United States Patent

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[54] **BROWNING APPARATUS FOR USE IN A MICROWAVE OVEN**
9 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **219/10.55,** 219/10.81
[51] **Int. Cl.** **H05b 9/06,** H05b 9/04
[50] **Field of Search** 219/10.55, 10.81

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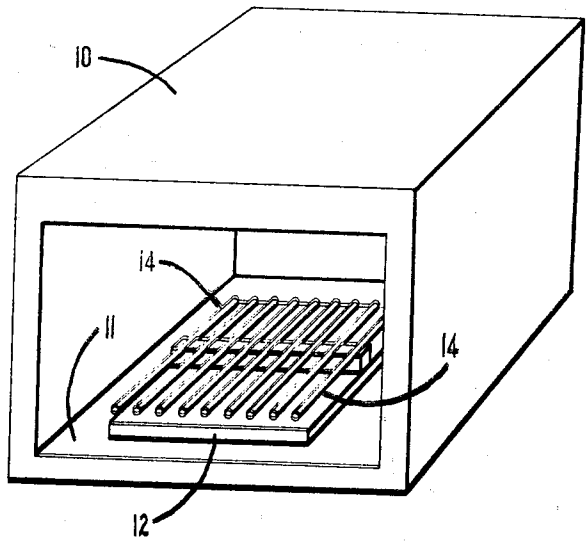
ABSTRACT: In a microwave oven wherein a portion of food is to be cooked, microwave coupling devices are located in contact or close proximity to the food for the purpose of browning the food. The microwave devices, in one embodiment, include a plurality of metal rods, each having a length that is a multiple of a half wavelength with respect to the microwave energy within the oven. The microwave devices effectively transform the microwave energy into thermal energy in which form the energy causes the browning of the food contained therein.



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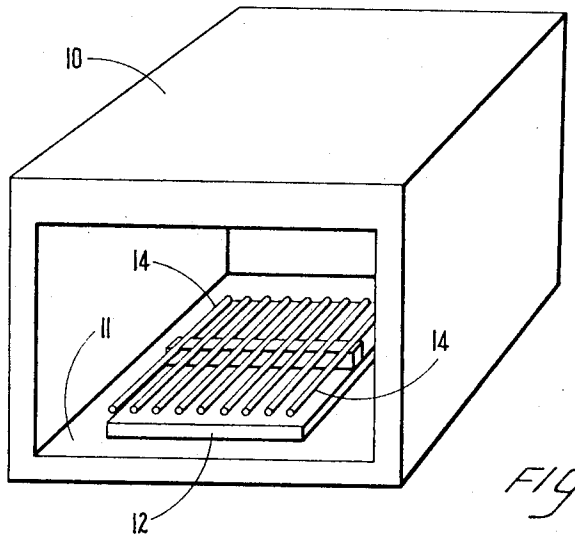

FIG. 1

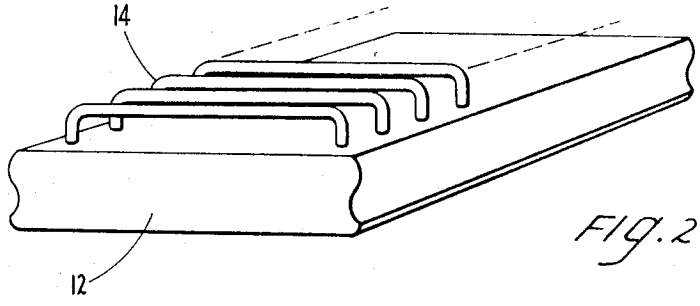

FIG. 2

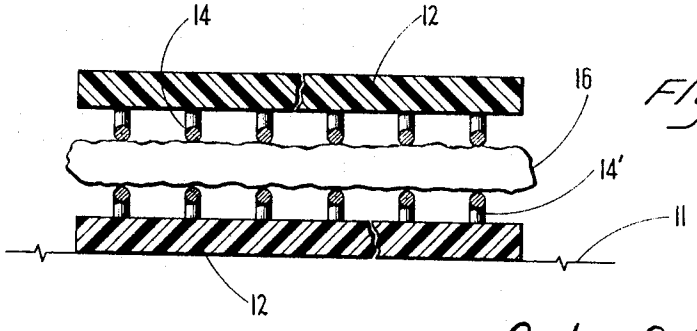

FIG. 3

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BROWNING APPARATUS FOR USE IN A MICROWAVE OVEN

BACKGROUND OF THE INVENTION

The present invention pertains generally to microwave cooking, and in more particular to a microwave coupling/thermal conducting device located within the oven for causing a browning of the food contained therein.

One of the early dissatisfactions noticed with food that had been cooked by the use of microwave energy was the absence of a browning of the food. It is desirable to brown food cooked in a microwave oven for two principal reasons. First, browned food has a more acceptable appearance, and more important, in many cases browned foods taste better. Both of these factors are important marketing factors in the acceptability of microwave ovens.

Certain bulky foods tend to brown because of prolonged heating periods required to cook them and because of the attendant surface concentration in the heating of the foods. However, these effects are not appreciably present in most foods. Therefore, one approach was to use several different kinds of coatings to enhance surface coloration. One such attempt used additives to enhance browning. The disadvantages associated with the use of additives was that they had to be carefully controlled so that the flavors and texture characteristic of the foods was not altered by their use.

Another method investigated involved use of a high-loss dielectric material placed adjacent to the food to be cooked. The high-loss properties of the dielectric caused it, upon microwave radiation, to attain higher temperatures than adjacent food. Some browning of the food was caused by the radiation from the hotter high-loss dielectric material. However, the concentration of heating by this process was inefficient and the placement of the dielectric material was difficult to control. In addition, this technique caused food contamination and the equipment tended, in general, to be both expensive and fragile.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide improved thermal food browning apparatus.

It is a further object of the present invention to provide thermal food browning apparatus that is moderately priced, easy to fabricate, and extremely durable.

It is still another object of the present invention to provide an apparatus that efficiently browns the food leaving an appearance of searing or broiling.

A further object of the present invention is to provide food browning apparatus that uses resonant inductive browning means.

The aforementioned objects are provided in the present invention by the use of a plurality of metal rods, each having a length that is a multiple of a half wavelength with reference to the microwave source frequency and with the rods supported in relatively close proximity to or in contact with the food being cooked. In one embodiment, these metal rods are embedded in and supported by a dielectric such as a fiber glass board. Food is in contact or close proximity to these rods, which can be arranged on both sides of the food. The use of the half wavelength metal rods which respond to the microwave source causes an increase in the microwave currents on the surface of the rods and effectively causes the browning of the food contained in the oven.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** shows a microwave oven that has thermal browning apparatus,

FIG. **2** shows one embodiment of the thermal browning apparatus of the present invention, and

FIG. **3** is a cross-sectional view showing a piece of food located between a double row, rod arrangement.

DETAILED DESCRIPTION

Referring in particular to FIG. **1**, there is shown microwave oven **10**, which can be any of a variety of conventional ovens using microwave energy for cooking. Within oven **10** there is disposed a dielectric board **12** positioned on the bottom **11** of the oven interior. This board **12** may be made of fiber glass, ceramic, plastic or similar dielectric material. The board is designed to support a plurality of metal rods **14**. The rods **14** are supported at a fixed distance above the board **12** by a center support. Food **16** may be placed on and supported by, rods **14**. The oven **10** includes a microwave radiating source (not shown) for cooking the food. By making the lengths of the rods **14** integer multiples of a half wavelength with respect to the frequency of the microwave source, there is caused a resonant increase in the microwave currents on the surface of the rods. By the use of a resistive metal for rods **14**, the resonant currents will cause the rods to attain much higher temperatures than the average temperature of the food. One such desirable rod was found to be one made of stainless steel. This material also had the advantage of not contaminating the food and is a noncorrosive material which can be easily cleaned. Similarly board **12** should be made of a material which is easy to clean. The rods **14** should also have a low thermal mass so that high food heating efficiency is retained. Stainless steel is a moderately priced material which is easy to fabricate and extremely durable and refractory, for the purpose.

With the use of apparatus similar to that shown in FIG. **2**, at 2,450 Megahertz, a Fiberglas board (0.060 inch thick) was drilled with two rows of half-inch spaced holes. The rows were 2.4 inches apart and 0.048-inch diameter stainless steel rods with their ends bent to match this separation were inserted into the board. The food, which was a small steak, was supported in the center of the oven with similar resonant grids on both sides as shown in cross section in FIG. **3** where rows **14** and **14'** of rods are suitably supported in parallel arrangement by boards **12**. The steak was cooked to a medium rare condition, surface grid browned after 40 seconds of exposure to the microwave energy levels provided by one particular oven.

As a matter of convenience, the frames of dielectric bases **12** may be freely movable within the oven so that they may be placed on top of the food for top browning. The number and spacing of the rods may vary depending upon the amount of heat desired for browning of the food.

With the use of a microwave source that is oriented on the top of the oven and with the further use of rod grids above and below the food product, more browning is observed on the top surface of the food than on the bottom. This is caused by the shadowing effect provided by the top rod structure. This condition may be varied to provide essentially equal browning on both surfaces of the food by providing for two microwave source feeds, one from the top and the other from the bottom of the oven **10**. Similarly, if a single microwave source is used, this can be coupled with a hybrid coupler to provide dual, top and bottom feeds.

An alteration in the length of the metal rods to correct for the dielectric loading of the adjacent food has been found to be not required. This is probably due to the limited contact made by the rods with the irregular surface of the food.

Certain modifications also are contemplated as falling within the scope of the present invention. For example, various shapes of support boards can be used and also different shaped rods arranged in nonparallel and other configurations.

What I claim is:

1. Microwave coupling thermal conducting device for generation of thermal energy for use in the browning of food products, said coupling device being contained in a microwave oven including a microwave source and comprising a plurality of metal rods, each having a length that is substantially a multiple of a half wavelength with respect to the frequency of the microwave source, dielectric means supporting said rods in spaced relation to each other with said rods

positioned to contact food being cooked and to respond to the microwave source energy causing an increase in microwave currents on the surface of said rods thereby generating the heat required for browning of the food at least in the areas where the food is touching said rods.

2. Microwave coupling device as defined in claim 1 wherein said plurality of metal shaped rods are each parallel one to the other.

3. Microwave coupling device as defined in claim 1 wherein said dielectric means are freely movable within said oven.

4. Microwave coupling device as defined in claim 2 and further including a dielectric support board with said rods supported thereon.

5. Microwave coupling device as defined in claim 1 and further including a second plurality of metal rods, and a second dielectric means supporting said second plurality of rods, each of said rods having a length that is a multiple of a half wavelength with respect to the frequency of the microwave source and supported in relatively close proximity to the food being cooked, said second plurality of metal rods adapted for arrangement in facing relationship to said first plurality of rods on the other side of the food.

6. Microwave coupling device as defined in claim 5 wherein said metal rods of said first plurality are all parallel to each other and the metal rods of said second plurality are all parallel to each other, and further wherein said first and second plurality of metal rods lie respectively in parallel planes.

7. In a microwave oven including a source of microwave energy, apparatus for use in the browning of foods comprising dielectric supporting means, a plurality of elongated metal elements supported along at least a portion by said dielectric supporting means, said elements being spaced with a surface of at least one of said elements contacting the food being cooked and to respond to the microwave source energy thereby causing concentrated heating of the food in the area surrounding the contacting surface of the element.

8. Apparatus as defined in claim 7 wherein said plurality of metal elements includes a plurality of rods spaced from each other and wherein said dielectric supporting means includes an extending supporting portion coupled to said rods at a portion intermediate the ends of said rods.

9. Apparatus as defined in claim 7 wherein said plurality of metal elements includes a plurality of rods spaced from each other having ends that are supported by said dielectric supporting means.