A counter-top microwave oven comprises an upstanding box-like metal wall structure defining a heating cavity. Microwave source means including a ridge waveguide for radiating the microwaves into the heating cavity from the top thereof, the cavity being so dimensioned and the waveguide being so positioned as to excite in the cavity two predetermined complementary transverse electric field modes having resonant frequencies relatively close to each other, for establishing a predetermined field pattern in the heating cavity.
MICROWAVE OVEN WITH WAVEGUIDE FEED

BACKGROUND OF THE INVENTION

The present invention relates to electronic heating apparatus of the type commonly referred to as a microwave oven, and specifically to a microwave oven of the counter-top variety which has a heating cavity with dimensions generally comparable to a wavelength of the microwave energy used. More particularly, the present invention is an improvement of the invention disclosed in the copending U.S. application Ser. No. 430,730 of James E. Staats and Louis H. Fitzmayer, filed Jan. 4, 1974, entitled “MICROWAVE OVEN WITH PREFERRED MODES,” and assigned to the assignee of the present invention.

In that copending application, there are disclosed a number of different forms of a microwave oven heating enclosure having microwave energy radiated thereinto by a probe antenna, the cavity dimensions and antenna location providing for the excitation in the heating cavity of two complementary transverse electric (TE) field modes, thereby resulting in a heating pattern which affords fairly uniform heating of a wide variety of low impedance food loads without necessitating the use of a mode stirrer.

SUMMARY OF THE INVENTION

It is a general object of the present invention to provide an electronic heating apparatus characterized by a heating cavity which has microwave energy fed thereto through a waveguide, the apparatus being dimensioned and arranged for excitation in the cavity of two predetermined complementary TE field modes which afford a desirable heating pattern for improved cooling performance.

More specifically, it is an important object of this invention to provide an electronic heating apparatus comprising a metal enclosure in the form of an upstanding rectangular parallelepiped defining a heating cavity for receiving therein a body to be heated, the enclosure including a rectangular top wall having a rectangular opening therein adjacent to one corner thereof, source means including a ridge waveguide electrically coupled to the heating cavity through the opening in the top wall for transmitting microwave energy of a predetermined wavelength into the heating cavity, the heating cavity being dimensioned for exciting therein two predetermined complementary electromagnetic field modes having resonant frequencies relatively close to each other, at least one of the predetermined electromagnetic field modes having the fields thereof constant in a direction parallel to one of the dimensions of the heating cavity, each of the predetermined electromagnetic field modes having the fields thereof varying in the direction in which the fields of the other mode are constant, whereby there is established in the heating cavity and electromagnetic field pattern providing uniform heating of an associated body.

Further features of the invention pertain to the particular arrangement of the parts of the electronic heating apparatus whereby the above-outlined and additional operating features thereof are attained.

The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following specification taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front perspective view of a microwave oven including a heating enclosure constructed in accordance with and embodying the features of the present invention; and

FIG. 2 is a diagrammatic perspective view of the heating cavity of the electronic heating apparatus of FIG. 1, diagrammatically illustrating the two complementary transverse electric field modes excited therein.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now in particular to FIGS. 1 and 2 of the drawings, there is illustrated a microwave oven, generally designated by the numeral 10, constructed in accordance with and embodying the features of the present invention. The microwave oven 10 is adapted for placement on top of a table or counter and is housed in a cabinet which includes an upstanding front panel 11, a rear wall 12, a top wall 13, a bottom wall 14 and a pair of opposed side walls 16 and 17. Mounted within the oven cabinet along side the front panel 11 is a heating enclosure, generally designated by the numeral 20, including a top wall 21, a bottom wall 22, a rear wall 23 and a pair of opposed side walls 24 and 26, the front of the heating enclosure 20 being closed by a door 15 which, in the closed position thereof, forms the front wall of the heating enclosure 20, which enclosure is generally in the form of a rectangular parallelepiped. Formed in the top wall 21 adjacent to the right rear corner thereof, as viewed in FIG. 2, is a rectangular opening 28 for a purpose to be described more fully below.

The heating enclosure 20 serves to separate the interior of the oven cabinet into a heating cavity defined within the heating enclosure 20 and a machinery compartment 25 between the heating enclosure 20 and the oven cabinet walls 12, 13, 14 and 17. Mounted in the machinery compartment 25 is a microwave source mechanism (not shown) including a magnetron, a power supply and a transmission line, for generating and transmitting microwave energy to a generally rectangular ridge waveguide, generally designated by the numeral 30, disposed at the top of the heating enclosure 20. The magnetron and power supply therefor may be of any suitable construction, but are preferably of the type illustrated in the aforementioned copending U.S. application Ser. No. 430,730, which operates from normal 120 volt a.c. household current and generates microwave energy having a frequency of 915 MHz.

The ridge waveguide 30 overlaps the top wall 21 of the heating enclosure 20 and, in particular, overlaps the opening 28 in the top wall 21. The portion of the waveguide 30 overlying the top wall 21 has an open bottom for communication with the interior of the heating enclosure 20 through the opening 28, whereby microwave energy may be radiated into the heating cavity through the opening 28.

It is a significant feature of the present invention that the heating enclosure 20 is so dimensioned that there can be excited therein two predetermined complementary electromagnetic field modes which afford a preferred heating pattern to give good heating perform-
 ance without necessitating a mode stirrer or other mov-
ing mechanism in the heating cavity. Preferably the two
predetermined complementary modes will have very
nearly the same resonant frequency, which will prefer-
ably be on the high side of the microwave band of
890–940 MHz. allotted for microwave heating devices
and selected for use in this invention.

More particularly, it has been found that a desirable
heating pattern is provided when there is produced in
the heating enclosure 20 the TE_{0,1,2} mode resonant at
approximately 950 MHz, and the TE_{1,0,2} mode, reso-
nant at approximately 945 MHz., where the numeral
subscripts represent, respectively, the variations of the
mode fields in the directions of the width, height and
depth of the heating cavity. In FIG. 2 of the drawings,
the field pattern of the TE_{0,1,2} mode is diagrammatically
illustrated in dashed lines and is designated by the
numeral 40, while the field pattern of the TE_{1,0,2} mode is
diagrammatically illustrated in broken line and desig-
nated by the numeral 45. As can be seen from FIG. 2,
the TE_{0,1,2} mode has fields constant only in the direc-
tion of the width of the heating cavity, while the TE_{1,0,2}
mode has fields constant only in the direction of the
height of the heating cavity, whereby these two modes
compliment each other in producing a desirable com-
posite field pattern which varies in all three dimensions.

In order to produce this predetermined electromagnetic
field mode pattern, the heating enclosure 20 has
a width of 14 inches, a height of 13 inches and a depth
of 14 inches, the rectangular opening 28 in the top wall
measuring 3 inches by 5 inches.

From the foregoing, it can be seen that there has
been provided an improved microwave heating appara-
tus having a heating enclosure to which microwave en-
ergy is fed by a ridge waveguide, the heating cavity
being dimensioned to provide excitation of two predet-
etermined complementary electromagnetic field modes.

More particularly, there has been provided an elec-
tronic heating apparatus of the character described,
wherein the heating enclosure is in the form of a rect-
angular parallelepiped having a rectangular opening in
the top wall thereof through which microwave energy
at a frequency of 915 MHz. is radiated from a ridge
waveguide for producing in the heating cavity the
TE_{0,1,2} and the TE_{1,0,2} field modes, respectively reso-
nant at approximately 950 MHz. and approximately
945 MHz.

While there has been described what is at present
considered to be the preferred embodiment of the in-
vention, it will be understood that various modifica-
tions may be made therein and it is intended to cover
in the appended claims all such modifications as fall
within the true spirit and scope of the invention.

What is claimed is:

1. Electronic heating apparatus comprising a metal
enclosure in the form of an upstanding rectangular par-
allelepiped defining a heating cavity for receiving
therein a body to be heated, said enclosure including a
rectangular top wall having a rectangular opening
therein adjacent to one corner thereof, source means
including a ridge waveguide electrically coupled to said
heating cavity through said opening in said top wall for
transmitting microwave energy of a predetermined
wavelength into said heating cavity, said heating cavity
being dimensioned for exciting therein two predeter-
mined complementary electromagnetic field modes
having resonant frequencies relatively close to each
other, at least one of said predetermined electromagnetic field modes having the fields thereof constant in
a direction parallel to one of the dimensions of said
heating cavity, each of said predetermined electromagnetic field modes having the fields thereof varying in
the direction in which the fields of the other mode are
constant, whereby there is established in said heating
cavity in electromagnetic field pattern providing uni-
form heating of an associated body.

2. The electronic heating apparatus set forth in claim
1, wherein said predetermined frequency is 915 MHz.

3. The electronic heating apparatus set forth in claim
1, wherein said heating cavity has a width of 14 inches
and a height of 13 inches and a depth of 14 inches, said
opening being disposed adjacent to the rear of said en-
closure.

4. The electronic heating apparatus set forth in claim
1, wherein said heating cavity has a width of 14 inches
and a height of 13 inches and a depth of 14 inches, said
opening being disposed adjacent to the rear of said en-
closure and having dimensions 3 inches by 5 inches.

5. The electronic heating apparatus set forth in claim
1, wherein said predetermined frequency is 915 MHz.,
and one of said predetermined modes is transverse
electric field mode resonant at a frequency of approxi-
mately 950 MHz. and the other of said predetermined
modes is a transverse electric mode resonant at a fre-
quency of approximately 945 MHz.

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