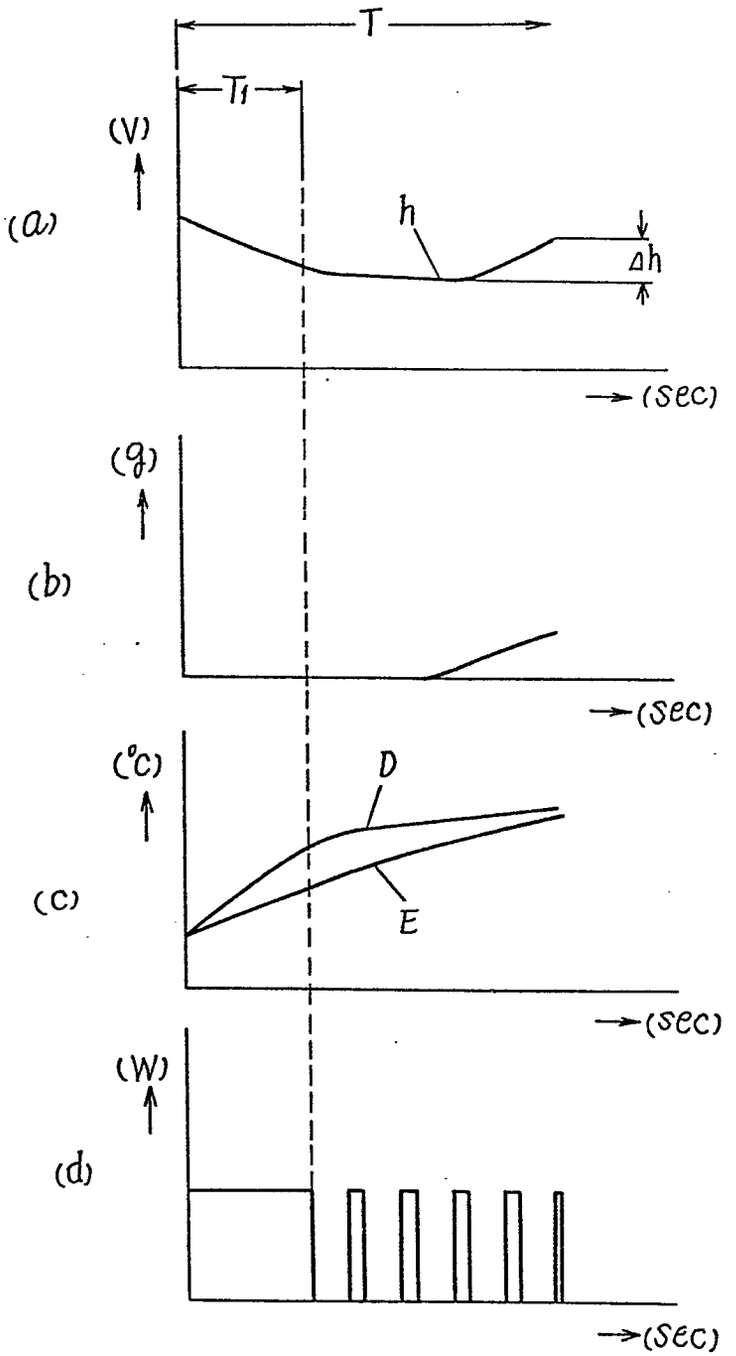


Fig.7

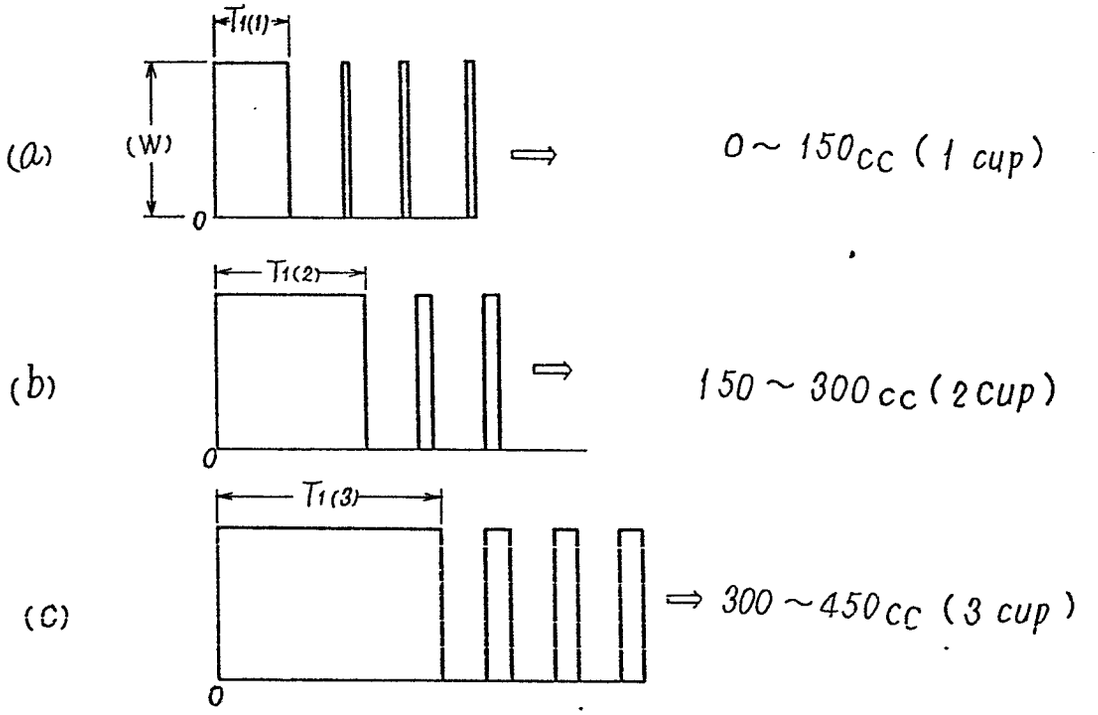


Fig.8

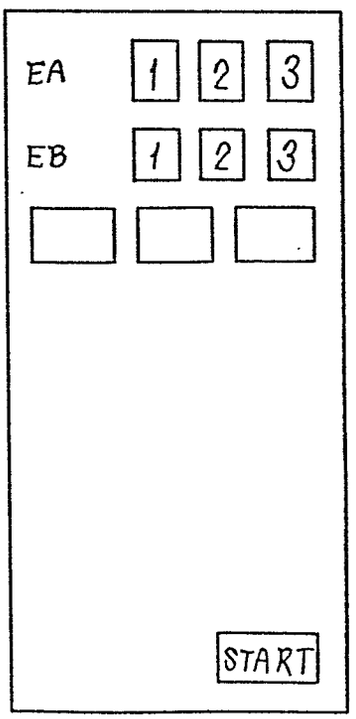
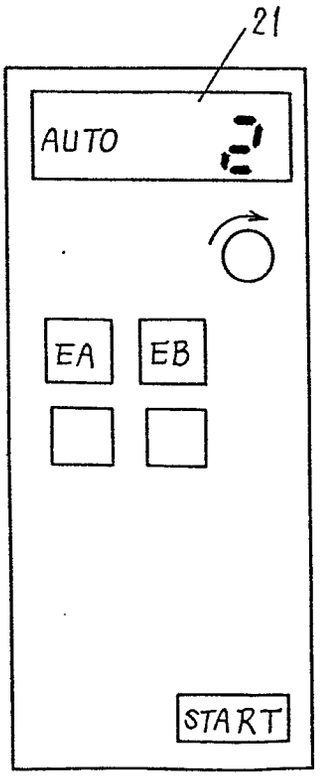


Fig. 9



LIST OF REFERENCE NUMBERS IN THE DRAWINGS

1... transformer

2... magnetron

3... capacitor

4... diode

5... heating chamber

6... food

7... air outlet

8... humidity sensor

9... resistor

10... standard signal source

11... pre-amplifier

12... minimum value holding circuit

13... subtractor

14... voltage comparator

15... driver

16... contact

17... bowl

18... menu selector

19... heating sequence memory and selector

20... display tube

21... display section

22... knob

C... difference signal

T... heating time

INTERNATIONAL SEARCH REPORT 0083663

International Application No. PCT/JP82/00274

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, A23L 1/32

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
I P C	F24C 7/08, F24C 7/02, A23L 1/32

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	JP,A, 52-154140 (Matsushita Electric Industrial Co., Ltd.) 21. December. 1977 (21. 12. 77)	1 - 3
Y	National Technical Report, Vol. 24, No. 5 (October, 1978) Matsushita Electric Industrial Co., Ltd. Kanazawa Takato and five others, "Shitsudo Kenchishiki Jido Denshi Range", P. 876-885	1 - 3

* 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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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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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

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"&" 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]
October 12, 1982 (12.10.82)	October 25, 1982 (25.10.82)
International Searching Authority [1]	Signature of Authorized Officer [20]
Japanese Patent Office	