A microwave oven is disclosed which eliminates the need for a wave guide and mechanical stirrer while achieving an even distribution of microwave energy within the oven cavity. The microwave oven comprises a housing having an oven cavity defined by conductively bound surfaces. One of the surfaces, preferably the bottom surface, is of a horn-like structure having diverging surfaces facing the interior of the cavity. An aperture is located at the center portion of the horn-like structure to receive the radiating portion of a magnetron tube to enable the magnetron to feed microwave energy directly into the oven cavity. The outer portion of the diverging surfaces adjoins a cylindrical surface, the radius of the cylinder being a multiple of the wave length of the radiated microwaves.
MICROWAVE OVEN HAVING A MAGNETRON EXTENDING DIRECTLY INTO THE OVEN CAVITY

BACKGROUND OF THE INVENTION

1. Field of the Invention
   The present invention relates generally to microwave ovens and more particularly to microwave ovens in which the source of microwave energy radiates directly into the oven cavities.

2. Description of the Prior Art
   In present day conventional microwave ovens, the magnetrons, or other microwave generators, are usually positioned entirely outside of the oven cavities. In the constructions of this type, the radiating portions of the tubes communicate with the oven cavities via wave guides. These wave guides are usually rectangularly or cylindrically shaped, having one end enveloping the radiating portion of the magnetron, and the other end communicating with a rectangular feed box which, in turn, opens into the oven cavity.
   Present day microwave ovens also have mechanical stirrers positioned either within the feed boxes or within the oven cavities adjacent the openings of the feed boxes in order to assist in evenly distributing the microwave energy throughout the oven cavities.
   Although present day microwave ovens operate adequately, they have a shortcoming in that the wave guides and mechanical stirrers add to the cost of manufacture of the ovens and it would be highly desirable to eliminate these constructions.
   Assignee's predecessor, the Franklin Oven Division of the Studebaker Corporation, attempted to eliminate the wave guide by extending the radiating ends of the magnetron tubes directly into the oven cavities. This structure is shown in U.S. Pat. Nos. 3,281,567 and 3,308,261, presently assigned to the Assignee of the present application.
   However, it was found that the ovens of this type had very poor heating patterns and, as a result, still required mechanical stirrers to assist in the distribution of microwave energy within the cavities.
   The microwave ovens disclosed in U.S. Pat. Nos. 3,127,494 and 3,127,495, also presently assigned to the Assignee of the present application, eliminated the need for mechanical stirrers by providing a "concentrator" 32 which functioned to focus the microwave energy directly into the foodstuff. The shortcoming with this construction was that the microwave energy was concentrated on the central portion of the cavity cooking shelf, leaving the outer areas of the shelf with a much lower concentration of energy. Moreover, the magnetrons in these ovens were physically separated from the oven cavities and required wave guides to communicate therewith.

SUMMARY OF THE INVENTION

The present invention obviates the above-mentioned shortcomings by providing a microwave oven that eliminates the need for a wave guide and stirrer, while achieving an even distribution of energy within the oven cavity. In its broadest aspect, the present invention pertains to a microwave oven having an oven cavity defined by conductively bounded surfaces, one of the surfaces being composed of surface elements which extend from a specific area toward adjoining wall surfaces at internal angles which are greater than 90°. A source of microwave energy is mounted in the specific area to feed microwave energy directly into the cavity. In this manner, the one surface functions to evenly distribute the microwave energy throughout the oven cavity.

The outer portions of the one surface adjoin a cylindrical surface the radius of which is a multiple of the wave length of the radiated microwaves.

The features of the present invention which are believed to be novel are set forth with particularity in the appended Claims. The present invention, both as to its organization and manner of operation, together with a further advantages thereof, may best be understood by references to the following description, taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a microwave oven utilizing the oven cavity structure of the present invention;
FIG. 2 is an elevational view of the interior construction of the oven cavity;
FIG. 3 is a sectional view of the horn-like structure of the present invention; and
FIG. 4 is an elevational view of the horn-like structure taken along lines 4-4 of FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, FIG. 1 illustrates a microwave oven, generally indicated by arrow 10, having a housing formed by a plurality of outer walls 11. The housing also includes a front face 12 forming an opening into an oven cavity 13. An oven door 14 is pivotally mounted on the front face 12 of the oven and is adapted to completely enclose the opening of the cavity 13 and extend over the front face 12 of the oven forming the opening.

Although not restricted thereto, the oven door 14 can be of the type described in Assignee's copending U.S. Pat. applications Ser. Nos. 266,059 and 292,529. The outer end of the oven door 14 includes a latch assembly 15 having a plurality of hooked latches 16 which are adapted to extend into a plurality of openings 17 formed on the front face 12 of the oven in order to be engaged by a plurality of spring-biased catches (not shown). The latch assembly is disclosed in Assignee's copending U.S. Pat. application Ser. No. 290,000. In accordance with a door and latch assembly of this type, a door release lever 18 is located on the control panel 19 of the oven which functions to activate the spring-biased catches to unlock the hooked latches 16 to open the oven door 14.

The cavity 13 is formed by a plurality of conductive-ly-bound surfaces 20 which are formed by a plurality of rectangular walls located on the three sides and on the top side of the cavity 13. The bottom side of cavity 13 is hidden from view in FIG. 1 and will be more fully described hereinafter. A ceramic panel 21, which functions as a shelf, is located over the bottom side of the cavity 13.

The side walls 20 and the front face 12 are joined at their corners, as illustrated. The front face 12 includes an annular cavity 22 which functions as a choke and is adapted to receive a quantity of dielectric material 23. This choke structure is more fully described in Assignee's copending U.S. Pat. application, Ser. No. 266,059.
In accordance with the present invention, the bottom side of the cavity 13 is formed by an annular flange 24 forming the large circular aperture 26 which is adapted to receive a horn-like structure 25.

Referring now to FIGS. 2, 3, and 4, the horn-like structure 25 comprises a frusto-conical surface 27 diverging outwardly into the interior of the oven cavity 13. As shown in FIG. 2, the conical surface 27 forms an interior angle \( \alpha \) with the adjoining side walls 20 which is greater than 90°. As shown in FIG. 3, the diverging surfaces 27 have opposed angles (one of which is shown as angle \( \beta \)) of less than 180°.

The outer portions of the conical surface 27 adjoin a cylindrical surface 28. In the present embodiment, the radius of the cylinder is approximately 4\(^{1/4}\) inches, which is substantially equal to the wavelength of the microwave energy having a frequency of 2,450 megahertz. The top surface of the horn-like structure 25 is bent outwardly in a flat plane 29 which is adapted to extend over and be supported by the flanged surface 24. The central portion 31 of the horn-like structure 25, which forms the truncated portion thereof, includes an aperture 32 extending therethrough. This truncated portion supports a flange 33 which in turn functions as a support for a magnetron 34. The magnetron 34 includes a plurality of cooling fins 35 which are adapted to extend around the magnetron tube 36. The magnetron 36 includes a radiating portion 37 which is adapted to extend through the aperture 32. As shown in FIG. 4, the conical surface 27 also includes a plurality of air or cooling holes 38 mounted on both sides of the aperture 32.

**OPERATION**

As described in the Description Of The Prior Art, a magnetron radiating directly into the microwave oven cavity has already been tried before. However, the microwave distribution of these prior ovens was not satisfactory for commercial utilization. Applicants have found that, by utilizing the horn-like structure 25 in combination with the magnetron extending through the aperture 32 thereof, an even wave distribution is set up within the oven cavity 13 which heretofore was not possible with prior "direct feed" microwave ovens. Moreover, Applicants have found that the wave distribution can also be further improved by having the conical surface 27 adjoin a cylindrical surface 28 at its outer edge, and having the radius of the conical surface approximate the wavelength of the radiated microwave energy. Because of this discovery, Applicants have been successful in providing a microwave oven that eliminates the need for waveguides and mode stirrers while still achieving an even distribution of microwave energy within the oven cavity.

It should be noted that various modifications can be made to the apparatus while still remaining with the purview of the following claims.

What is claimed is:

1. A microwave oven comprising: an oven cavity defined by conductively bounded surfaces; one of said surfaces extending toward adjoining surfaces at internal angles which are greater than 90°, said one surface forming a truncated cone having an aperture formed at the truncated end of said cone; and a source of microwave energy mounted adjacent said one surface, said source of microwave energy comprising a magnetron having a radiating portion extending through said aperture into said cavity.

2. The invention of claim 1 wherein the outer periphery of said one surface adjoins a cylindrical surface.

3. The invention of claim 2 wherein the radius of said cylindrical surface is a multiple of the wavelength of the emanating microwave energy.

4. The invention of claim 1 wherein said conical surface adjoins a cylindrical surface.

5. The invention of claim 4 wherein the radius of said cylindrical surface is a multiple of the wavelength of the emanating microwave energy.

6. A microwave oven comprising: an oven cavity defined by conductively bounded surfaces; one of said surfaces forming a horn-like structure having diverging surfaces facing the interior of said cavity, said diverging surfaces having opposed angles of less than 180°, the central portion of said horn-like structure further including an aperture formed therein; and a source of microwave energy mounted within said horn-like structure, said source of microwave energy comprising a magnetron having a radiating portion extending through said aperture into said cavity.

7. A microwave oven comprising: an oven cavity defined by conductively bounded surfaces; one of said surfaces extending toward adjoining surfaces at internal angles which are greater than 90°, said one surface further including an aperture formed therein; and a source of microwave energy mounted adjacent said one surface, said source of microwave energy comprising a magnetron having a radiating portion extending through said aperture into said cavity.

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