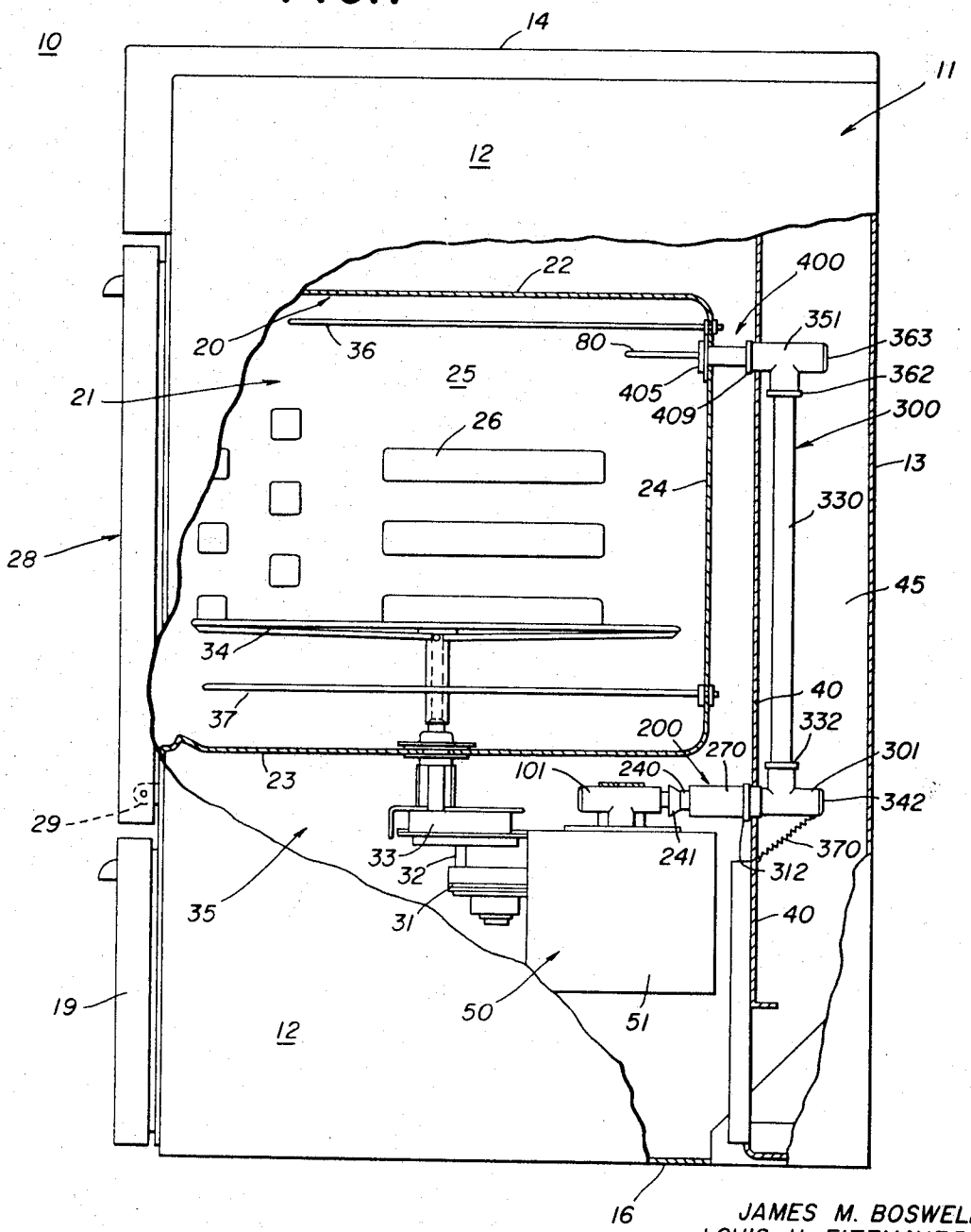
April 15, 1969 J. M. BOSWELL, JR., ETAL 3,439,144

ELECTRONIC OVEN

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FIG. 1



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ELECTRONIC OVEN

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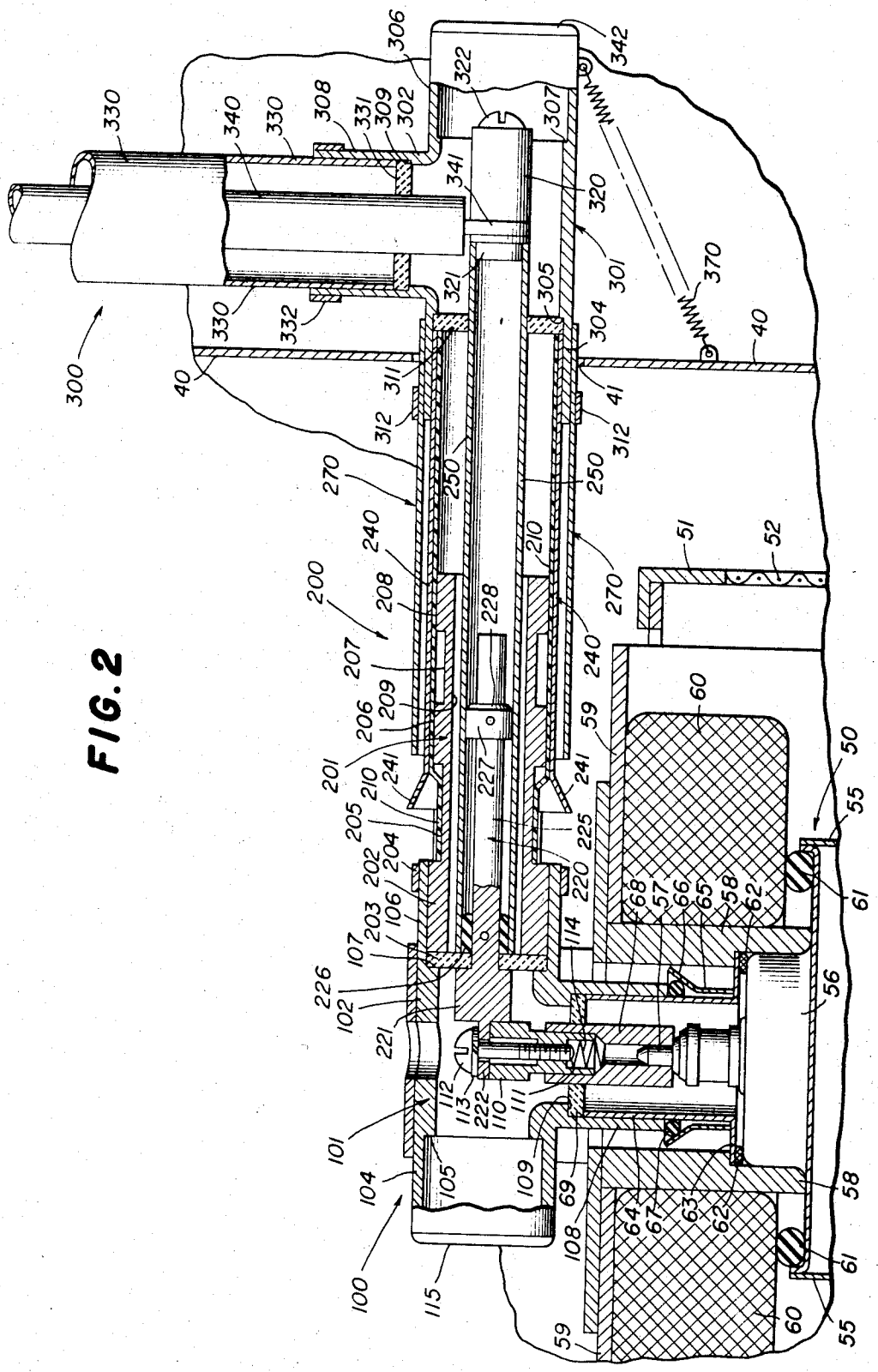


FIG. 2

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ELECTRONIC OVEN

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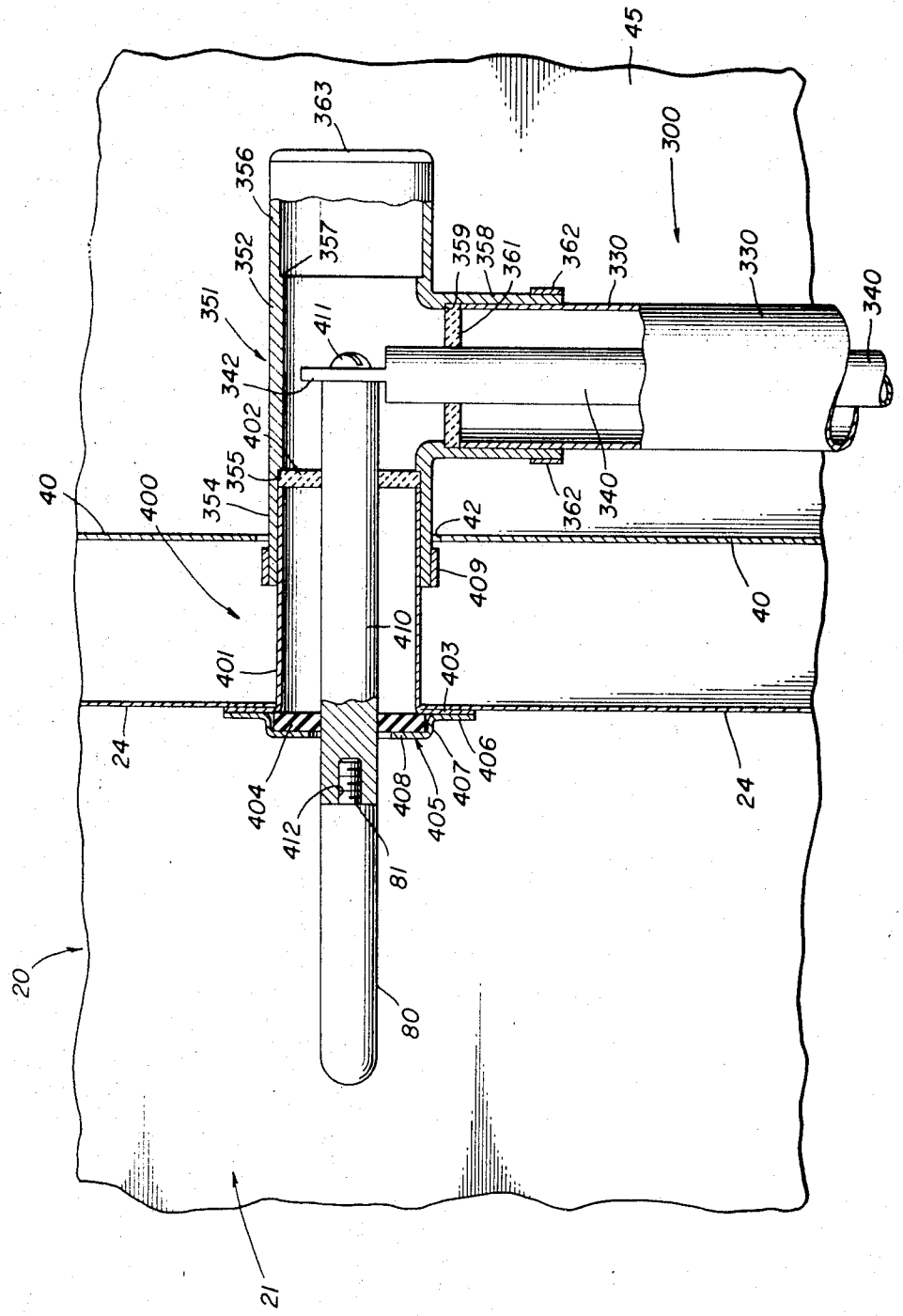


FIG. 3

United States Patent Office

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3,439,144

ELECTRONIC OVEN

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Int. Cl. H05b 9/06

U.S. Cl. 219—10.55 18 Claims

ABSTRACT OF THE DISCLOSURE

There is disclosed an electronic oven comprising a liner defining a cooking cavity, an ultra-high frequency generator, and a coaxial transmission line interconnecting the generator and the cooking cavity, the line including a choke joint providing D.C. insulation between the generator and the cooking cavity, an impedance transformation, means for disconnecting the transmission line, a choke filter for the third and higher harmonics of the generator frequency to attenuate radiation thereof from the choke joint and to provide high attenuation thereof, thereby substantially to prevent transmission of the third harmonic and multiples thereof along the transmission line.

The present invention is directed to an electronic oven, and particularly to an improved transmission line and filter therefor.

The present invention is particularly useful when the generator for the electronic oven includes a magnetron deriving its operating potentials from a voltage doubler and rectifier power supply wherein neither the anode nor the cathode of the magnetron may be grounded for safety purposes. In such cases it is necessary to provide a D.C. break or choke joint in at least the outer conductor, and preferably also the inner conductor, of the transmission line coupling the output of the magnetron to the cooking cavity so that the outer conductor and the liner defining the cooking cavity can be grounded without interfering with the operation of the magnetron and its power supply. In such systems difficulty has been encountered in preventing escape of the third harmonic and multiples of the third harmonic from the choke joint used in providing the D.C. insulation between the generator and the cooking cavity, and there also has been encountered excessive propagation of the third harmonic and multiples thereof of the operating frequency of the magnetron to the cooking cavity.

It is an important object of the present invention to provide an improved electronic oven of the type set forth including a coaxial transmission line having therein a choke tube surrounding the outer conductor at the choke joint providing a D.C. insulation between the magnetron and the cooking cavity, the choke tube being spaced from the associated outer conductor and having one end thereof disposed adjacent to the open end of the associated outer conductor and having the other end thereof connected to the associated outer conductor, the distance between the electrical connection of the choke tube to the associated outer conductor and the end of the choke tube adjacent to the free end of the outer conductor being equivalent to one quarter wavelength of the frequency of operation of the magnetron to provide a high impedance at the open end of the associated outer conductor to the third and higher harmonics of the frequency of operation of the magnetron.

Another object of the invention is to provide an electronic oven having a transmission line including therein a pair of telescopically overlapping outer conductors electrically insulated from each other to provide a choke joint, the inner one of the overlapping outer conductors

having a plurality of spaced-apart lands on the surface thereof disposed toward the other outer conductor, the width of the lands and the spaces therebetween being such that in cooperation with the other outer conductor there is provided a choke filter for the third and higher harmonics of the frequency of operation of the magnetron further to attenuate radiation of the third and higher harmonics of the frequency of operation of the magnetron from the joint between the overlapping outer conductors.

A further object of the invention is to provide an improved electronic oven of the type set forth having a transmission line including therein a first outer conductor and a first inner conductor coaxially arranged and coupled to the output terminals of the magnetron, a second outer conductor electrically connected to the first outer conductor and having the longitudinal axis thereof disposed at an angle with respect thereto and a second inner conductor disposed within the second outer conductor and insulated therefrom and having one end thereof connected to the first inner conductor and having the longitudinal axis thereof disposed at an angle with respect to the first inner conductor, and a tuning slug extending longitudinally outwardly from the first inner conductor at the juncture thereof with a second inner conductor, the tuning slug providing a capacitance that cooperates with the distributed capacitance and inductance in the transmission line to provide a low pass filter for frequencies below the third harmonic and multiples of the third harmonic of the frequency of operation of the magnetron, whereby in the transmission of electromagnetic wavelength between the first and second inner conductors there is effected high attenuation of the third harmonic and multiples of the third harmonic of the frequency of operation of the magnetron.

Further features of the invention pertain to the particular arrangement of the parts and elements of the electronic oven and the transmission line forming a part thereof, 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, in which:

FIGURE 1 is a side view with certain parts broken away of an electronic oven embodying therein the present invention;

FIG. 2 is a fragmentary view of an enlarged scale in vertical section with certain portions broken away of the lower portion of the transmission line of the present invention; and

FIG. 3 is a fragmentary view on an enlarged scale in vertical section with certain portions broken away of the upper portion of the transmission line of the present invention.

Referring to FIG. 1 of the drawings, the electronic oven **10** there illustrated, and embodying the features of the present invention, is in the form of a combination electric and electronic range that is especially designed for home use. More particularly, the electronic oven **10** comprises an upstanding box-like casing **11** formed of steel including a pair of side walls **12**, a rear wall **13** which is preferably removable, a top wall **14** and a bottom wall **16**. The casing **11** houses in the upper central portion thereof a metal liner **20** defining a heating or cooking cavity **21** therein, the metal liner **20** preferably being formed of steel, and essentially comprising a box-like structure provided with a top wall **22**, a bottom wall **23**, a rear wall **24** and a pair of opposed side walls **25**; whereby the liner **20** is provided with an upstanding front opening into the

cooking cavity **21** defined therein. Further, the casing **11** is provided with a front door **28** arranged in a front opening formed therein and cooperating with the front opening provided in the liner **20**, the front door **28** being mounted adjacent to the lower end thereof upon associated hinge structure **29**; whereby the front door **28** is movable between a substantially vertical closed position and a substantially horizontal open position with respect to the front opening provided in the liner **20**.

An electric heating unit **36** is arranged in the upper portion of the cooking cavity **21** adjacent to and below the top wall **22** and an electric heating unit **37** is arranged in the lower portion of the cooking cavity **21** adjacent to and above the bottom wall **23**; which electric heating units **36** and **37** are of the sheathed resistance type and are utilized in carrying out the conventional baking and broiling cooking operations in the cooking cavity **21**. The side walls **25** of the liner **20** further carry thereon a plurality of shelf supports **26** for supporting shelfs (not shown) that in turn support items to be cooked within the cooking cavity **21**.

Disposed below the bottom wall **23** is a bottom machinery compartment **35** in the lower portion of the casing **11**, a lower front panel **19** being provided that is removable to give access to the bottom machinery compartment **35**. Mounted in the bottom machinery compartment **35** is an electric motor **31** having an output drive shaft **32** that drives a gear reducer **33**, the output shaft of which extends upwardly through the bottom wall **23** and carries on the upper end thereof a turntable **34** arranged in the lower portion of the cooking cavity **21**. The turntable **34** is mounted for rotation upon operation of the motor **31** and is adapted to support food to be heated or cooked in an electronic cooking operation that is carried out in the cooking cavity **21**. The motor **31** is operative to turn the turntable **34** at a rate of approximately six revolutions per minute.

A rear baffle **40** is provided to the rear of the liner **20** and extends across the casing **11** between the side walls **12** thereof, the baffle **40** being formed of metal, such as steel, and cooperating with the casing **11** to provide a rear machinery compartment **45**, the rear machinery compartment **45** being disposed behind the liner **20** and access thereto being provided through the removable rear wall **13**.

There is arranged in the bottom machinery compartment **35** a magnetron-type generator **50** for supplying ultra-high frequency electromagnetic wave energy for electronic cooking within the cooking cavity **21**, the magnetron **50** being of the construction and arrangement disclosed in United States Letters Patent No. 3,315,121 granted Apr. 18, 1967 to James E. Staats for Crossed-Field Electric Discharge Device. Referring to FIGS. 1 and 2, it will be seen that the magnetron **50** is disposed within a box-like structure or casing **51** that extends completely about the magnetron **50** but is open on two opposed sides thereof, i.e., the sides disposed to the left and right in FIGS. 1 and 2. The magnetron **50** and the associated parts therefor are electrically insulated from the casing **51** since high operating D.C. potentials are present on those parts electrically connected directly to the magnetron **50**. Preferably the openings of the casing **51** are covered with reticulated metal members or screens **52** that permit passage of cooling air therethrough and about the magnetron **50** but prevent contact of the user with the magnetron **50** and the parts disposed thereabout that carry the high operating D.C. potentials.

The magnetron **50** includes an outer wall **55** that is directly connected to the anode thereof and which is provided at the upper end thereof with an end bell **56** carrying thereon an inner output terminal **57**, the exterior surface of the end bell **56** providing an annular outer output terminal for the magnetron **50**. Surrounding the end bell **56** is an annular magnetic pole piece **58** that is connected to a yoke **59** providing magnetic coupling to a second pole piece disposed at the other end of the magnetron **50** to establish a magnetic field through the magnetron **50**, a magnetic field coil **60** surrounding the magnetic pole piece **58** to create a strong magnetic field therethrough. As illustrated, an O-ring **61** of silicone rubber is disposed between the field coil **60** and the end bell **56**. An electrical connection is made to the annular outer output terminal provided by the end bell **56** by means of a wire mesh ring **62** resting on the upper surfaces thereof and in turn resting against a flange **63** formed on the lower end of an annular outer conductor **64**, a second annular member **65** having an outwardly flared flange **66** being provided around the annular conductor **64** and resting upon the flange **63** thereof and having a wire mesh ring **67** disposed between the outer conductor **64** and the flange **66**. The inner output terminal **57** has threadedly connected thereto an upstanding conductor **68** that is disposed within the annular outer conductor **64** and generally concentric therewith and extending upwardly through an opening in a ceramic insulator **69** that rests upon the upper end of the outer conductor **64**. It will be understood that the RF output from the magnetron **50** appears between the outer conductor **64** and the inner conductor **68** serving as the components of a coaxial transmission line for ultra-high frequency electromagnetic wave energy.

A transmission line is provided to interconnect the output of the magnetron **50** to the cooking cavity **21**, the transmission line being particularly illustrated in FIGS. 2 and 3 of the drawings and including a short vertical section **100**, a first horizontal section **200**, a second longer vertical section **300** and an upper horizontal section **400** connecting to an antenna **80** extending into the rear of the cooking cavity **21** for the introduction of microwave energy thereinto. More specifically, it will be seen that the horizontal transmission line section **200** extends essentially rearwardly from the magnetron **50** and through the wall **40** and into the rear machinery compartment **45** and there connects with the upstanding transmission line section **300** which in turn connects with the horizontal transmission line **400** that extends forwardly through the wall **40** and to the rear wall **24** of the cooking cavity **21** for connection to the antenna **80** disposed therein.

Referring specifically to FIG. 2 of the drawings, it will be seen that the transmission line section **100** comprises a T **101** including a body **102** having a pair of arms **104** and **106** and a leg or arm **108**, each provided with a cooperating internal seat or shoulder **105**, **107** and **109**, respectively. More particularly, the leg **108** is positioned downwardly and receives telescopically therein the upper end of the annular outer conductor **64**, the ceramic spacer **69** also being disposed therein and abutting against the shoulder **109**, the lower end of the leg **108** pressing against the wire mesh gasket **67** whereby the outer conductor **64** is coupled to the leg **108**. Disposed within the T **101** is a bullet **110** having a lower end **111** formed as a plurality of prongs that fit into the annular opening in the upper end of the inner conductor **68**, a screw **112** extending into an opening in the upper end of the bullet **110** and downwardly therethrough and forcing the prongs on the lower end **111** outwardly firmly to connect to the conductor **68**, thereby to provide an electrical connection therewith; preferably a lock washer **113** is provided to hold the screw **112** in the adjusted position thereof. It will be understood that a suitable opening is formed in the T **101** above the screw **112** to provide access thereto during the assembly operation and a spring **114** is also provided in the conductor **68**, the spring **114** being useful during assembly of the parts to assure the proper positioning of the bullet **110** with respect to the conductor **68**. Finally, a dust cap **115** is provided closing the outer end of the leg **104**.

The horizontal transmission line section **200** includes a first tube or outer conductor **201**, a first inner conductor **220**, a second tube or outer conductor **240** and a second inner conductor **250** which is also preferably in the form of a tube. The outer conductor **201** is annular in form and includes a mounting portion **202** having an external diameter slightly less than the internal diameter of the leg **106** of the T **101** and telescopically received therein and abutting against a washer **203** of polytetrafluoroethylene resin, the preferred resin being that sold under the trademark "Teflon" positioned against the shoulder **107** in the leg **106**. A suitable clamp **204** is provided fixedly to interconnect the leg **106** and the mounting portion **202**, thus firmly to mount the outer conductor **201** on the T **101** and to provide a good electrical connection therebetween. The portion of the outer conductor **201** extending beyond the leg **106** and to the right in FIG. 2 has a first recess therein as at **205** and a second recess therein as at **207**, the recesses **205** and **207** cooperating with the outer free end of the conductor **201** to provide a pair of spaced-apart lands **206** and **208**.

The inner conductor **220** includes a body portion **221** disposed within the T **101** and having integral therewith an ear **222** having an opening therethrough receiving the shank of the screw **112**, the washer **113** clamping the ear **222** against the bullet **110** to provide a good mechanical connection and a good electrical connection between the bullet **110** and the inner conductor **220**. Extending outwardly to the right from the body **221** and integral therewith is a cylindrical probe **225** that extends through an opening in the washer **203** and generally concentric with and spaced from the inner surface **209** of the outer conductor **201**. A first ring **226** of low-loss dielectric material is carried by the probe **225** adjacent to the insulator **203** and in surrounding relationship therewith, and a second ring **227** of low-loss dielectric material is carried by the probe **225** intermediate the ends thereof but disposed toward the outer end thereof and in surrounding relationship therewith. The rings **226** and **227** are firmly affixed to the probe **225**, the preferred material of construction of the rings **226** and **227** being a synthetic organic plastic resin, the preferred resin being polytetrafluoroethylene resin.

The outer conductor **201** and the inner conductor **220** form a section of a coaxial transmission line to which are applied both the RF output from the magnetron **50** and the D.C. operating potentials applied thereto. In order to isolate electrically with respect to D.C. potentials the magnetron **50** from the cooking cavity **21**, and more particularly to make it possible to ground the outer conductor of the transmission line and the liner **20** defining the cooking cavity **21**, it is necessary electrically to insulate with respect to D.C. potentials the outer conductor **201** from the cooperating outer conductor **240** and also preferably electrically to insulate with respect to D.C. potentials the inner conductor **220** from the cooperating inner conductor **250**. To this end a layer or sleeve **210** of electrically insulating and dielectric material is provided covering the major portion of the length of the conductor **201**, and specifically that portion thereof which is telescopically received within the cooperating outer conductor **240**. More specifically, the inner diameter of the outer conductor **240** is slightly greater than the outer diameter of the insulating sleeve **210** so as to receive the associated end of the outer conductor **201** and the surrounding sleeve **210** therein in telescoping relationship. Also, the outer or lefthand end of the outer conductor **240** is outwardly flared as at **241** so as to provide for easy assembly of the outer conductor **240** over the inner conductor **201** and its enclosing insulating sleeve **210**.

The inner conductor **250** is tubular in form and has an inner diameter only slightly greater than the outer diameter of the rings **226** and **227** carried by the inner conductor **228**, the lefthand end of the inner conductor **250** telescopically receiving therein the adjacent end of the inner conductor **220** and more specifically the probe **225** and the rings **226** and **227** carried thereon, the lefthand end of the conductor **250** abutting against the insulator **203**.

Finally, there is provided about the outer conductor **240** a choke sleeve or tube **270** having an inner diameter substantially greater than the outer diameter of the outer conductor **240** and spaced uniformly therefrom thereabout a predetermined distance and having the lefthand end thereof as viewed in FIG. 2 terminated a short distance away from the outwardly flared portion **241**, all for reasons that will be described in detail hereinafter.

The vertically extending transmission line section **300** includes at the lower end thereof a T **301** including a body **302** having a pair of arms **304** and **306** and a leg or arm **308** each provided with a cooperating internal seat or shoulder **305**, **307** and **309**, respectively. More specifically, the leg **304** is disposed to the left as viewed in FIG. 2 and carries therein a washer or insulator **311** of "Teflon" disposed against the shoulder **305** and extends from the rear machinery compartment **45** through an opening **41** in the wall **40** and into the bottom machinery compartment **35**. The inner diameter of the leg **304** is slightly greater than the outer diameter of the adjacent end of the outer conductor **240** so that the adjacent or righthand end of the outer conductor **240** is telescopically received in the leg **304** and abuts against the ceramic washer **311**. The outer diameter of the leg **304** is slightly smaller than the inner diameter of the choke tube **270** so that the choke tube **270** is telescopically received thereover. An annular clamp **312** is provided about the adjacent end of the choke tube **270** to clamp the choke tube **270** on the leg **304** and to clamp the leg **304** against the adjacent end of the outer conductor **240** to provide a good mechanical connection between the outer conductor **240**, the choke tube **270** and the T **301**, and also to provide for good electrical connection between the outer conductor **240** and the choke tube **270** at the outer end of the leg **304**. The righthand end of the inner conductor **250** as viewed in FIG. 2 extends outwardly and to the right through the opening disposed centrally in the washer **311**, the free end of the inner conductor **250** fitting over and affixed to a shouldered member **321**. A tuning slug **320** carries a screw **322** therein for the purpose of affixing the tuning slug **320** to the member **321** and the conductor **250**.

The vertical transmission line section **300** further includes an outer annular conductor **330** and an inner annular conductor **340** extending upwardly from the T **301** to a second T **351** (see FIG. 3). More specifically, the lower end of the outer conductor has an outer diameter that is slightly less than the inner diameter of the leg **308** and is telescopically received therein and bears downwardly against a washer or insulator **331** of "Teflon" supported on the shoulder **309** of the T **301**. An annular clamp **332** is provided about the leg **308** to clamp it about the lower end of the outer conductor **330** to provide both a good mechanical connection and a good electrical connection therebetween. The lower end of the inner conductor **340** extends downwardly through an opening disposed centrally in the ceramic washer **331** and carries a connecting portion **341** that is connected to the tuning slug **320** so that the inner conductor **340** and the tuning slug **320** are connected both mechanically and electrically. There also is provided a dust cap **342** to close the leg **306**.

The upper end of the vertical transmission line section **300** is provided by the T **351** that includes a body **352** having a pair of arms **354** and **356** and a leg or arm **358** each provided with a cooperating internal seat or shoulder **355**, **357** and **359**, respectively. More particularly, the leg **358** is positioned downwardly and has an internal diameter slightly greater than the external diameter of the upper end of the outer conductor **330**, whereby the upper end of the outer conductor **330** is telescopically received in the leg **358**, a ceramic washer or insulator **361**

being provided abutting against the shoulder **359** and against the upper end of the outer conductor **330**. In order to provide both a good mechanical connection and a good electrical connection between the leg **358** and the outer conductor **330**, an annular clamp **362** is provided about the lower end of the leg **358** to clamp it tightly about the upper end of the outer conductor **330**. The upper end of the inner conductor **340** extends upwardly through an opening disposed centrally in the insulating washer **361** and into the body **352** of the T **351**, a connecting portion **342** being provided on the upper end thereof. The outer end of the leg **356** is closed by a dust cover **363**.

The upper horizontal transmission line section **400** comprises a tube or outer conductor **401** and an inner conductor **410**. The outer diameter of the outer conductor **401** is slightly less than the inner diameter of the leg **354** on the T **351** and is telescopically received therein and abuts against a ceramic washer or insulator **402** that bears against the shoulder **355** in the leg **354**. It will be noted that the leg **354** extends forwardly through an opening **42** in the wall **40** and thus from the rear machinery compartment **45** to the rear wall **24** of the liner **20** and through an opening therein. The forward or lefthand end of the outer conductor **401** is viewed in FIG. 3 has an outwardly directed flange **403** therearound that is suitably secured to the rear wall **24** of the liner **20**. The righthand end of the outer conductor **401** is held in the operative position with respect to the leg **354** by an annular clamp **409** disposed about the forward end of the leg **354** and clamping it against the associated end of the outer conductor **401**. Covering the outer end of the outer conductor **401** is a ceramic washer or insulator **404** that is held in place by a mounting member **405** that includes a flange **406** secured to the flange **403**, an annular body **407** extending to the left and an inwardly directed retaining flange **408** that serves to hold the insulator **404** against the flange **403** and centered with respect to the outer conductor **401**.

The inner conductor **410** is in the form of a rod that extends through aligned openings in the insulators **402** and **404**, the rear end of the inner conductor **410** being secured as by the screw **411** to a connecting portion **342** at the upper end of the inner conductor **340**. The forward end of the rod **410** has a threaded opening **412** therein that receives a threaded stud **81** on the rear end of the antenna **80**, the antenna **80** being in the form of a probe extending into the cooking cavity **21** defined by the liner **20**.

A coaxial transformer is provided by the parts in the transmission line section **200** to transform the effective impedance of the cooking cavity **21**, the transmission line and the magnetron **50** to match the higher impedance of the average load in the cooking cavity **21**. More specifically, the transformer determines the coupling between the magnetron **50** and the cooking cavity **21** and serves to decouple the load in the cooking cavity **21** from the magnetron **50** to improve the stability of operation of the electronic oven. The critical parts in the coaxial transformer are the outer conductor **201** and the inner conductor **250**, the ratio between the inner diameter of the outer conductor **201** and the outer diameter of the inner conductor **250** being approximately 1.5:1, thereby providing the necessary transformer action and decoupling as described.

As has been explained heretofore, the preferred power supply for the magnetron **50** is a voltage doubler and rectifier system which can be connected directly to a household three-wire Edison supply to provide the necessary potentials for operating the magnetron **50** without the use of any power transformer therein. A voltage doubler system, however, cannot have either of the output terminals thereof grounded, whereby both the output terminal in the form of the conductor **64** and the output conductor **68** from the magnetron **50** carry thereon high potentials with respect to ground potential during the operation of the magnetron **50**. For safety reasons it is essential that the oven liner **20** and the various parts connected thereto be grounded, and therefore it is necessary to provide a D.C. decoupling insulation in the transmission line between the liner **20** and the magnetron **50** so as to prevent the application of the high potentials on the magnetron **50** to the oven liner **20**. Accordingly, a D.C. insulation break has been provided in the outer conductor, and specifically, the insulating sleeve **210** has been provided between the outer conductor **201** and the outer conductor **240**, whereby there is a transmission of microwave energy therebetween but no transmission of D.C. potentials therebetween. Likewise, the inner conductor **220** is insulated with respect to the inner conductor **250** so as to prevent transmission of D.C. potential therebetween while providing for an efficient transmission of microwave energy therebetween. It will be understood therefore that the outer conductor **240** and the inner conductor **250** are insulated wtih respect to D.C. potentials from the associated outer conductor **201** and inner conductor **220**, respectively, while propagating therebetween the RF energy from the magnetron **50** to the oven cavity **21**.

These overlapping conductors **201–240** and **220–250** also provide a filter for the second and fourth harmonic of the fundamental operating frequency of the magnetron **50**, substantially to attenuate the transmission of the second and fourth harmonics from the magnetron **50** to the cooking cavity **21**. To this end the outer conductors **201** and **240** overlap a length that is substantially equivalent to a quarter wavelength of the operating frequency of the magnetron **50**, and the inner conductors **220** and **250** likewise overlap a length equivalent substantially to one quarter wavelength of the operating frequency of the magnetron **50**. The provision of the ring **227** on the probe **225** also causes preferential attenuation of the fourth harmonic of the fundamental operating frequency of the magnetron **50**, the ring **227** being positioned a predetermined distance from the outer end of the probe **225** equal substantially to a quarter wavelength of the fourth harmonic of the fundamental operating frequency of the magnetron **50**. As a result, the overlapping relationship of the outer conductors **201** and **240**, the overlapping relationship of the inner conductors **220** and **250** and the position of the rings **226** and **227** on the probe **225** serve to provide an efficient filter for the second and fourth harmonics of the fundamental operating frequency of the magnetron **50**, thus highly to attenuate the transmission of the second and fourth harmonics from the magnetron **50** to the cooking cavity **21**.

It will be appreciated that the construction of the horiozntal transmission line section **200** is such as to permit ready assembly and disassembly between the parts thereof. More specifically, the outer conductor **240** is slidingly received over the insulating sleeve **210** and can be readily removed therefrom by movement to the right as viewed in FIG. 2. Likewise, the inner conductor **250** is simply slidingly fitted over the probe **225** and the rings **226** and **227** thereon, whereby the inner conductor **250** can be removed therefrom by simply moving it to the right as viewed in FIG. 2. In short, those parts mounted on and connected to the T **301** can be bodily moved to the right for dissassembly with respect to those parts mounted on the T **101**, thus providing for a ready disassembly of the transmission line section **200** into two telescoping parts. To facilitate assembly of the two telescoping transmission line sections, the forward or righthand end of the ring **227** is beveled as at **228** to facilitate the insertion of the conductor **250** thereover, and the outer conductor **240** has the lefthand end thereof flared outwardly as at **241** to facilitate assembly thereof over the insulating sleeve **210**. In order to hold the parts in the assembled position with the lefthand end of the inner conductor **250** firmly pressed against the insulating washer **203**, a spring **370** has been provided interconnecting the T **301** and the wall **40**, the spring **370** being under tension and urging the T **301** and the parts mounted thereon to

the left as viewed in FIG. 2 and into the assembled position thereof.

While the above described choke joint structure admirably fulfills the desired purpose of providing a D.C. insulation between the outer conductors **201–240** and between the inner conductors **220–250**, while providing for ready assembly and disassembly thereof, a problem is encountered in that there is a tendency for the third and higher harmonics of the fundamental operating frequency of the magnetron **50** to escape from the resultant choke joint to an undesirable degree. Accordingly, there has been provided in accordance with the present invention the coke tube **270** and a choke filter formed by the outer conductors **201** and **240** substantially to attenuate and essentially to eliminate the propagation of the third harmonic and higher harmonics of the operating frequency of the magnetron **50** from the choke joint. Referring first to the choke tube **270**, the righthand end thereof as viewed in FIG. 2 is electrically connected to or shorted to the outer conductor **240** at the lefthand end of the leg **304** on the T **301**, and the distance between this point of shorting and the forward or lefthand end of the choke tube **270** is equal to one quarter wavelength of the fundamental operating frequency of the magnetron **50**. The dimension recited offers a high impedance to the third and higher harmonics at the lefthand end of the choke tube **270** in the space between the choke tube **270** and the outer conductor **240** and particularly the flared end **241** thereof. The choke tube **270** also isolates the outer conductor **240** from the field coil housing or magnetic yoke **59**, thus preventing any transportation of third harmonic wave energy in the space between the choke tube **270** and the yoke **59**. As a result there is substantially no leakage of the third and higher harmonics from the juncture between the outer conductors **201** and **240**, although there is a low impedance for the fundamental frequency of the magnetron **50** at the outer end of the inner conductor **201**, thereby to provide for efficient transmission of the fundamental frequency from the outer conductor **201** to the outer conductor **240** for further transmission to the cooking cavity **21**.

The choke filter provided by the outer conductor **201** in cooperation with the outer conductor **240** provides a short for the third and higher harmonics of the fundamental operating frequency of the magnetron **50** so as further to attenuate the radiation of these frequencies from the choke joint between the outer conductors **201** and **240**, and specifically at the flared end **241** of the outer conductor **240**. This choke filter is provided by the lands **206** and **208** and the spaces **205** and **207**, the dimensions of these parts being adjusted and arranged so that the distances between any two points of impedance discontinuity on the lands **206** and **208** are integral multiples of one-half the wavelength of the third, fourth, fifth, sixth, seventh and eight harmonics of the fundamental operating frequency of the magnetron **50**. More specially, the dimensions of the outer conductor **201** are chosen and arranged so that the width of the lands **206** and **208** is equal to approximately 0.039 times the fundamental wavelength of the magnetron **50**, the space **207** has a width equal to 0.049 times the fundamental wavelength of the magnetron **50**, the overall length of the outer conductor **201** is equal to one quarter wavelength of the fundamental frequency of the magnetron **50** and the internal diameter of the outer conductor **201** is equal to 0.058 times the fundamental wavelength of the magnetron **50**. When the parts are so dimensioned, there can be no points of resonance for the wavelength or one-half the wavelength of the third, fourth, fifth, sixth, seventh and eighth harmonics of the fundamental frequency of the magnetron **50** in the choke filter. Accordingly, there is a high attenuation of the third and higher harmonics of the fundamental frequency of the magnetron **50** in passing from the outer conductor **201** to the outer conductor **240**, thus highly to attenuate radiation of the third and higher harmonics of the fundamental frequency of the magnetron **50** from the joint therebetween and specifically at the flared end **241** of the outer conductor **240**.

Turning now to the third harmonic filter provided by the tuning slug **320** in FIG. 2, the tuning slug **320** adds capacitance to the transmission line at the right angle turn or juncture of the inner conductors **250** and **340** in the T **301**. This added capacitance acts with existing distributed capacitance and inductance in the transmission line to give a rejection filter or "notch" filter effect at the third harmonic and multiples of the third harmonic of the fundamental frequency of the magnetron **50**. More specifically, there is provided at the righthand end of the tuning slug **320** a high impedance to the third harmonic and multiples thereof and at the connector **341** a low impedance to the third harmonic and multiple thereof which tends to reflect the third harmonic and multiples thereof back toward the magnetron **50**, thus substantially to attenuate and prevent transmission of the third harmonic and multiples thereof from the inner conductor **250** onto the inner conductor **340**. As a consequence, the tuning slug **320** has the effect of effectively filtering the third harmonic and multiples thereof from the energy transmitted into the transmission line section provided by the conductor **330–340**, thus highly to attenuate the transmission of the third harmonic and multiples thereof of the operating frequency of the magnetron **50** to the cooking cavity **21**.

In a typical construction of the electronic oven **10**, the T's **101**, **301** and **351** are formed of copper, the outer conductor **201**, the inner conductor **220**, the inner conductor **250** and the inner conductor **340** are formed of aluminum. The outer conductor **240**, the choke sleeve **270** and the outer conductor **330** are formed of copper. The outer conductor **401**, the inner conductor **410**, and the antenna **80** are formed of nickel plated steel. In a preferred embodiment of the invention, the magnetron **50** has a frequency of operation of 915 megacycles in which case the outer conductor **201** has an overall length of 3.25 inches, an outer diameter of the mounting portion **202** of 1.125 inches, an inner diameter of 0.75 inch, an external diameter of the lands **206** and **208** of 1.028 inches, an external diameter of the spaces **205** and **207** of 0.970 inch, a length of the lands **206** and **208** of 0.50 inch and a length of the space **207** of 0.63 inch.

From the above it will be seen that there has been provided an electronic oven which fulfills all of the objects and advantages set forth above.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be understood that various modifications can 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. An electronic oven comprising a box-like metal liner defining a cooking cavity, a generator for supplying ultra-high frequency electromagnetic energy of a predetermined frequency, said generator having an annular outer output terminal and an inner output terminal both at high potentials with respect to ground potential, and a coaxial transmission line interconnecting said generator and said cooking cavity and including a top section coupled to said cooking cavity and a bottom section coupled to said generator and an intermediate section interconnecting said top and bottom sections, said top section including a first tube connected to said liner and extending outwardly therefrom to provide a first outer conductor and a first inner conductor disposed within said first tube and insulated therefrom and having the outer end thereof coupled to said cooking cavity, said bottom section including a second tube connected to said annular outer output terminal and providing a second outer conductor and a second inner conductor connected to said inner output terminal and disposed within said second tube and insu-

lated therefrom, a third tube telescopically overlapping said second tube and insulated therefrom and extending outwardly therefrom to provide a third outer conductor, a third inner conductor disposed within said third tube and insulated therefrom and telescopically overlapping said second inner conductor and insulated therefrom, said intermediate section including a fourth tube providing a fourth outer conductor interconnecting and electrically connected to both said first tube and said third tube and having the longitudinal axis thereof disposed at an angle with respect to said third tube, a fourth inner conductor disposed within said fourth tube and insulated therefrom and having one end thereof connected to said first inner conductor and having the other end thereof connected to said third inner conductor and having the longitudinal axis thereof disposed at an angle with respect to said third inner conductor, the end of said third tube disposed toward said generator being outwardly flared to facilitate insertion thereinto of the adjacent end of said second tube, a choke tube surrounding said third tube and having one end thereof disposed adjacent to the flared end of said third tube and spaced away therefrom and having the other end thereof electrically connected to said third tube, the distance between the electrical connection of said choke tube to said third tube and the end of said choke tube adjacent to the flared end of said third tube being equivalent to one quarter wavelength of the frequency of operation of said generator to provide a high impedance at the flared end of said third tube to the third and higher harmonics of the frequency of operation of said generator thereby highly to attenuate radiation of the third and higher harmonics of the frequency of operation of said generator from the joint between said second and third tubes, said second tube having a plurality of spaced-apart lands on the surface thereof disposed toward said third tube, the width of said lands and the spaces therebetween being such that in cooperation with said third tube there is provided a choke filter for the third and higher harmonics of the frequency of operation of said generator further to attenuate radiation of the third and higher harmonics of the frequency of operation of said generator from the joint between said second and third tubes, and a tuning slug extending longitudinally outwardly from said third inner conductor at the juncture thereof with said fourth inner conductor, said tuning slug providing a capacitance that cooperates with the distributed capacitance and inductance in said transmission line to provide a rejection filter for the third harmonic of the frequency of operation of said generator and multiples of said third harmonic, whereby in the transmission of the electromagnetic wave energy between said third and fourth inner conductors there is effected high attenuation of the third harmonic of the frequency of operation of said generator and multiples of said third harmonic.

2. The electronic oven set forth in claim 1, wherein said second tube and said third inner conductor cooperate to provide a coaxial transformer to transform the impedance of said generator and said transmission line to match the higher impedance of the average load in said cooking cavity, the ratio between the inner diameter of said second tube and the outer diameter of said third inner conductor being approximately 1.5:1.

3. The electronic oven set forth in claim 2, wherein the inner diameter of said second tube is equivalent in length to 0.058 times the predetermined wavelength of operation of said generator.

4. An electronic oven comprising a box-like metal liner defining a cooking cavity, a generator for supplying ultra-high frequency electromagnetic energy of a predetermined frequency, said generator having an annular outer output terminal and in inner output terminal both at high potentials with respect to ground potential, and a coaxial transmission line interconnecting said generator and said cooking cavity and including a top section coupled to said cooking cavity and a bottom section coupled to said generator and an intermediate section interconnecting said top and bottom sections, said top section including a first tube connected to said liner and extending outwardly therefrom to provide a first outer conductor and a first inner conductor disposed within said first tube and insulated therefrom and having the outer end thereof coupled to said cooking cavity, said bottom section including a second tube connected to said annular outer output terminal and providing a second outer conductor and a second inner conductor connected to said inner output terminal and disposed within said second tube and insulated therefrom, a third tube telescopically overlapping said second tube and insulated therefrom and extending outwardly therefrom to provide a third outer conductor, a third inner conductor disposed within said third tube and insulated therefrom and telescopically overlapping said second inner conductor and insulated therefrom, said intermediate section including a fourth tube providing a fourth outer conductor interconnecting and electrically connected to both said first tube and said third tube and having the longitudinal axis thereof disposed at an angle with respect to said third tube, a fourth inner conductor disposed within said fourth tube and insulated therefrom and having one end thereof connected to said first inner conductor and having the other end thereof connected to said third inner conductor and having the longitudinal axis thereof disposed at an angle with respect to said third inner conductor, the end of said third tube disposed toward said generator being outwardly flared to facilitate insertion thereinto of the adjacent end of said second tube, and a choke tube surrounding said third tube and having one end thereof disposed adjacent to the flared end of said third tube and spaced away therefrom and having the other end thereof electrically connected to said third tube, the distance between the electrical connection of said choke tube to said third tube and the end of said choke tube adjacent to the flared end of said third tube being equivalent to one quarter wavelength of the frequency of operation of said generator to provide a high impedance at the flared end of said third tube to the third and higher harmonics of the frequency of operation of said generator thereby highly to attenuate radiation of the third and higher harmonics of the frequency of operation of said generator from the joint between said second and third tubes, said second tube having a plurality of spaced apart lands on the surface thereof disposed toward said third tube, the width of said lands and the spaces therebetween being such that in cooperation with said third tube there is provided a choke filter for the third and higher harmonics of the frequency of operation of said generator further to attenuate radiation of the third and higher harmonics of the frequency of operation of said generator from the joint between said second and third tubes.

5. The electronic oven set forth in claim 4, wherein said lands and the spaces therebetween are arranged so that the distances between any two points of impedance discontinuity on adjacent lands are multiples of the wavelength or one-half the wavelength of the third and fourth and fifth and sixth and seventh and eighth harmonics of the predetermined frequency of operation of said generator.

6. The electronic oven set forth in claim 4, wherein two of said lands are provided having a space therebetween and on each side thereof, the width of each of said lands being equivalent in length to about 0.039 times the wavelength of the predetermined frequency of operation of said generator, and the width of the space between said lands being equivalent in length to about 0.049 times the wavelength of the predetermined frequency of operation of said generator.

7. An electronic oven comprising a box-like metal liner defining a cooking cavity, a generator for supplying ultra-high frequency electromagnetic energy of a predetermined

frequency, said generator having an annular outer output terminal and an inner output terminal both at high potentials with respect to ground potential, and a coaxial transmission line interconnecting said generator and said cooking cavity and including a top section coupled to said cooking cavity and a bottom section coupled to said generator and an intermediate section interconnecting said top and bottom sections, said top section including a first tube connected to said liner and extending outwardly therefrom to provide a first outer conductor and a first inner conductor disposed within said first tube and insulated therefrom and having the outer end thereof coupled to said cooking cavity, said bottom section including a second tube connected to said annular outer output terminal and providing a second outer conductor and a second inner conductor connected to said inner output terminal and disposed within said second tube and insulated therefrom, a third tube telescopically overlapping said second tube and insulated therefrom and extending outwardly therefrom to provide a third outer conductor, a third inner conductor disposed within said third tube and insulated therefrom and telescopically overlapping said second inner conductor and insulated therefrom, said intermediate section including a fourth tube providing a fourth outer conductor interconnecting and electrically connected to both said first tube and said third tube and having the longitudinal axis thereof disposed at an angle with respect to said third tube, a fourth inner conductor disposed within said fourth tube and insulated therefrom and having one end thereof connected to said first inner conductor and having the other end thereof connected to said third inner conductor and having the longitudinal axis thereof disposed at an angle with respect to said third inner conductor, the end of said third tube disposed toward said generator being outwardly flared to facilitate insertion thereinto of the adjacent end of said second tube, a choke tube surrounding said third tube and having one end thereof disposed adjacent to the flared end of said third tube and spaced away therefrom and having the other end thereof electrically connected to said third tube, the distance between the electrical connection of said choke tube to said third tube and the end of said choke tube adjacent to the flared end of said third tube being equivalent to one quarter wavelength of the frequency of operation of said generator to provide a high impedance at the flared end of said third tube to the third and higher harmonics of the frequency of operation of said generator thereby highly to attenuate radiation of the third and higher harmonics of the frequency of operation of said generator from the joint between said second and third tubes, and a tuning slug extending longitudinally outwardly from said third inner conductor at the juncture thereof with said fourth inner conductor, said tuning slug providing a capacitance that cooperates with the distributed capacitance and inductance in said transmission line to provide a low pass filter for frequencies below the third harmonic of the frequency of operation of said generator and multiples of said third harmonic, whereby in the transmission of the electromagnetic wave energy between said third and fourth inner conductors there is effected high attenuation of the third harmonic of the frequency of operation of said generator and multiples of said third harmonic.

8. The electronic oven set forth in claim **7**, wherein said second tube and said third tube telescopically overlap a distance equivalent to a quarter wavelength of the predetermined frequency of operation of said generator, and said second inner conductor and said third inner conductor telescopically overlap a distance equivalent to a quarter wavelength of the predetermined frequency of operation of said generator, thereby to provide high attenuation of the second harmonic and multiples thereof of the predetermined frequency of operation of said generator in transmission of electromagnetic wave energy along said transmission line.

9. An electronic oven comprising a box-like metal liner defining a cooking cavity, a generator for supplying ultra-high frequency electromagnetic energy of a predetermined frequency, said generator having an annular outer output terminal and an inner output terminal both at high potentials with respect to ground potential, and a coaxial transmission line interconnecting said generator and said cooking cavity and including a top section coupled to said cooking cavity and a bottom section coupled to said generator and an intermediate section interconnecting said top and bottom sections, said top section including a first tube connected to said liner and extending outwardly therefrom to provide a first outer conductor and a first inner conductor disposed within said first tube and insulated therefrom and having the outer end thereof coupled to said cooking cavity, said bottom section including a second tube connected to said annular outer output terminal and providing a second outer conductor and a second inner conductor connected to said inner output terminal and disposed within said second tube and insulated therefrom, a third tube telescopically overlapping said second tube and insulated therefrom and extending outwardly therefrom to provide a third outer conductor, a third inner conductor disposed within said third tube and insulated therefrom and telescopically overlapping said second inner conductor and insulated therefrom, said intermediate section including a fourth tube providing a fourth outer conductor interconnecting and electrically connected to both said first tube and said third tube and having the longitudinal axis thereof disposed at an angle with respect to said third tube, a fourth inner conductor disposed within said fourth tube and insulated therefrom and having one end thereof connected to said first inner conductor and having the other end thereof connected to said third inner conductor and having the longitudinal axis thereof disposed at an angle with respect to said third inner conductor, the end of said third tube disposed toward said generator being outwardly flared to facilitate insertion thereinto of the adjacent end of said second tube, said second tube having a plurality of spaced apart lands on the surface thereof disposed toward said third tube, the width of said lands and the spaces therebetween being such that in cooperation with said third tube there is provided a choke filter for the third and higher harmonics of the frequency of operation of said generator further to attenuate radiation of the third and higher harmonics of the frequency of operation of said generator from the joint between said second and third tubes, and a tuning slug extending longitudinally outwardly from said third inner conductor at the juncture thereof with said fourth inner conductor, said tuning slug providing a capacitance that cooperates with the distributed capacitance and inductance in said transmission line to provide a low pass filter for frequencies below the third harmonic of the frequency of operation of said generator and multiples of said third harmonic, whereby in the transmission of the electromagnetic wave energy between said third and fourth inner conductors there is effected high attenuation of the third harmonic of the frequency of operation of said generator and multiples of said third harmonic.

10. The electronic oven set forth in claim **9**, wherein the lands and the spaces therebetween are arranged so that the distances between any two points of impedance discontinuity on adjacent lands are multiples of the wavelength or one-half the wavelength of the third and fourth and fifth and sixth and seventh and eighth harmonics of the predetermined frequency of operation of said generator.

11. The electronic oven set forth in claim **9**, wherein two of said lands are provided having a space therebetween and on each side thereof, the width of each of said lands being equivalent in length to about 0.039 times the wavelength of the predetermined frequency of operation of said generator, and the width of the space between

said lands being equivalent in length to about 0.049 times the wavelength of the predetermined frequency of operation of said generator.

12. The electronic oven set forth in claim 9, wherein said second tube and said third tube telescopically overlap a distance equivalent to a quarter wavelength of the predetermined frequency of operation of said generator, and said second inner conductor and said third inner conductor telescopically overlap a distance equivalent to a quarter wavelength of the predetermined frequency of operation of said generator, thereby to provide high attenuation of the second harmonic and multiples thereof of the predetermined frequency of operation of said generator in the transmission of electromagnetic wave energy along said transmission line.

13. An electronic oven comprising a box-like metal liner defining a cooking cavity, a generator for supplying ultra-high frequency electromagnetic energy of a predetermined frequency, said generator having an annular outer output terminal and an inner output terminal both at high potentials with respect to ground potential, and a coaxial transmission line interconnecting said generator and said cooking cavity and including a top section coupled to said cooking cavity and a bottom section coupled to said generator and an intermediate section interconnecting said top and bottom sections, said top section including a first tube connected to said liner and extending outwardly therefrom to provide a first outer conductor and a first inner conductor disposed within said first tube and insulated therefrom and having the outer end thereof coupled to said cooking cavity, said bottom section including a second tube connected to said annular outer output terminal and providing a second outer conductor and a second inner conductor connected to said inner output terminal and disposed within said second tube and insulated therefrom, a third tube telescopically overlapping said second tube and insulated therefrom and extending outwardly therefrom to provide a third outer conductor, a third inner conductor disposed within said third tube and insulated therefrom and telescopically overlapping said second inner conductor and insulated therefrom, said intermediate section including a fourth tube providing a fourth outer conductor interconnecting and electrically connected to both said first tube and said third tube and having the longitudinal axis thereof disposed at an angle with respect to said third tube, a fourth inner conductor disposed within said fourth tube and insulated therefrom and having one end thereof connected to said first inner conductor and having the other end thereof connected to said third inner conductor and having the longitudinal axis thereof disposed at an angle with respect to said third inner conductor, the end of said third tube disposed toward said generator being outwardly flared to facilitate insertion thereinto of the adjacent end of said second tube, and a choke tube surrounding said third tube and having one end thereof disposed adjacent to the flared end of said third tube and spaced away therefrom and having the other end thereof electrically connected to said third tube, the distance between the electrical connection of said choke tube to said third tube and the end of said choke tube adjacent to the flared end of said third conductor being equivalent to one quarter wavelength of the frequency of operation of said generator to provide a high impedance at the flared end of said third conductor to the third and higher harmonics of the frequency of operation of said generator thereby highly to attenuate radiation of the third and higher harmonics of the frequency of operation of said generator from the joint between second and third tubes.

14. An electronic oven comprising a box-like metal liner defining a cooking cavity, a generator for supplying ultra-high frequency electromagnetic energy of a predetermined frequency, said generator having an annular outer output terminal and an inner output terminal both at high potentials with respect to ground potential, and a coaxial transmission line interconnecting said generator and said cooking cavity and including a top section coupled to said cooking cavity and a bottom section coupled to said generator and an intermediate section interconnecting said top and bottom sections, said top section including a first tube connected to said liner and extending outwardly therefrom to provide a first outer conductor and a first inner conductor disposed within said first tube and insulated therefrom and having the outer end thereof coupled to said cooking cavity, said bottom section including a second tube connected to said annular outer output terminal and providing a second outer conductor and a second inner conductor connected to said inner output terminal and disposed within said second tube and insulated therefrom, a third tube telescopically overlapping said second tube and insulated therefrom and extending outwardly therefrom to provide a third outer conductor, a third inner conductor disposed within said third tube and insulated therefrom and telescopically overlapping said second inner conductor and insulated therefrom, said intermediate section including a fourth tube providing a fourth outer conductor interconnecting and electrically connected to both said first tube and said third tube and having the longitudinal axis thereof disposed at an angle with respect to said third tube, and a fourth inner conductor disposed within said fourth tube and insulated therefrom and having one end thereof connected to said first inner conductor and having the other end thereof connected to said third inner conductor and having the longitudinal axis thereof disposed at an angle with respect to said third inner conductor, the end of said third tube disposed toward said generator being outwardly flared to facilitate insertion thereinto of the adjacent end of said second tube, said second tube having a plurality of spaced apart lands on the surface thereof disposed toward said third tube, the width of said lands and the spaces therebetween being such that in cooperation with said third tube there is provided a choke filter for the third and higher harmonics of the frequency of operation of said generator further to attenuate radiation of the third and higher harmonics of the frequency of operation of said generator from the joint between said second and third tubes.

15. The electronic oven set forth in claim 14, wherein said lands and the spaces therebetween are arranged so that the distances between any two points of impedance discontinuity on adjacent lands are multiples of the wavelength or one-half the wavelength of the third and fourth and fifth and sixth and seventh and eighth harmonics of the predetermined frequency of operation of said generator.

16. The electronic oven set forth in claim 14, wherein two of said lands are provided having a space therebetween and on each side thereof, the width of each of said lands being equivalent in length to about 0.039 times the wavelength of the predetermined frequency of operation of said generator, and the width of the space between said lands being equivalent in length to about 0.049 times the wavelength of the predetermined frequency of operation of said generator.

17. An electronic oven comprising a box-like metal liner defining a cooking cavity, a generator for supplying ultra-high frequency electromagnetic energy of a predetermined frequency, said generator having an annular outer output terminal and an inner output terminal both at high potentials with respect to ground potential, and a coaxial transmission line interconnecting said generator and said cooking cavity and including a top section coupled to said cooking cavity and a bottom section coupled to said generator and in intermediate section interconnecting said top and bottom sections, said top section including a first tube connected to said liner and extending outwardly therefrom to provide a first outer conductor and a first inner conductor disposed within said first tube and insulated therefrom and having the outer end

thereof coupled to said cooking cavity, said bottom section including a second tube connected to said annular outer output terminal and providing a second outer conductor and a second inner conductor connected to said inner output terminal and disposed within said second tube and insulated therefrom, a third tube telescopically overlapping said second tube and insulated therefrom and extending outwardly therefrom to provide a third outer conductor, a third inner conductor disposed within said third tube and insulated therefrom and telescopically overlapping said second inner conductor and insulated therefrom, said intermediate section including a fourth tube providing a fourth outer conductor interconnecting and electrically connected to both said first tube and said third tube and having the longitudinal axis thereof disposed at an angle with respect to said third tube, a fourth inner conductor disposed within said fourth tube and insulated therefrom and having one end thereof connected to said first inner conductor and having the other end thereof connected to said third inner conductor and having the longitudinal axis thereof disposed at an angle with respect to said third inner conductor, and a tuning slug extending longitudinally outwardly from said third inner conductor at the juncture thereof with said fourth inner conductor, said tuning slug providing a capacitance that cooperates with the distributed capacitance and inductance in said transmission line to provide a low pass filter for frequencies below the third harmonic of the frequency of operation of said generator and multiples of said third harmonic, whereby in the transmission of the electromagnetic wave energy between said third and fourth inner conductors there is effected high attenuation of the third harmonic of the frequency of operation of said generator and multiples of said third harmonic.

18. The electronic oven set forth in claim **17**, wherein said second tube and said third tube telescopically overlap a distance equivalent to a quarter wavelength of the predetermined frequency of operation of said generator, and said second inner conductor and said third inner conductor telescopically overlap a distance equivalent to a quarter wavelength of the predetermined frequency of operation of said generator, thereby to provide high attenuation of the second harmonic and multiples thereof of the predetermined frequency of operation of said generator in the transmission of electromagnetic wave energy along said transmission line.

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