United States Patent

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[54] **SOLID STATE MICROWAVE OVEN**
4 Claims, 10 Drawing Figs.

[52] **U.S. Cl.** **219/10.55,** 331/107; 219/10.75
[51] **Int. Cl.** **H05b 9/06,** H05b 5/00
[50] **Field of Search** 219/10.55; 331/107

[56] **References Cited**

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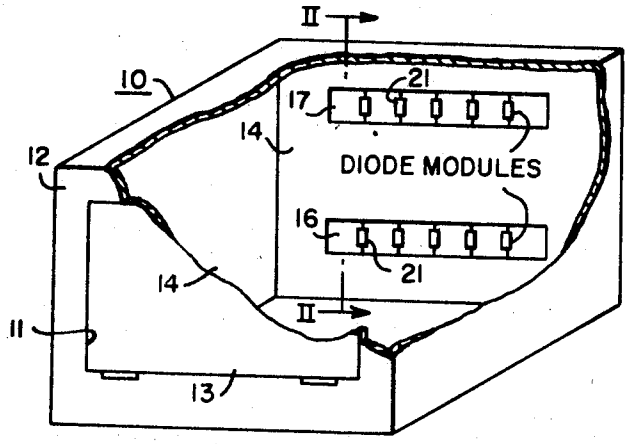
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ABSTRACT: Apparatus for the treatment of materials by the application of heat for rapidly drying, cooking or the like, of the materials. The apparatus is characterized by the provision of a plurality of solid state oscillators, generating frequencies in the microwave region, the number and location of oscillators being such as to provide uniform distribution of the energy.



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SHEET 1 OF 2

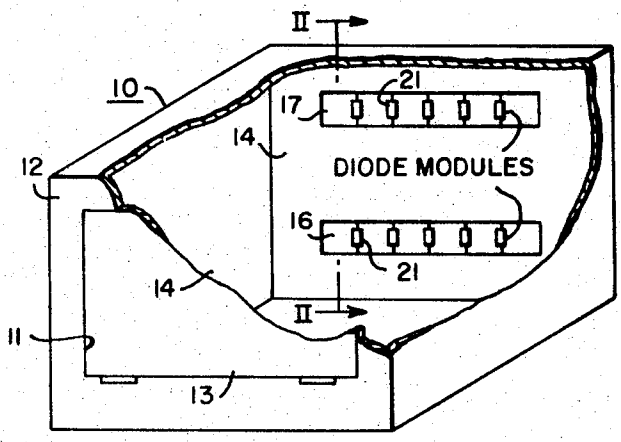


FIG. 1.

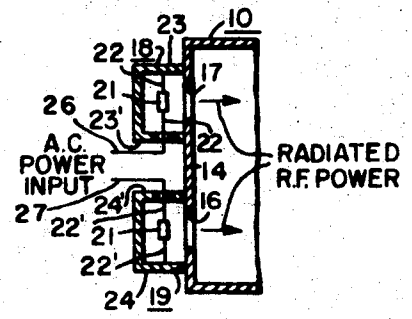


FIG. 2.

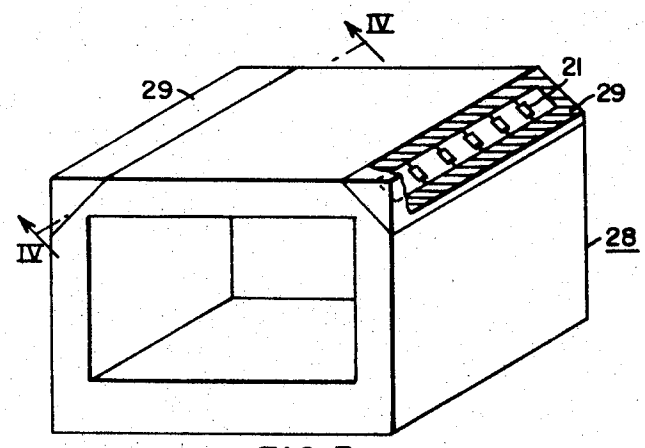


FIG. 3.

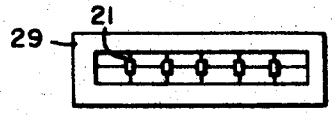


FIG. 4.

WITNESSES

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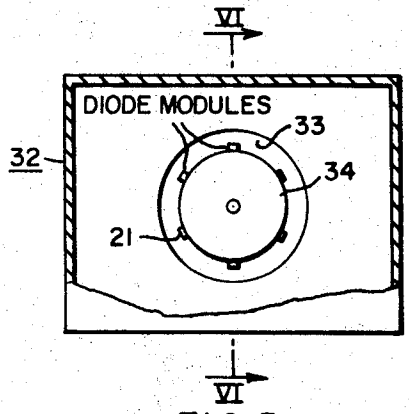


FIG. 5.

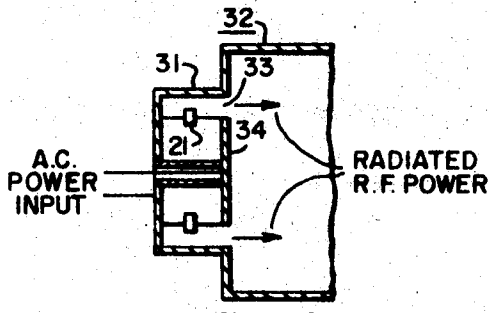


FIG. 6.

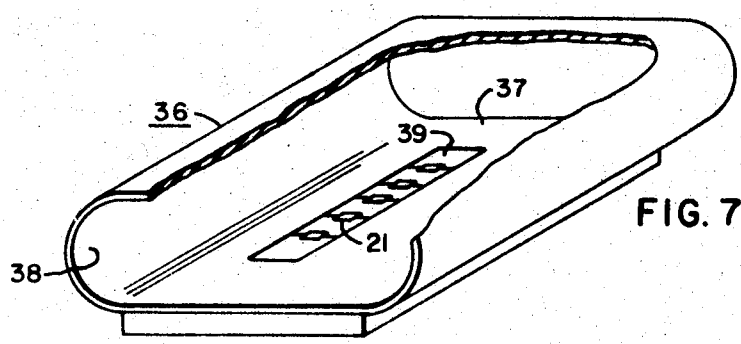


FIG. 7.

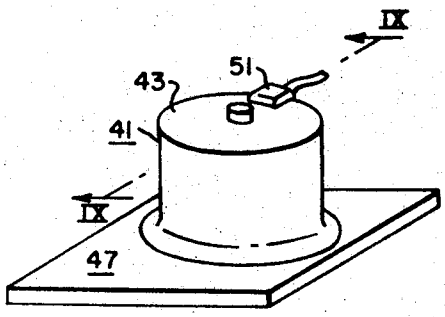


FIG. 8.

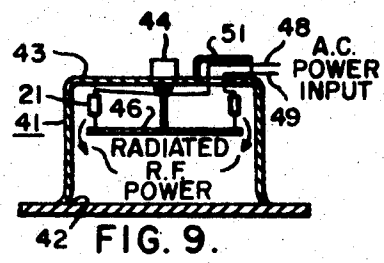


FIG. 9.

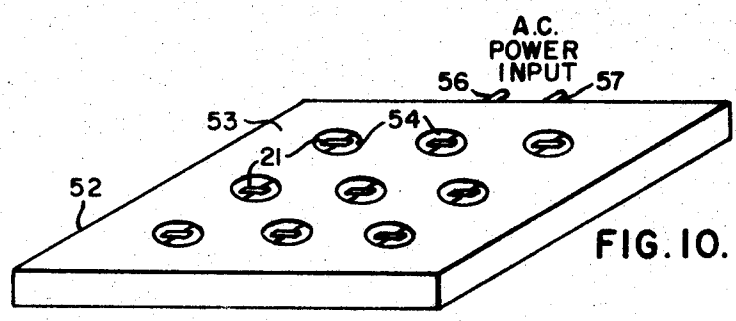


FIG. 10.

SOLID STATE MICROWAVE OVEN

BACKGROUND OF THE INVENTION

This invention relates, in general, to the exposure to electromagnetic radiation, of materials in a resonator facility and, more particularly, to the source and distribution for such a facility.

It is well known that conventional microwave generating facilities, for example, magnetrons, have a relatively short life span. The feasibility of redundancy by utilizing conventional components has been considered, however, as will be appreciated by those skilled in the art, it is not practical since the duplication of components would increase the existing problem of available space, particularly in domestic devices and commercial devices such as those which would be utilized in aircraft.

While the mean time to failure, of magnetrons, is on the order of 500 hours, there is no guarantee that they will not fail before the first cycle of operation has been completed. Since all known systems employ a single magnetron, the ramifications of such a failure are quite apparent. Furthermore, because of the practice, dictated by economics and space problems, of employing a single magnetron, the cavity or oven configuration is limited to that of a cube or rectangular parallelepiped. While it has been taught in the prior art to employ two magnetrons, they operate at different frequencies to provide simultaneous deep penetration and shallow penetration of the material. Such a teaching does not provide freedom of cavity, configuration design nor does it eliminate the potential frustration of the intended purpose.

Accordingly, a general object of this invention is to provide a new and improved materials treatment apparatus utilizing electromagnetic radiation.

It is a more particular object of this invention to provide, in materials treatment apparatus, an energy source which lends itself to departing from enclosure configurations utilized the prior art.

Another object of this invention is to provide, in a microwave oven, microwave generating structure having a mean time to failure, on the order of 10 times that heretofore experienced in such devices.

It is another object of this invention to provide a microwave source suitable for readily converting a conventional cooking oven to a microwave oven.

Yet another object of this invention is to provide a microwave cooking device requiring a relatively small energy source.

BRIEF SUMMARY OF THE INVENTION

Briefly, the above-cited objects are accomplished by the provision, in one embodiment of the invention, of a number of solid state oscillators which generate frequencies in the microwave region of the spectrum. The number and location of the oscillators is such as to provide mode mixing of the microwaves to thereby effect uniform heating of the material. This arrangement, therefore, where the energy source and the mode mixing means are one and the same, is defined as an active mode mixing system.

In another embodiment of the invention, a plurality of oscillators are disposed in an open end container or lid which fits over a pan or a metal sheet to form a cavity wherein materials may be exposed to the energy source.

Another embodiment of the invention constitutes a plug-in module tray employing microwave oscillators. The module tray serves to convert a conventional cooking oven to a microwave cooking oven.

Further objects and advantages of the present invention will become apparent when considered in view of the following detailed description and drawings forming a part hereof.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a somewhat diagrammatical perspective view, partly broken away, of an oven representing one embodiment of the invention;

FIG. 2 is a cross-sectional view taken along the line II–II of FIG. 1;

FIG. 3 is a somewhat diagrammatical view, partly broken away, of an alternate form of the embodiment of the invention shown in FIG. 1;

FIG. 4 is a cross-sectional view taken along the line IV–IV of FIG. 3;

FIG. 5 is an elevational view, in cross section, of an alternate form of the embodiment of the invention shown in FIG. 1;

FIG. 6 is a cross-sectional view taken on the line VI–VI of FIG. 5;

FIG. 7 is a perspective view of an alternate form of the embodiment illustrated in FIG. 1;

FIG. 8 is a perspective view of a cooking lid representing a modified embodiment of the invention shown in FIGS. 1—7;

FIG. 9 is a cross-sectional view taken on the line IX–IX of FIG. 8; and

FIG. 10 is a perspective view of a plug-in module tray representing a third embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings and especially FIGS. 1 and 2, reference 10 character designates generally a cooking oven or enclosure having an access opening 11 in a first wall 12 thereof. An enclosure is defined as structure for confining electromagnetic energy. A door structure 13 serves to close the opening 11 during operation of the oven. A rear wall 14 of the oven is provided with a pair of elongated slots 16 and 17 providing communication between the interior of the oven and a pair of channels 18 and 19 provided in the rear wall 14. A plurality of solid state modules 21 having their leads 22 and 22′ attached to opposite walls 23, 23′, and 24, 24′ delineating the channels 18 and 19 and are thereby supported therein. The modules 21 comprise microwave oscillators preferably of either the Gunn or Avalanche Transit Time type. The operation and construction of such oscillators are discussed in an article "Recent Advances in Solid State Microwave generators," at pages 71—80 of Advances in Microwaves, Vol. 2, 1967, Academic Press Inc., New York. Input leads 26 and 27, across which a varying electrical potential is impressed are connected to the module leads as indicated in FIG. 2.

FIGS. 3—6 illustrate various spatial arrangements which may be occupied by the modules 21 in, for example, a rectangular cavity. As shown in FIGS. 3 and 4, the modules 21 are supported in the upper corners of an oven 28 by angulated supports 29. In FIGS. 5 and 6 the modules 21 are supported in an annular channel 31 communicating with the interior of an oven 32 to a slot 33 of circular extent, in a rear wall 34 of the oven 32.

An oven 36 (door removed), as shown in FIG. 7, has an oval-shaped cross section with modules 21 disposed, contiguous a bottom segment 37 of an annular wall 38 and in an elongated radiating slot 39 in the segment 37. Such a configuration, as shown in FIG. 7, is made feasible by the incorporation of the modules 21, and as shown is suitable for use as a "table top" oven.

FIGS. 8 and 9 show a lid 41 having an open end 42 and a closed end 43. The lid is provided with a knob or handle 44 for manipulation thereof. A plurality of modules 21 are supported within the lid 41 intermediate the end 43 and a plate 46 therein. The lid cooperates with a sheet metal sheet 47 or a pan (not shown) to form a resonant cavity for cooking foodstuffs requiring relatively small microwave energy output. The input to the module 21 is accomplished through leads 48 and 49 in a plug connector 51.

Turning now to FIG. 10, there is shown a plug-in tray structure generally indicated by reference character 52. The tray structure 52 comprises a rectangularly shaped module support having a top wall 53 provided with a plurality of coupling apertures 54 with modules 21 connected thereat. AC power is supplied to the modules by terminals 56 and 57 which are

adapted to be received in a female receptacle of a conventional oven now shown.

Since numerous changes may be made in the above described apparatus and different embodiments of the invention may be made without departing from the spirit thereof, it is intended that all matter contained in the foregoing description or shown in the accompanying drawings, shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. A microwave device for heating materials, said device comprising:
   a. a tray structure;
   b. said tray structure being flattened and rectangularly spa shaped and having a top wall;
   c. said top wall having a plurality of apertures;
   d. a solid state module disposed in each of said apertures, each of said solid state modules functioning as a microwave oscillator;
   e. leads extending from opposite sides of each of said modules and physically connected to walls forming the outline of each of said apertures for supporting said modules in said tray structure;
   f. a pair of input terminals extending into said tray structure for series connection to said solid state modules; and
   g. whereby said tray structure may be utilized in conjunction with a conventional oven to provide it with a microwave heating capability.

2. A microwave device for heating materials, said device including:
   a. a surface;
   b. said surface having aperture means;
   c. solid state module means disposed in said aperture means, each of said solid state module means functioning as a microwave oscillator;
   d. leads extending from opposite sides of each of said module means and physically connected to walls forming the outline of said aperture means for supporting said module means in said surface;
   e. a pair of input terminals extending into said surface for series connection to said solid state modules;
   f. said solid state modules being serially connected; and
   g. whereby said solid state modules provide microwave heating.

3. A microwave device for heating materials, said device including:
   a. a lidlike portion;
   b. a supported plate spatially displaced from said lidlike portion;
   c. said lidlike portion including a closed end;
   d. solid state module means disposed between said closed end and said supported plate for functioning as microwave oscillator means;
   e. leads extending from opposite sides of each of said module means and physically connected to said closed end and said supported plate for supporting each of said module means in said lidlike portion;
   f. a pair of input terminals extending into said tray structure for series connection to said solid state modules;
   g. said solid state modules being serially connected;
   h. whereby said solid state modules provide microwave heating.

4. The microwave device for heating materials set out in claim 3 wherein:
   a. said lidlike portion has an open end;
   b. said open end is closed by mounting said lidlike portion on a pan element; and
   c. whereby said lidlike portion and said pan element form an enclosure for said solid state module means.