

[54] **MODE-SHIFTING SYSTEM FOR MICROWAVE OVENS**

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[51] Int. Cl. **H05b 9/06**

[58] Field of Search..... 219/10.55; 333/21 R

[56]

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[57]

ABSTRACT

A mode-shifting system for microwave ovens comprising spaced dielectric blocks located within the cavity of a microwave oven to ensure uniform distribution of electromagnetic wave energy throughout the foodstuffs placed within such cavity.

1 Claim, 3 Drawing Figures

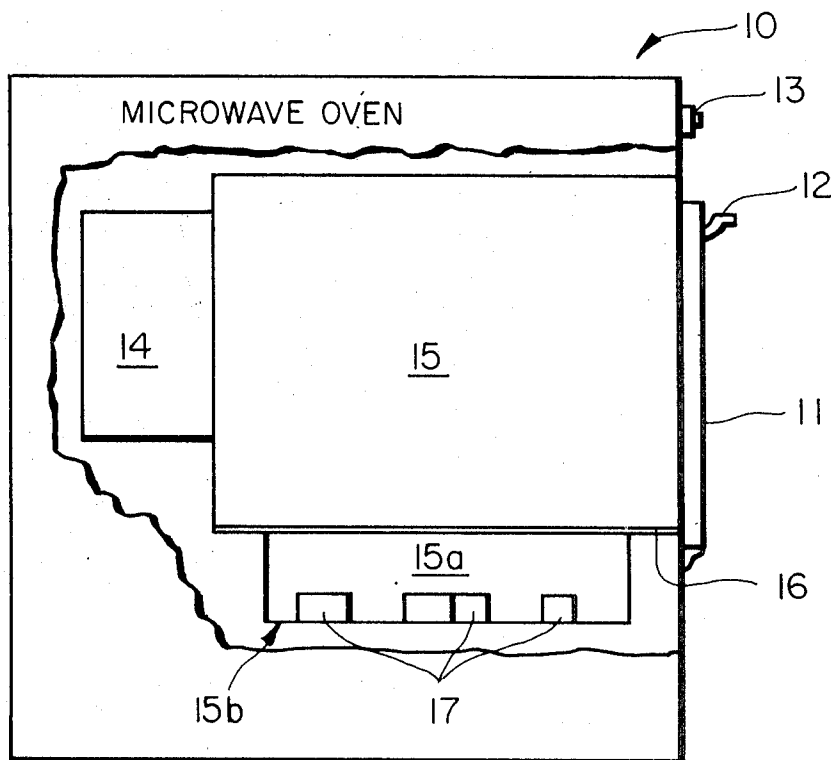


Fig. 1

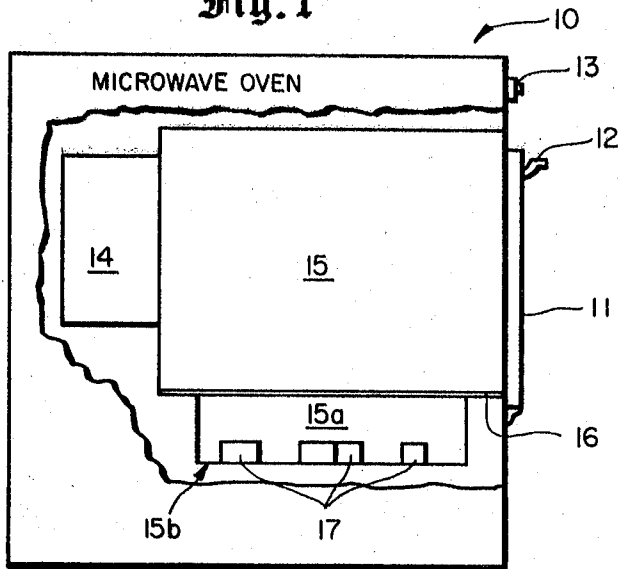


Fig. 3

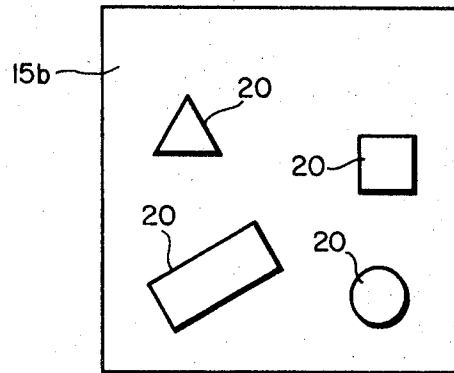
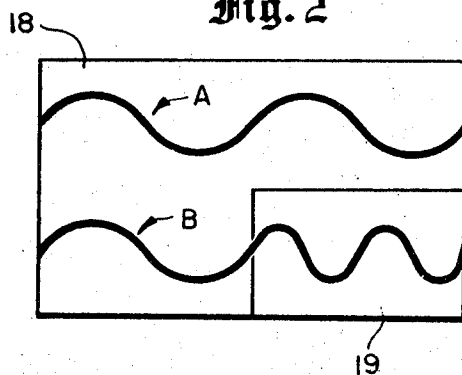


Fig. 2



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MODE-SHIFTING SYSTEM FOR MICROWAVE OVENS

FIELD OF THE INVENTION

This invention relates to mode shifting of electromagnetic wave energy and more particularly to a novel mode-shifting system for distributing electromagnetic wave energy within a cavity of a microwave oven.

DESCRIPTION OF THE PRIOR ART

It is well known that electromagnetic wave energy may be utilized for heating foodstuff. The foodstuff may be placed in a heating cavity of a microwave oven and exposed to electromagnetic wave energy supplied by a suitable source, e.g., a magnetron. Molecular agitation within the foodstuff resulting from the exposure to electromagnetic wave energy provides frictional heat to cook the foodstuff in a relatively short period of time as compared to conventional gas or electric heating. It is desirable to have a uniform application of electromagnetic wave energy throughout the foodstuff to ensure satisfactory cooking of the entire foodstuff. The cavity of the microwave oven is of a defined dimension; therefore, the electromagnetic wave energy supplied thereto establishes a defined number of stable modes of oscillations as a function of the geometry and the dimensions of the cavity.

However, it has often been found that such stable modes do not provide uniform cooking of the foodstuffs. Therefore, metallic stirring devices have been employed in the prior art to establish complex modes in the cavity. These stirring devices were usually metal plates or rods that would be mechanically moved within the heating cavity in order to change the physical dimensions of the cavity as seen by the electromagnetic wave energy source. In addition, ferromagnetic gyrators were employed to change the polarization of the electromagnetic wave energy in order to establish additional modes of oscillation. However, both of the aforementioned devices include moving parts, thus such devices are susceptible to breakdown.

Accordingly, it is an object of the present invention to provide an improved mode-shifting system which ensures improved uniform distribution of the electromagnetic wave energy within the cavity of a microwave oven.

It is a further object of the present invention to provide an improved mode-shifting system which includes no moving parts.

It is a still further object of the present invention to provide an improved mode-shifting system which is relatively inexpensive.

It is another object of the present invention to provide an improved mode-shifting system which does not interfere with the usable space within the cavity of a microwave oven.

SUMMARY OF THE INVENTION

In accordance with the objects set forth above, the present invention provides a mode-shifting system for microwave ovens comprising spaced dielectric blocks located within the heating cavity of a microwave oven to ensure uniform distribution of electromagnetic wave energy throughout the foodstuffs placed within such cavity. The dielectric blocks may be of different geometric configurations and may be affixed in stationary positions within the heating cavity in particular system

configurations as a function of the frequency of the electromagnetic wave energy and the physical dimensions of the cavity of the microwave oven.

BRIEF DESCRIPTION OF THE DRAWINGS

Additional objects, advantages, and characteristic features of the present invention will become readily apparent from the following detailed description of the preferred embodiments of the invention when taken in conjunction with the accompanying drawings in which:

FIG. 1 is a side elevational view of a microwave oven, with a portion of the side housing cut away to expose the cavity of the microwave oven, in accordance with the present invention;

FIG. 2 is a front view of a plane of a cavity of a microwave oven, in accordance with the present invention; and

FIG. 3 is a plan view of the bottom of a cavity of a microwave oven having a mode-shifting system, in accordance with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1, there is shown a side elevational view of a microwave oven 10 in accordance with the present invention. On the right side of FIG. 1, there is shown a door 11, having a handle 12, which accommodates the insertion and the removal of foodstuffs to and from a cavity 15 of the microwave oven 10. The numeral 13 designates the various controls for operating the microwave oven 10, while the numeral 14 symbolically represents the area occupied by various circuits, the power supplies, the magnetron, etc., which are necessary to operate the microwave oven 10.

FIG. 1 is shown with a portion of the side housing cut away to expose the cavity 15 within the microwave oven 10. In the process of cooking foods, the item to be cooked would be placed onto a shelf 16, which may be a thin sheet of any suitable dielectric material, for example, pyro-ceram, which is a highly heat resistant pyrex. A thin sheet of such material does not interfere with the radiation pattern and will not crack under normal microwave operating conditions. Shown below the shelf 16 is another portion of the cavity 15, designated as 15a. Such cavity portions are well known as the deep well cavities and are employed to provide a more evenly distributed radiation pattern in order to ensure more efficient overall cooking of the foodstuffs, i.e., electromagnetic wave energy may enter at more points on the surface of the foodstuffs. Located on a shelf 15b of the deep well cavity 15a are blocks 17, composed of dielectric material, which form the novel mode-shifting system in accordance with the present invention. It is well known that a defined number of modes of electromagnetic wave energy will be established in the cavity of a microwave oven as a function of the geometry and dimensions of such cavity. When foodstuffs are placed in such a cavity, stable modes allow electromagnetic wave energy to enter the foodstuffs at various angles. It is well known that if one were to place a wiener in such a microwave cavity it is possible to heat both ends of the wiener without heating the center portion of the wiener. On the other hand, if one were to introduce material into the cavity that would change the wavelength of the electromagnetic wave energy, additional modes would be established in the cavity. For example, if one were to introduce a material having a dielectric

constant other than air into a particular empty region of a cavity, the wavelength in that region would be different than the wavelength of the electromagnetic wave energy if the region were to remain empty.

Referring now to FIG. 2, there is shown a rectangle illustrative of a plane 18 within the cavity of a microwave oven having a width of two wavelengths as defined by an electromagnetic wave designated A in the upper region of the plane 18. Dielectric material has the effect of storing electromagnetic wave energy. If one were to introduce a block of dielectric material 19 having a dielectric constant of four into the plane 18, an electromagnetic wave designated B, of three wavelengths, would exist in the width of the bottom region of the cavity. Thus, the dielectric block 19 will distort the electromagnetic wave energy so as to establish additional modes. Furthermore, one can imagine that if the waves of electromagnetic wave energy strike the dielectric block 19 at different angles, the number of modes would be further increased. Thus, the complex additional modes provided allow electromagnetic wave energy of various wavelengths to pass through the foodstuffs at different angles and additional points than realized in conventional microwave oven cavities.

Referring now to FIG. 3, There is shown a plan view of the deep well cavity 15a along with the dielectric blocks 20. It is to be understood that the dielectric blocks 20 need not be of any particular geometric configuration, but may be rectangular, triangular, cylindrical, or irregularly-shaped, some of which are shown. A particular microwave oven design may have different requirements in order to increase the number of modes so as to ensure an improved uniform distribution of electromagnetic wave energy throughout the foodstuffs, e.g., dielectric blocks 20 of various sizes and shapes may be placed in various positions within the cavity 15. While the present invention teaches dielectric blocks 20 disposed within the deep well cavity 15a, the dielectric blocks may be placed anywhere within the cavity 15 as long as they serve to ensure an improved uniform distribution of electromagnetic wave energy throughout the foodstuffs without physically interfering with the insertion of foodstuffs to the cavity 15.

The dielectric blocks 20 comprising the mode-

shifting system of the present invention have a relatively low loss-tangent, compared to that of the foodstuffs being cooked in the microwave ovens; therefore, the dielectric blocks will not heat up during the process of cooking the foodstuffs. It has been found that in order to obtain the confinement of the electric field in a dielectric block of polypropylene, the block should be approximately $\frac{3}{4}$ inch thick for a frequency of 2450 megahertz. Other dielectric materials such as titanium dioxide and quartz have been effectively utilized to provide additional modes so as to eliminate cold spots in the cavity of microwave ovens. While FIG. 3 illustrates a plurality of separate dielectric blocks 20, the dielectric blocks 20 may be fabricated as part of an integral sheet of dielectric material.

Thus, although the present invention has been shown and described with reference to particular embodiments, for example, a mode-shifting system comprised of dielectric material of various block configurations, nevertheless, various changes and modifications obvious to a person skilled in the art to which the invention pertains, for example, a mode-shifting system comprised of dielectric material fabricated in hollow cylinders or irregularly shaped configurations are deemed to lie within the spirit, scope and contemplation of the invention as set forth in the appended claims.

What is claimed is:

1. A method for providing additional modes of electromagnetic wave oscillations in a microwave oven comprising the steps of:

providing a compartment below a shelf forming the bottom side of the microwave oven cooking cavity; measuring the distribution of electromagnetic wave energy within the oven cavity;

locating at least one dielectric block within the compartment below the cooking cavity shelf, each block receiving and changing the wavelengths of electromagnetic wave energy passing there-through; and

positioning each of the blocks within the compartment at desired locations for more evenly distributing the electromagnetic wave energy within the oven cavity.

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