United States Patent

Yasuoka

[15] **3,692,968**

[45] **Sept. 19, 1972**

[54] **ELECTRONIC OVEN**

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[73] Assignee: **Sanyo Electric Co., Ltd.**

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[21] Appl. No.: **117,304**

[30] **Foreign Application Priority Data**

April 6, 1970 Japan 45/20685
April 6, 1970 Japan 45/20686

[52] **U.S. Cl.**.....**219/10.55,** 219/400
[51] **Int. Cl.**.....**H05b 9/06**
[58] **Field of Search**.....219/10.55, 400

[56] **References Cited**

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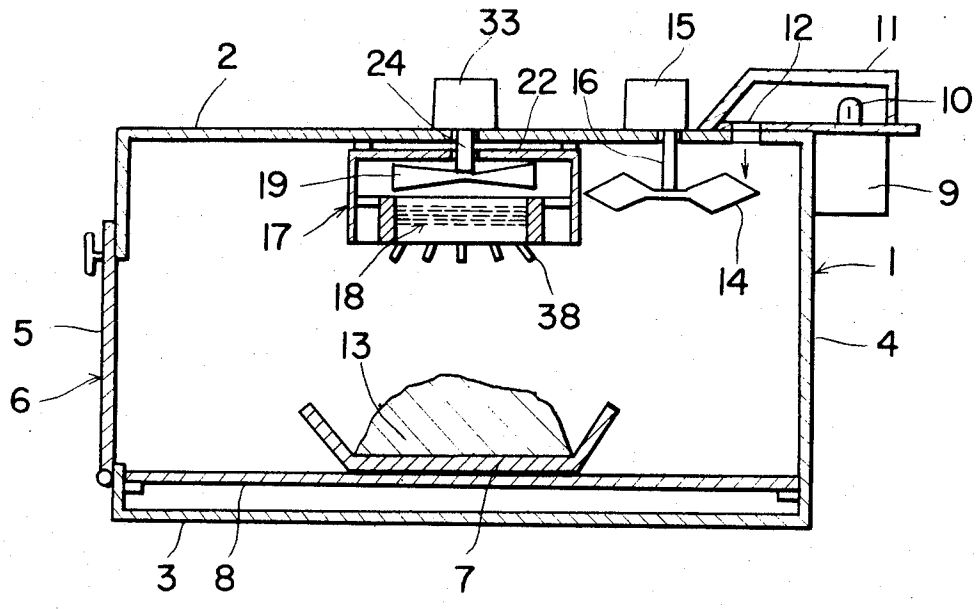
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Primary Examiner—J. V. Truhe
Assistant Examiner—Hugh D. Jaeger
Attorney—Staas, Halsey & Gable

[57] **ABSTRACT**

An electronic oven comprising an oven-defining structure equipped with means for effecting the browning action on an object to be heated, said browning means including means for creating a forced circulation of air and a heating assembly, whereby hot air of relatively high temperature can advantageously be directed toward the object so that the browning or scorching action can be performed in a short time as rapidly as the object can be heated solely by the application of high frequency energy.

15 Claims, 5 Drawing Figures



PATENTED SEP 19 1972

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SHEET 1 OF 3

Fig. 1

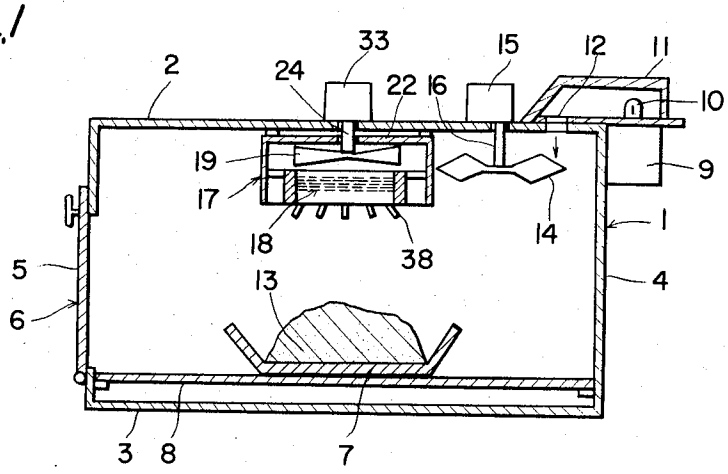
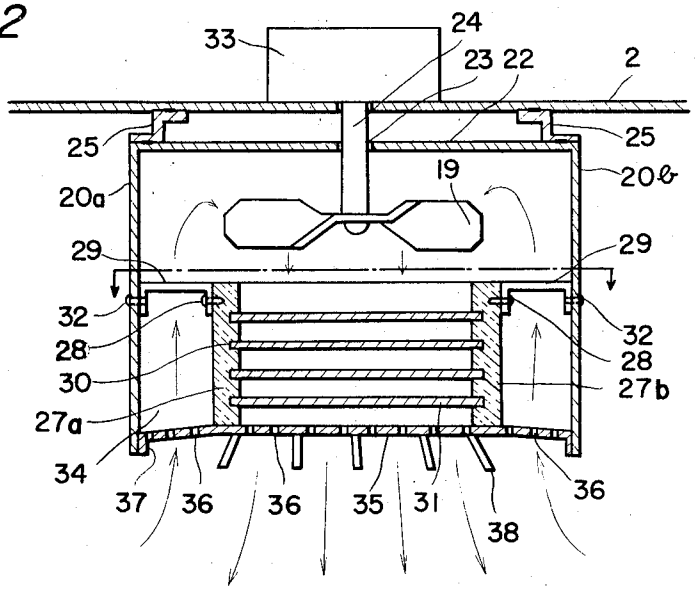


Fig. 2



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Fig.3

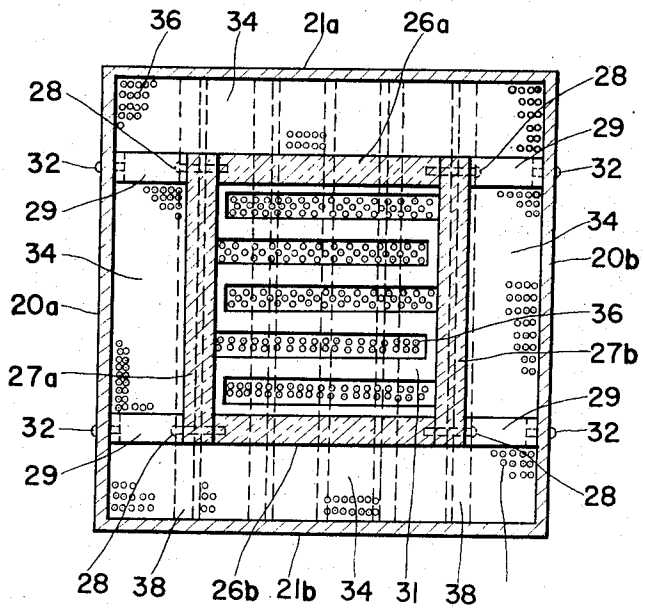

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Fig.4

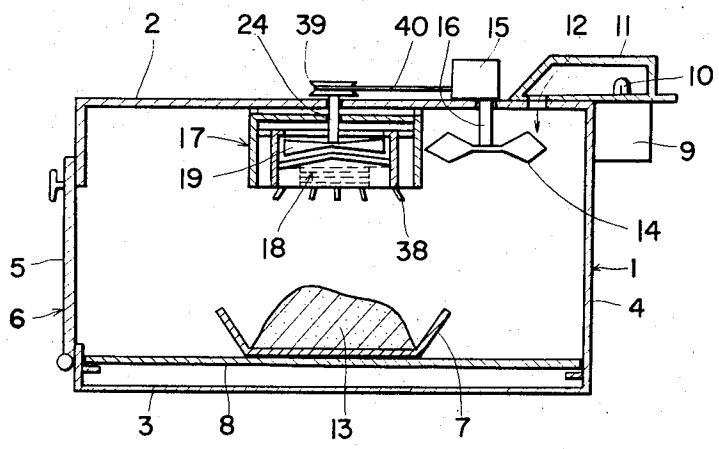
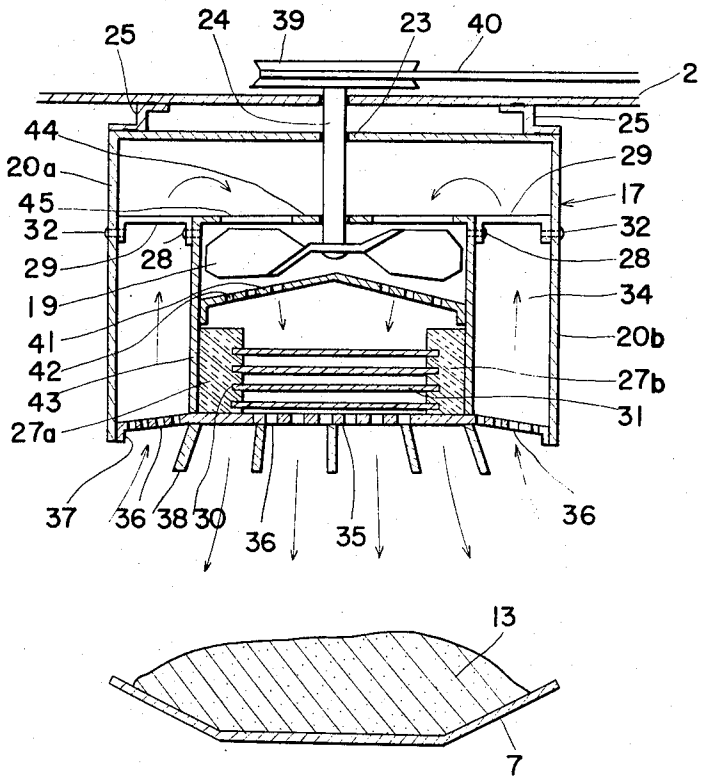

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Fig. 5


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ELECTRONIC OVEN

The present invention relates to an electronic oven having a magnetron for generating high frequency energy and, more particularly, to an improvement in an electronic oven of the type above referred to comprising means for effecting a browning action on material to be heated within the electronic oven by means of the high frequency energy.

Before the description proceeds, it is to be noted that the term "browning" should, in addition to its lexicographical meaning, be construed as meaning of scorching or burning as well. This is because, in some countries in this global earth, the scorchedness, that is, the scorch suitably formed on the surface of a food item, is sometimes necessitated to add a taste to the food item thereby not only to decorate the dinner table with it, but also to give an appetite. However, the term "browning" is herein used throughout the description of the present invention for the sake of brevity unless a distinction between "browning" and "scorching" or "-burning" is necessitated.

It has been well known that, as electronic ovens for domestic use have been developed into mass production, a revolution has broken out in the house-keeping of the user especially in the role of a house wife. Any type of such electronic ovens is also referred to as "-microwave oven" or "high-frequency oven" and operates to heat-treat food material extraordinarily in a short time as compared with the conventional electric oven or roaster and gas oven. Nevertheless, other than the food material having moisture of appreciable value, any non-conductive materials having negligible dielectric losses or moisture-containing dielectric material can be employed for items to be heat-treated by the electronic oven.

The principle in which high frequency energy or microwave energy can be employed for heating purpose is well known in the art as generally understood that dielectric hysteresis or dielectric loss takes place in an object to which the high frequency energy or microwave energy is applied.

However, such a modern convenience has one inconvenience in that it cannot perform the browning action even if the energy is radiated, for example, to a food item for a relatively long time. For this reason, in order to obtain brownness on the surface of the food item, a diluted solution of soy sauce has been painted over the surface thereof prior to the application of high frequency energy or an additional heating instrument has been employed for heat-treatment subject to the food item cooked by the energy.

To eliminate this inconvenience inherent to the modern convenience, an improvement has been proposed as disclosed in the U.S. Pat. Nos. 2,831,952 and 3,081,392, wherein a resistance heating element is incorporated in the high-frequency oven.

In either of the devices of the above numbered U.S. Patents, it is apparent that, even if the resistance heating element is operated at the same time as high frequency energy is applied to the food item, a longer time is required than the time required to apply the high frequency energy until the desired degree of brownness can be obtained on the surface of the food item. In addition, various switching instruments are provided so that the user will feel inconvenience in operating such an electronic oven.

Accordingly, one important object of the present invention is to provide an electronic oven of the type above referred to wherein means is provided for effecting the browning action on the surface of material to which high frequency energy is applied or radiated.

Another object of the present invention is to provide an electronic oven of the type above referred to wherein means is provided for creating a forced circulation of hot air generated by the browning means.

A further object of the present invention is to provide an electronic oven of the type above referred to wherein a heat-conduction shielding means is provided for preventing the oven proper from being heated during the operation of the browning means.

A still further object of the present invention is to provide an electronic oven of the type above referred to comprising the above mentioned means which can be manufactured at low cost without necessitating a complicated skill.

These and other objects and features of the present invention will become apparent from the following description taken in conjunction with preferred forms of embodiment of the present invention only for the illustrative purpose with reference to the attached drawings, in which;

FIG. 1 is a schematic side sectional view of an electronic oven in one embodiment of the present invention,

FIG. 2 is a similar view to FIG. 1, showing an essential portion thereof on an enlarged scale,

FIG. 3 is a cross sectional view taken along the line III—III in FIG. 2,

FIG. 4 is a schematic side sectional view of an electronic oven in another embodiment of the present invention, and

FIG. 5 is a similar view to FIG. 4, showing an essential portion thereof on an enlarged scale.

It is to be noted that like parts are designated by like reference numerals throughout the attached drawings. In addition, although schematically shown in the attached drawings, the electronic oven should be constructed such that no wave leakage occur even during a period in which such oven is operated.

Referring now to FIG. 1, an oven-defining metallic structure 1 of any known electronic oven assembly is shown as formed with six walls disposed in box-like configuration, these walls including upper and lower walls 2 and 3, a rear wall 4, two side walls (not visible) and a front wall 5 constituted by the back of a door 6.

This oven-defining metallic structure 1 so far described may be of any known construction and the object to be heated is adapted to be disposed in a non-metallic utensile 7 inserted through the door 6 and placed on an grill shelf 8 which is formed to permit passage of high frequency energy therethrough.

Mounted on a rear wall 4 at an upper position in the example as shown is a magnetron assembly 9 for producing high frequency waves or microwaves which are radiated by an antenna 10, the radiated waves being guided to the interior of the oven-defining structure 1 by means of a wave guide 11 through an opening 12 formed in the upper wall 2. The microwaves emerging from the opening 12 are adapted to be stirred, for the purpose of enhancing the heating effect in the object 13 to be heated, for example, a food item, by a vane

type stirrer or mode changer **14** which is driven by a motor **15** mounted on the upper wall **2** through a drive shaft **16** in a manner as is well known in the art.

Means for effecting the browning action on the food item **13** according to the present invention comprises a metallic casing **17** in which a heating assembly **18** and a fan **19** are accommodated, the details of which will be hereinafter fully described with reference particularly to FIG. **2** and FIG. **3**.

The casing **17** is integrally formed into a box-like configuration with two pairs of opposed side partitions **20***a*, **20***b* and **21***a*, **21***b* and a ceiling **22** having a through hole **23** through which a shaft **24** is extended as will be mentioned later. This casing **17** is suspended from the upper wall **2** preferably in a spaced relation with respect to the latter by means of a suitable number of bracket members **25** each rigidly connecting between the upper wall **2** and the ceiling **22**. However, it is to be noted that this casing **17** should preferably be positioned just above the food item **13** if the latter is usually placed over the central portion of the lower wall **3**. Although the detail is not shown, each bracket member **25** may have the both ends rigidly connected with the upper wall **2** and the ceiling **22**, respectively, by means of any suitable connecting means such as spot welding or screwing.

This casing **17** is adapted to accommodate therein the heating assembly **18** including two pairs of opposed blocks **26***a*, **26***b* and **27***a*, **27***b* each preferably made of heat insulating material. Particularly as shown in FIG. **3**, these blocks **26***a*, **26***b*, **27***a* and **27***b* are assembled into a reduced configuration similar to that of the casing **17** by any known means such as employing a suitable number of screws which are generally indicated by **28**. However, some of these screws **28** may be commonly employed for connecting a suitable number of supporting strips, generally indicated by **29**, to these blocks, only four of which are employed and connected to a pair of opposed blocks **27***a* and **27***b* in the example as shown.

Formed on the opposed surfaces of one pair of these blocks **27***a* and **27***b* is a plurality of grooves **30**, each having the same number thereof, for supporting the corresponding number of heating elements **31**, all of these elements **31** being connected to a suitable power source (not shown) in any known manner. Each heating element **31** is preferably made of a sheet of any suitable high resistivity metal such as nickelchromium alloys or other resistance heater material well known in the art, which said sheet is in turn shaped into a substantially zigzag configuration particularly as shown in FIG. **3**.

The heating assembly **18** thus constructed is suspended within the casing **17** through the supporting strips **29** which are in turn connected with a pair of the opposed side partitions **20***a* and **20***b* by means of screws **32** so that the heating assembly **18** can be removed from the interior of the casing **17** when repair or replacement is desired.

Positioned above the heating assembly **18** is the fan **19** adapted to be driven by a motor **33**, mounted on the upper wall **2** of the oven-defining structure **1**, through the shaft **24** for creating a forced circulation of hot air within the casing **17**. As will be understood later, instead of the motor **33**, a gear train or pulley-belt power transmission system may be provided between the corresponding end of the shaft **24** and the mode changer operating motor **15** so that the fan **19** can be rotated by said single motor **15**. When this fan **19** is driven, a downwardly directed wind will be created which is in turn heated by the heating elements **31** while passing through the latter. The wind thus heated to relatively high temperature, i.e., hot air, is employed for surface treatment of the food item **13**, and thereafter circulates in a manner as indicated by arrow-headed lines in FIG. **2**. However, it is to be noted that a spacing **34** defined around the heating assembly **18** within the casing **17** serves as means for preventing the oven-defining structure **1** from being excessively heated under the influence of the heat energy created by the heating elements **31**. In other words, the temperature of air upwardly flowing toward an upper portion of the heating assembly **18** within the casing **17** is lower than that of air downwardly emerging through the heating assembly **18** and, therefore, the upwardly flowing air acts as heat insulator so that the temperature of the structure **1** can be maintained substantially at the same value as that of a conventional electronic oven which is not equipped with such heating assembly.

Means for shielding the invasion of high frequency energy into the interior of the casing **17** including the spacing **34** and the heating assembly **18** is also provided as comprising a metallic panel **35** preferably made of the same material as employed in the oven-defining structure **1** and formed with a plurality of small holes **36** each so sized that the cut-off frequency is smaller than the frequency of radiation energy present in the oven proper. This metallic panel **35** has its four-sided edge downwardly bent so that, when this panel **35** is inserted in the casing as shown in FIG. **2**, said edge **37** resiliently engages to a four-sided lower end of the casing **17**. In order to prevent this panel **35** from being accidentally removed, a suitable number of screws (not shown) may be employed for connecting the edge **37** to the lower end of the casing **17** or connecting the panel **35** to the blocks **26***a*, **26***b*, **27***a* and **27***b*. The metallic panel **35** is connected with a plurality of hot air orienting devices, five of which in the form of a metal strip are illustrated and indicated by **38** in the instance shown in FIG. **2** and FIG. **3**. These devices **38** may be connected to the panel **35** by any means such as spot welding. Although in the instance as shown metal strips are employed for the hot air orienting device **38**, it is to be noted that annular deflectors each made of metal may be employed for the same purpose.

In another preferred embodiment of the present invention shown in FIG. **4** and FIG. **5**, instead of the fan driving motor **33** shown in FIG. **1** and FIG. **2**, the fan **19** is adapted to be driven by the mode changer driving motor **15** through a pulley-belt power transmission system. This pulley-belt power transmission system comprises a pulley **39** rigidly mounted on the corresponding end of the shaft **24** and an endless belt **40** drivingly mounted around the pulley **39** and the other drive pulley (not shown) associated with the motor **15**.

In the embodiment shown in FIG. **4** and FIG. **5**, means for exclusively downwardly reflecting heat energy created by the elements **31** toward a lower portion of the interior of the casing **17** is provided. This reflecting means comprises an umbrella-shaped plate **41**

formed with a plurality of annularly disposed holes **42** located a sufficient distance apart from the center of the umbrella-shaped plate **41**, which the center is in alignment with the longitudinal axis of the shaft **24**. This plate **41** is mounted over the blocks **26***a*, **26***b*, **27***a* and **27***b*.

Additionally provided is an enclosure **43** made of metal and having a four-sided wall surrounding the heating assembly **18** and an upper wall **44** integral with said four-sided wall and formed with an inlet window **45** through which the upwardly flowing air is forcibly sucked by the rotating fan **19** into the heating assembly **18**. By this provision, it will be understood that the forced circulation of air can be obtained in a regular manner without accompanying any noise resulting from possible turbulence of air within the casing **17**.

In addition, the reflecting means also acts to prevent the transmission of heat energy from the heating assembly **18** toward an upper portion thereof so that the fan **19** will not be badly affected.

In either of the embodiments of the present invention shown in FIG. **1** through FIG. **3** or FIG. **4** and FIG. **5**, the total wattage of the heating elements **31** is preferably in the range of from 500 to 1,000 with the air flow rate of about 20 to 100 liters per minute so that the temperature of air can be elevated up to 350° to 900° C.

It is to be noted that, since a plurality of the heating elements **31** is employed, a suitable switch or variable resistor may be employed for obtaining a desired initial temperature with respect to the kind of food item to be cooked. In addition, if a thermostat is provided, the temperature within the oven-defining structure **1** can be maintained at a constant value throughout the operation of the electronic oven.

Although the present invention has been described particularly in connection with the means for effecting the browning action on the food item, it is to be noted that, without operating the magnetron assembly **9**, the electronic oven according to the present invention can be used in a similar manner as the conventional electric oven. That is to say, the electronic oven provided with the heating assembly according to the present invention has a two-way purpose.

Other modification and change are apparent to those skilled in the art and, therefore, the present invention is not to be limited by the embodiments as hereinbefore fully described.

What is claimed is:

1. In a high frequency microwave oven, an oven-defining structure comprising upper, lower, and side walls made of metal, means for supplying high-frequency energy to said structure through an opening provided in one of said walls, a casing spacedly provided within said structure for therein accommodating means for creating a forced circulation of air and a heating assembly accommodated within said casing and including a plurality of parallely juxtaposed heating elements supported by a plurality of heat insulating blocks provided within said casing.

2. The high frequency oven construction according to claim **1**, wherein said means for creating a forced circulation of air comprises a fan adapted to be driven by means of an electric drive device for directing an air toward said heating assembly which is in turn directed to an object to be heated.

3. The high frequency oven construction according to claim **1**, wherein said heating elements comprises a sheet of nickel chromium shaped into a zigzag configuration.

4. The high frequency oven construction according to claim **1**, further comprising means for orienting hot air created by said heating element past said heating assembly, toward an object to be heated which has been placed on the lower wall of said oven-defining structure.

5. The high frequency oven construction according to claim **1**, wherein said heating assembly is provided with means for exclusively downwardly reflecting heat energy created by said heating elements.

6. The high frequency oven construction according to claim **1**, further comprising an enclosure for effecting a forced circulation of air in a regular manner without accompanying any noise in cooperation with said means for creating the forced circulation of air.

7. The high frequency oven construction according to claim **1**, further comprising a metallic panel formed with a plurality of small holes for shielding the invasion of high frequency energy into said heating assembly.

8. The high frequency oven construction according to claim **1**, wherein said heating assembly and said means for creating the forced circulation of air are adapted to be operated in synchronism with a magnetron for producing high frequency energy.

9. The high frequency oven construction according to claim **1**, wherein said means for creating a forced circulation of air comprises a fan adapted to be driven by a power transmitted from an electric drive device adapted for operating a mode changer.

10. The high frequency oven construction according to claim **7**, wherein said metallic panel is provided with a plurality of means for exclusively downwardly orienting toward an object to be heated hot air that has been created by a plurality of heating elements.

11. Oven apparatus for cooking a food substance disposed therein, said apparatus comprising:

an outer casing comprising upper, lower, and side walls, said outer casing having an opening therein;

means for supplying high frequency energy through said opening into said outer casing to produce standing electromagnetic field waves within said outer casing;

means for generating thermal energy disposed inside said outer casing; and

means for providing and directing a circulation of air along a first path from said thermal means to the food substance to be cooked and along a second path disposed between said first path and said side walls from the food substance to said thermal means.

12. Oven apparatus as claimed in claim **11**, wherein the air directed along said second path is cooler than that air directed along said first path to thereby provide a thermal insulation barrier for said outer casing.

13. Oven apparatus as claimed in claim **11**, wherein there is included a second inner casing for supporting said heating means centrally thereof and for supporting said air circulation means so as to direct air along said first path past said thermal means and onto to the food substance, said second inner casing including a return passage for the circulation of air along said second path disposed between said thermal means and the side walls of said second inner casing.

14. Apparatus as claimed in claim 3, wherein said second inner casing includes louver means for directing the circulation of air along said first path onto the food substance.

15. Apparatus as claimed in claim 3, wherein said second inner casing includes thermal energy reflecting means disposed between said air circulation means and said thermal means, said reflecting means having openings therein for the passage of air along said first path.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,692,968 Dated September 19, 1972

Inventor(s) Yoshio Yasuoka

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

[30] Foreign Application Priority Data

March 6, 1970	Japan 20685/1970
March 6, 1970	Japan.....20686/1970

Signed and sealed this 30th day of January 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

PO-1050
(5/69)

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