HEATING AND LOADING IMPLEMENT FOR MICROWAVE ENERGY

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ABSTRACT

A process and an implement for converting microwave energy into heat energy which includes a body having a plurality of resistive particles therein. Upon subjecting the particles to microwave irradiation, a plurality of electric arcs are generated throughout the particles, thereby resulting in the microwave energy being converted into heat energy, and the electric arcs serving as a load for the microwave irradiation source. The implement is particularly useful with microwave ovens.

11 Claims, 8 Drawing Figures
HEATING AND LOADING IMPLEMENT FOR MICROWAVE ENERGY

CROSS-REFERENCES TO RELATED APPLICATIONS

This application is a continuation-in-part application of my copending applications, U.S. Ser. No. 470,809, now abandoned, filed July 9, 1965, and U.S. Ser. No. 483,144 now abandoned, filed Aug. 27, 1965.

BACKGROUND OF THE INVENTION

This invention relates to an implement which in response to microwave irradiation is capable of processing and/or cooking a load. More particularly, this invention relates to an implement capable of converting microwave energy into heat energy which may thence be directed to an object to be processed.

Microwave ovens are extremely useful as cooking ovens; however, with conventional type microwave ovens, the searing, browning and crusting of foods constitutes a problem and requires either additional gas or electric heating elements in the microwave oven or the use of an externally located heating apparatus not related to the microwave oven. It is apparent that the heretofore methods employed for searing, browning and crusting are cumbersome, costly, time-consuming and generally unappealing to the users thereof.

Accordingly, one of the objects of this invention is a process for converting microwave energy into heat energy.

Another object of this invention is to provide an implement directly associated with microwave ovens so as to lend versatility to the cooking of foodstuffs. Advantageously, foodstuffs can be fried, roasted, grilled and baked with the desired crusting surface thereon.

Another object of this invention is to provide a microwave oven capable of cooking a foodstuff with a desired crusting surface thereon.

Still another object of this invention is to provide an implement for a microwave oven which, per se, is capable of acting as a dummy load for a microwave emitting source.

SUMMARY OF THE INVENTION

According to the objects of this invention, an implement, preferably taking the form of a cooking utensil or microwave oven shelf, is provided with a plurality of relatively small particles of resistive material therein. In response to receipt of microwave irradiation from a microwave source, a multitude of electric arcs are generated throughout the particles, thus resulting in the emitted microwave energy being converted into heat, and the electric arcs serving as a load for the microwave source.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and a fuller understanding of the invention may be had by referring to the drawings wherein:

FIG. 1 is a cross-sectional view of the implement taking the form of a cooking utensil;

FIG. 2 is a cross-sectional view of another embodiment of the implement taking the form of a "hot cube";

FIG. 3 is a cross-sectional side view of a microwave oven having incorporated therein another embodiment of the implement in the form of a shelf;

FIG. 4 is a view taken along line 4—4 of FIG. 3;

FIG. 5 is a cross-sectional side view of a microwave oven having incorporated therein another embodiment of the implement in the form of a shelf;

FIG. 6 is a cross-sectional front view of a microwave oven having incorporated therein another embodiment of the implement in the form of two shelves;

FIG. 7 is a cross-sectional side view of a microwave oven having incorporated therein another embodiment of the implement in the form of an electrical charcoal grill; and

FIG. 8 is a partial cross-sectional, plan view of another embodiment of the implement in the form of a grill-shelf.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to the drawings, it will be apparent that the inventive implement may be constructed and utilized in various embodiments. According to one embodiment, as seen in FIG. 1, an implement I is in the form of a cooking utensil and includes a body 10 which is permeable to microwave irradiation and preferably made of glass-ceramic type material, such as Pyroceram (manufactured by Corning Glass Works) or Cer-Vit (manufactured by Owens-Illinois). Located within body 10 is a bed or layer of particles 11 of a resistive material supported on an insulating medium 12 which may be of a material such as GR-25 (manufactured by General Refractories Company). A good heat conducting element 13, in the form of a plate, copper strips, rods, etc., is preferably located in contact with the particle bed 11. The heat conducting element 13, as illustrated in FIG. 1, preferably is a flat copper plate provided with openings 15—15 therethrough to permit the free random passage of microwave waves to and through the particles. In the event it is desired to utilize implement I, as a dummy load, per se, for a microwave emitting source, the heat conducting element 13 may be provided with a plurality of fins 16—16, as seen in phantom, which extend from the implement structure to cause a free release of heat therefrom. A top processing surface 17, made of a material similar to body 10, is in contact with heat conducting element 13, and is attached to the body at 18 by a suitable adhesive.

It has been found that the resistive particles 11 are, in actuality, a plurality of electrodes which support a plurality of spark gaps to discharge microwave energy therebetween. There are innumerable solid metals which will support an electric gap or arc. For example, the particles may be of a ferrite material having a high resistance to produce a relatively cool spark, when it is desired to use the implement as a household cooking utensil. On the other hand, a carbon material which possesses low resistance and produces a relatively hot spark may be utilized, when the implement is desired to be used in a refractory process for vaporizing metals. With the latter, ultra high heat temperatures may be obtained when considering carbon's melting point (approximately 6,500°F).

With respect to the heat insulation 12, it is of a material, such as described above, which is permeable to microwave energy and not lossy or self-heating when exposed to microwave energy. The heat insulation has a dual purpose; firstly, to direct the heat to the work load and, secondly, when the implement is used as a
While the implement has heretofore been discussed with respect to its use as a portable type article; namely a cooking utensil, "hot cube," body warmer and the like, the implement also may take the form of a shelf or shelves in a microwave oven. As seen in FIG. 3 and 4, there is illustrated a microwave oven 25 which is provided with a conventional microwave source 26, such as a generator or magnetron, for supplying microwave energy into cavity 27 through waveguide 28. An implement, generally referred to as \( I_1 \), takes the form of a shelf and includes a supporting element 30 for holding a ceramic type body 10c. Located within the body 10c is an insulating medium 12c having positioned thereon a plurality of resistive particles 11c. A heat conducting element 13c, having an opening 15c extending therethrough, is disposed in contact with the particles and the top portion 17c of body 10c, the top portion 17c being capable of receiving a foodstuff "F" thereon through closure 31.

The supporting element 30 is pivotally adjustable at pivot 32 located near the rearmost portion of the oven and is provided with cooperating adjustable pins 33 near the foremost portion of the oven for insertion into various openings 34—34 for locking the implement-shelf \( I_2 \) in a desired angular position. As a result of the angular position of the implement-shelf \( I_2 \), any by-products of cooking, such as rendered fat, which results from the operation of the microwaves and implement as previously described, will pass by gravity through opening 35 of a downwardly converging bottom 36 into a portable container 37 for subsequent use or disposal.

As seen in FIG. 5, there is illustrated another embodiment of the invention wherein the implement, referred to as \( I_3 \), takes the form of an upper shelf in an oven 25d. The oven is similar to the oven in FIGS. 3 and 4 with the exception that the implement-shelf \( I_2 \) is in an inverted position. As seen in FIG. 5, the implement-shelf \( I_2 \) rests on supporting elements 33d—33d and includes a bottom ceramic or quartz radiant panel 10d. An insulating medium 12d is provided on the top side of the shelf and houses a bed of resistive particles 11d therein. The insulating medium 12d herein takes on the added function of dividing the oven cavity so as to create a hot lower cavity and a relatively cooler upper cavity. A conventional bottom shelf 35, permeable to microwave energy, is provided on supporting elements 36—36 for holding a utensil 37 with a foodstuff, "F," thereon.

The operation is similar to that previously described with respect to the oven in FIGS. 3 and 4. Typically, the microwave generator is turned on and the implement shelf \( I_3 \) is preheated until the radiant panel 10d reaches such a point that it becomes hot, whereupon a foodstuff is placed under the radiant shelf. The foodstuff is cooked from both the microwave irradiation and the infra red radiation. Additionally, if an extra heavy, relatively darker crust is desired on the foodstuff, e.g., one which is cooked rare, the implement-shelf \( I_3 \) may be modified by conventional means to be movable, thus enabling the implement-shelf to be positioned into intimate contact with the foodstuff for a suitable period of time.

FIG. 6 discloses still another embodiment of the invention wherein the implement, referred to as \( I_1 \), takes the form of a pair of implement-shelves which may either be fixed or movable with respect to each

3 cooking utensil, to protect the cook and confine the heat generated by the arcing from a table subsequently receiving the implement.

Regarding the body or casing 10, it should be of a material, such as stated above, which is permeable to microwaves and not lossy or self-heating when exposed to microwave energy. The body is used to protectively contain the fragile heat insulating material and the loose pile or layer of resistive particles. Generally, the body or casing is constructed by sealing two portions together, one portion holding the particles and the other enclosing the particles and serving as a cooking surface.

With respect to heat conducting element 13, it is of a material, such as stated above, which is capable of equalizing the heat generated. The heat conducting material may be of the same material as the resistive particles or of a material complementary thereto, such as copper having a low resistance and ferrite having a high resistance. It is apparent, however, that materials having a low melting point, such as aluminum, may not be used with materials having a high melting point, such as carbon, when temperatures in excess of the low melting point material are required.

In operation, the implement is located in a suitable microwave cavity (not shown) and exposed to microwave irradiation, the microwaves contacting the particles 11. In response thereto, a plurality of electric arcs are generated throughout and between the particles 11 and the heat conducting element 13. Within a relatively short time, the particle bed appears as a glowing bed of coal emitting a high degree of heat in excess of 1,000°F. The amount of heat generated is dependent upon the amount and size of the resistive particles, the quantity of the released microwave energy and the time. The microwave arcing tends to terminate the released microwave power and, as a result, precludes a sufficient degree of reflection of microwave power back to the source, thereby preventing any damage thereto. It is apparent that the higher the output power of the microwave generator, the more resistive particles required to properly terminate it.

FIG. 2 is illustrative of another embodiment of the implement, referred to as \( I_1 \), which takes the form of a "hot cube." Implement \( I_2 \) includes an outer coating 10b of a suitable microwave permeable material, such as glass-ceramic, epoxy and, in this instance, preferably cardbord. A simple heat insulating material 12b, such as sand concrete or castable refractory material, is located within the outer coating 10b and completely envelops a bed of resistive particles 11b of a material such as a relatively inexpensive high-grade iron ore.

After exposure to microwave irradiation, the heat stored within the "hot cube" releases and can be used advantageously as a warmer for articles or animals. For example, the "hot cube" may be easily inserted into insulating containers (not shown) whereupon the stored heat releases from the "hot cube" to heat or cook a foodstuff in proximity thereto. Similarly, the "hot cube" may serve as a body warmer for people. The duration of the released heat is commensurate with the size and type of insulation coupled with the quantity of microwave irradiation of the particle bed. Significantly, in view of this low cost of fabricating a "hot cube," such may be marketed as a disposable item.
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5 other. As seen therein, lower implement-shelf Ia rests on adjustable supporting elements 33e and is provided with a bottom portion 12e, a bed of particles 11e and a top insulating portion 10e which cooperates with the bottom portion to encase the particle bed. Similarly, upper implement-shelf Ib rests on adjustable supporting elements 33e and is provided with a top portion 10e, a bed of resistive particles 11e, and a bottom insulating portion 12e which encases the particle bed in cooperation with the top portion. Optionally, a rotating spit 40 driven by a chain 41 connected to a motor (not shown) may be employed.

The implement shelves Ia—Ib may be moved as desired, i.e., towards each other, either separately or together or into contacting or nearly contacting relationships with the foodstuff "F" to obtain additional crustling on opposite sides thereof, in a similar manner as discussed with respect to FIG. 5. It should be noted that while manual means are illustrated to show relative movement of the shelves, suitable conventional mechanical or electromechanical means may be employed without departing from the invention.

FIG. 7 discloses still another embodiment of the invention and in its simplest structure, wherein the implement, referred to as Ia, takes the form of a microwave charcoal grill. Implement Ib is comprised of a body 10f having a plurality of resistive particles 11f therein. Typically, a ceramic or metallic grill 43, illustrated with a foodstuff "F" thereon, may either be placed on or above the particle bed 11f.

A microwave irradiation source 26f is located in the bottom portion of the oven 27f and, when energized, emits waves through waveguide 27f. The top portion of the oven is provided with a grid 45 having relatively small openings 46—46. The openings 46—46 are sufficiently small so as to confine microwave energy therein, yet sufficiently large to permit the passage of air therethrough for disposal of by-products of combustion. Upon energization of the microwave source 26f, conversion of the microwave energy into heat energy results in a similar manner as hereinbefore described. It should be noted that if the resistive particles 11f are of a material, such as carbon, which will ignite when heated in the presence of air, the burning carbon, burning fat and the microwave energy will swiftly barbeque the foodstuff "F."

FIG. 8 discloses still another embodiment of the inventive implement wherein the implement, referred to as Ia, is capable of taking the form of a grill-shelf which may be used as a substitute for implement shelf Ib, illustrated in FIG. 3. Here a ceramic frame 50 holds hollow ceramic or quartz tubes 51 filled with a plurality of resistive particles 52.

In operation, grill shelf Ib is positioned in a microwave oven and preheated whereupon a foodstuff, such as a frozen steak, is placed thereon. With the aid of the energy from the microwave source, the steak is defrosted and cooked with a resultant grill pattern thereon which is similar to that obtained in prior art steak grilling, the gravy juice being collected in container 37. Additionally, the ceramic frame implement Ib remains cool and can be easily transported with the steak thereon to a receiving table.

It is to be understood that the above described arrangements of the various implements are illustrative of the application of the principal of the invention, each implement employing, at least, a plurality of resistive particles therein capable of receiving and converting microwave energy into heat energy. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention. Accordingly, it is to be understood that the present invention is to be limited only by the spirit and scope of the appended claims.

I claim:

1. In combination, means defining an oven cavity, a source of microwave energy connected to said cavity, an implement in said cavity, comprising:

   a body permeable to microwave energy, said body containing a plurality of resistive particles so disposed, which when exposed to microwave irradiation, results in a multitude of arcs being generated therethrough so as to convert said microwave irradiation into heat energy.

2. In an oven, cavity, according to claim 1, wherein said microwave permeable body is electrically insulated.

3. In an oven cavity, according to claim 1, wherein the resistive particles are of a ferrite material.

4. In an oven, according to claim 1, wherein the implement further includes a heat conducting element having at least one opening therein for permitting the passage of microwave irradiation to the resistive particles to load the microwave emitting means and to permit an equal distribution of heat for a workload.

5. In an oven, cavity, according to claim 2, wherein the implement is provided with at least one surface forming a shelf and said cavity is provided with means for adjustably supporting said body.

6. In an oven, according to claim 2, wherein the cavity contains a second said implement supported by said adjustably supporting means.

7. In a microwave oven having a shelf and means for emitting microwave energy into said oven, the improvement in said shelfing comprising:

   a first member of a microwave permeable material shaped to conform to the interior perimeter of the cavity with which it is to be used,

   a second member of a microwave absorptive material, and

   a plurality of rods of a heat conducting material embedded within the second member and arranged in a preselected pattern which will convey the heat generated within the material of said second member in the presence of microwave energy to an oven load, said second member and said rods being so disposed that the heat generated within said absorptive material is conducted to said first member.

8. An implement for heating an article for use in an oven chamber receptive to microwave radiation comprising:

   a first member of a microwave permeable material,

   a second member of a microwave (energy) absorptive material, and

   a heat conducting member in a preselected relationship with said second member for conducting the heat generated by said second member in the presence of microwave energy to said first member.
9. An implement, according to claim 1, wherein a portion of said body is of heat insulating material.

10. An implement, according to claim 9, wherein said body includes means for supporting an article in heat conducting relationship with said particles.

11. An implement according to claim 10, wherein said means is a grill.

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