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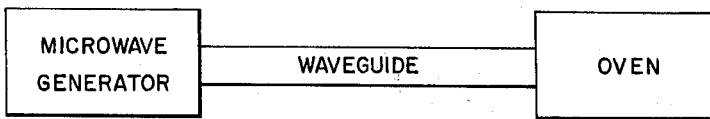
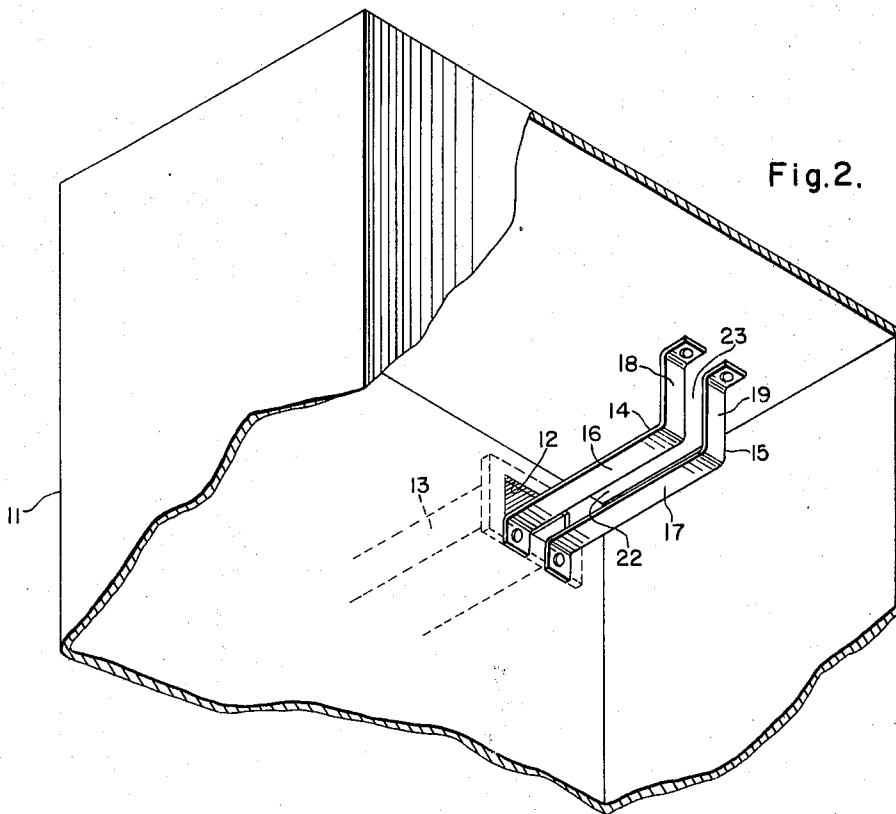


Fig.1.



WITNESSES

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This invention relates to heating of materials by exposure to electromagnetic radiation and concerns especially distribution of microwave energy for uniform heating thereby in an oven or similar enclosure.

Increase in temperature of materials exposed to electromagnetic radiation in the microwave portion of the spectrum (from about one thousand to three hundred thousand megacycles per second, corresponding to wavelengths of from about thirty centimeters to one millimeter) is a familiar phenomenon. Microwave generators operating in the lower portion of this range are used to provide energy to cooking ovens or the like. However, the pattern of radiation established in an oven, for example, resembles standing waves to such an extent that the food or other material to be heated is affected non-uniformly. For this reason it is customary to "stir" the pattern or "mix the modes" by means of a rotating fan having electrically conductive blades to reflect the radiation intermittently. However, the added initial cost and upkeep of such a device are unwelcome, and there is a great need for improvement.

A primary object of the present invention is assurance of heating uniformity in a microwave oven or the like without use of moving blades therein.

Another object is coupling of microwave energy from a waveguide into an oven or similar enclosure by stationary means effective to smooth or even out the energy pattern therein.

A further object is accomplishment by the previous objects without significantly decreasing the useful volume of the oven or like enclosure.

Other objects of this invention, together with means and methods for attaining the various objects, will be apparent from the following description and the accompanying diagrams.

FIG. 1 is a schematic representation in block form of apparatus useful according to the present invention; and

FIG. 2 is a perspective view of a portion of the apparatus of the preceding view, partly sectioned away to reveal interior elements.

In general, the objects of the present invention are accomplished, in apparatus for heating materials in an enclosure supplied with microwave energy through an opening therein, by means of a first slotted conductive structure located inside the enclosure, opposite and spaced from the opening, and by means of a second slotted conductive structure located inside the enclosure, extending inwardly thereof from one side of the opening, which may be combined into a single slotted structure.

FIG. 1 shows a microwave generator interconnected to an oven by a waveguide extending from the one to the other, all three elements being shown in block form. This is a common arrangement, the structure and function of which are well known in the art; the distinguishing features of the present invention appear in the next view.

FIG. 2 shows, in perspective and partly sectioned away to show the interior, oven 11, which is orthorhombic in shape (the floor or bottom wall not being shown). Visible in the rear wall, near a corner formed by intersection thereof with the top wall (or roof) and one side wall, is rectangular opening 12 to which rectangular waveguide 13 (indicated, with terminal flange, in broken lines as behind the rear wall) is juxtaposed. The long sides of the

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opening are parallel to the top wall, which is closest to the opening, and the narrow sides are parallel to the side walls, one of which is much closer to the opening than is the opposite side wall. The walls of the oven are made of electrically conductive material, usually aluminum, stainless steel or enameled metal or at least the interior surface is composed thereof, so as to contain the microwave energy received from the waveguide.

Prominently visible in the oven interior are laminar strips 14, 15 fastened (as by screws) at one end to the rear wall of the oven, and at the opposite end to the top wall thereof. The strips have respective horizontal portions 16, 17 and vertical portions 18, 19 (one each) at right angles to one another and to the walls to which the adjoining ends are fastened. The corresponding portions of the respective strips are coplanar with one another and are spaced apart by horizontal and vertical slots 22 and 23, respectively. As shown, the strips are identical with one another and are uniformly spaced throughout their length, although this is not necessarily the optimum arrangement. They are composed of conductive material, at least on their exterior surface, which may be like that of the oven walls (or interior surface). The horizontal portions of the respective strips terminate at the rear wall along the horizontal lower wide edge of opening 12, with their outer most edges at the opposite corners thereof (formed by intersection of that wide edge with the vertical narrow edges of the opening). The space in the oven interior between opening 12 and the vertical portions of the strips is unoccupied (except by the atmosphere in the oven) and thus may be considered to be free of material that might conduct (and, therefore, reflect) or appreciably absorb that microwave energy. The intervening distance, equal to the length of the horizontal portions of the strips, is appreciably greater than the wavelength of the microwave energy, being preferably one and one-half times as long or longer.

For example, the horizontal portions of the strips may be eight inches long for use at a wavelength of about five inches. The vertical portions would be essentially as long as the height (short dimension) of opening 12 plus the distance of the top edge of the opening from the top wall of the oven, approaching three and a half inches in the apparatus of the example. With the width of the strips at one and one-half inches each, the width of the slot therebetween may be the same, greater or smaller, such as about one and one-third inches.

A reasonably complete theoretical explanation of the action of the slotted structures or composite structure shown and described is not available for inclusion here. However, it may be helpful in appreciating the invention to assume that the incoming energy is partially transmitted through the slots (and open sides) and partially reflected by the strips, with the result that substantially all the energy becomes available to the interior of the oven in a mixture of modes sufficient to provide essentially uniform heating of lossy dielectric materials, such as food, in the oven.

The advantages of such a simple, inexpensive, and trouble-free solution to the problem of mode mixing in a microwave oven or similar enclosure are apparent. The dimensions, location and spacing of the slotted structures may be varied without departing from the invention as defined in the following claims.

The claimed invention:

1. In apparatus for heating materials in a walled enclosure adapted to contain microwave energy and supplied therewith through an opening in one wall thereof, the enclosure having another wall perpendicular to and intersecting the first wall near the opening therein, a plurality of electrically conductive strips spaced parallel to one

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another and terminating at one end at the opening, along the side thereof furthest from the second wall, and terminating at the opposite end against the second wall, an intermediate portion of the strips substantially paralleling the second wall for a distance exceeding the wavelength of the microwave energy.

2. In apparatus for heating materials in a walled enclosure adapted to contain microwave energy and supplied therewith through an opening in one wall thereof, the enclosure having another wall perpendicular to and intersecting the first wall near the opening therein, a plurality of electrically conductive strips spaced parallel to one another and terminating at one end at the opening, along the side thereof furthest from the second wall, and terminating at the opposite end against the second wall, an intermediate portion of the strips extending from the opening substantially parallel to the second wall for a distance exceeding the wavelength of the microwave energy, and the remaining intermediate portion extending therefrom substantially perpendicular to the second wall.

3. In apparatus for heating materials by microwave energy, a microwave generator, an orthorhombic walled enclosure having in one wall near a corner thereof a rectangular opening adapted to admit microwave energy and oriented with its sides parallel to the side edges of that wall, a waveguide outside the enclosure and interconnecting the microwave generator and the enclosure by way of the opening, a pair of conductive strips coplanar with one another and located inside the housing, the strips termi-

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nating at their one end against that wall and along that wide edge of the opening which is located further than the opposite wide edge from the nearer of the walls intersecting that wall parallel to the wide edges, the strips being spaced laterally from one another and extending substantially perpendicularly away from the opening for a distance exceeding the wavelength of the microwave energy, the space between the strips and that intersecting wall being essentially free of conductive material, and the strips then extending perpendicularly to and terminating at their other end against the intersecting wall.

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