United States Patent

Haagensen

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[54] MICROWAVE HEATING APPARATUS WITH RADIATION CONTROL AND MONITORING

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[52] **U.S. Cl.** **219/10.55**

[51] **Int. Cl.** **H05b 5/00**

[58] **Field of Search** 219/10.55

[56] **References Cited**

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[57] **ABSTRACT**

A radiation safety device located about the entrance to a microwave oven is comprised of a wave trough-type of transmission line within which a printed circuit cross-polarized antenna is disposed to permit induction of radiation of either transverse electric or transverse magnetic waves into propagation circuits containing both dissipative and conductive elements for reducing environmental radiation leakage.

20 Claims, 7 Drawing Figures

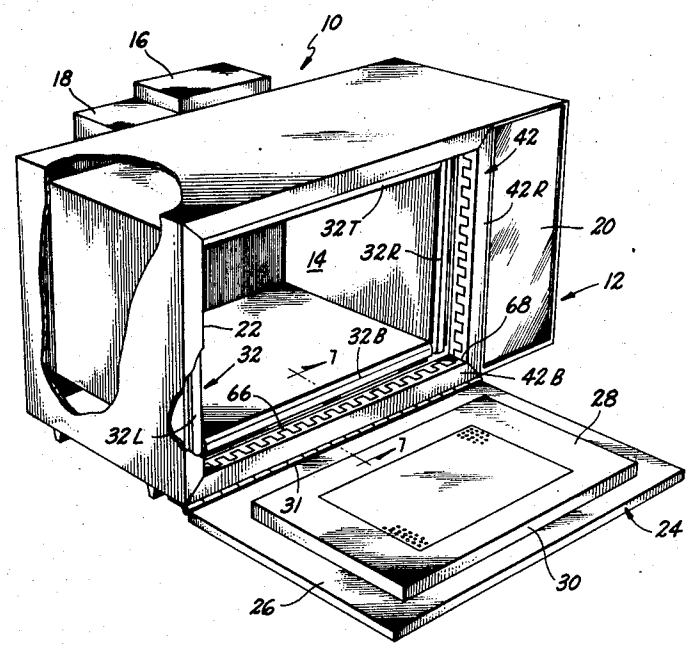
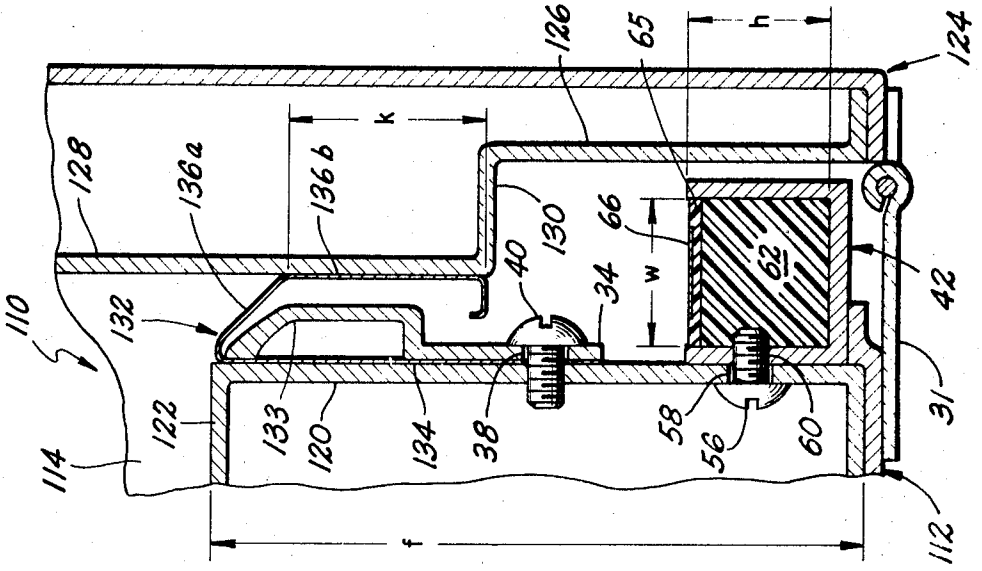


Fig 7



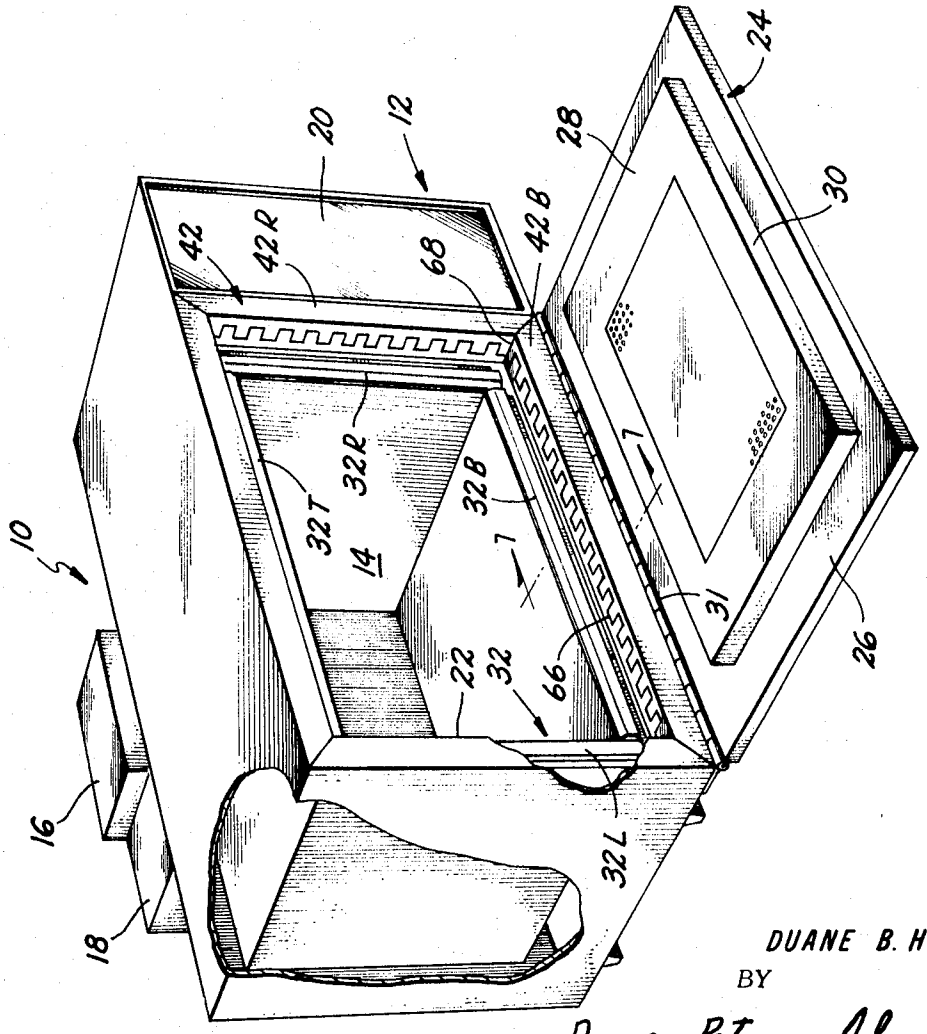


Fig 1

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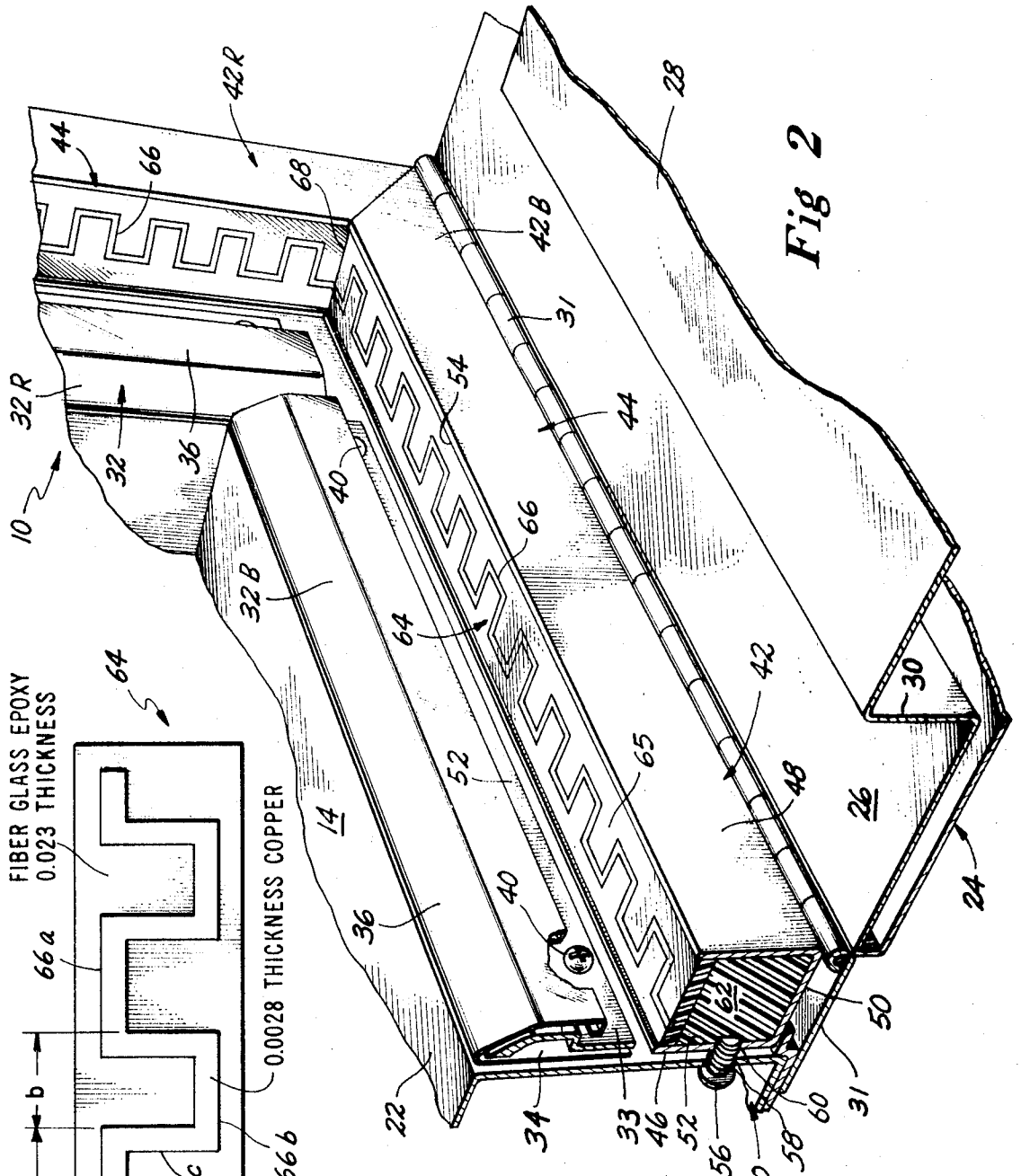

Fig 2

Fig 3

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Fig 4

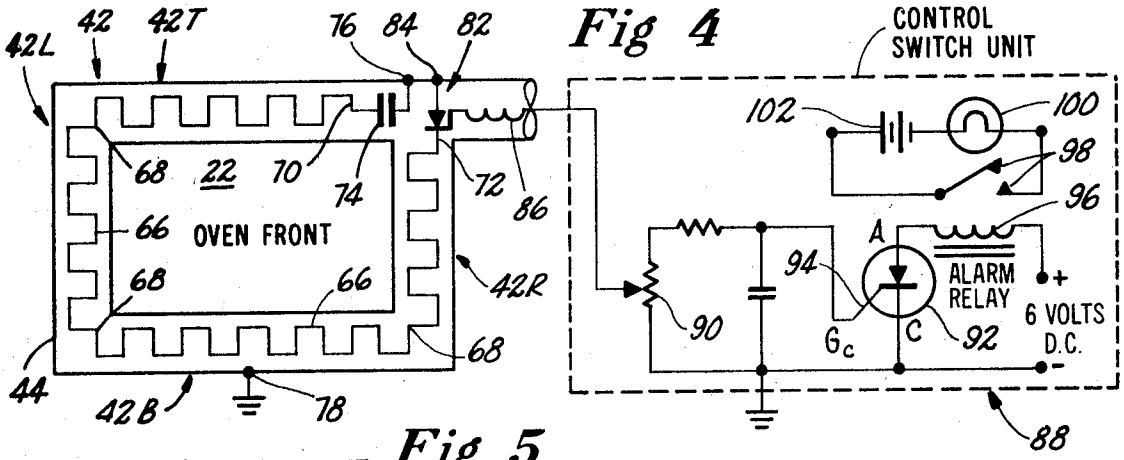


Fig 5

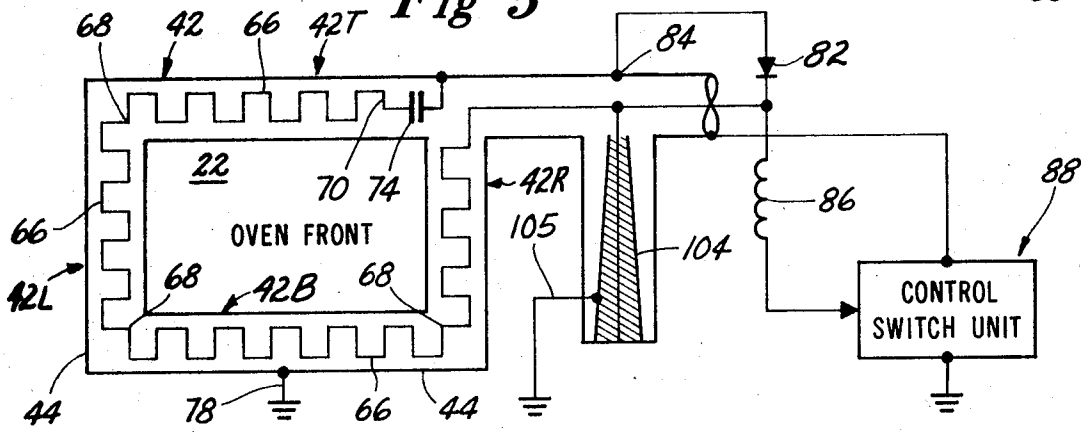
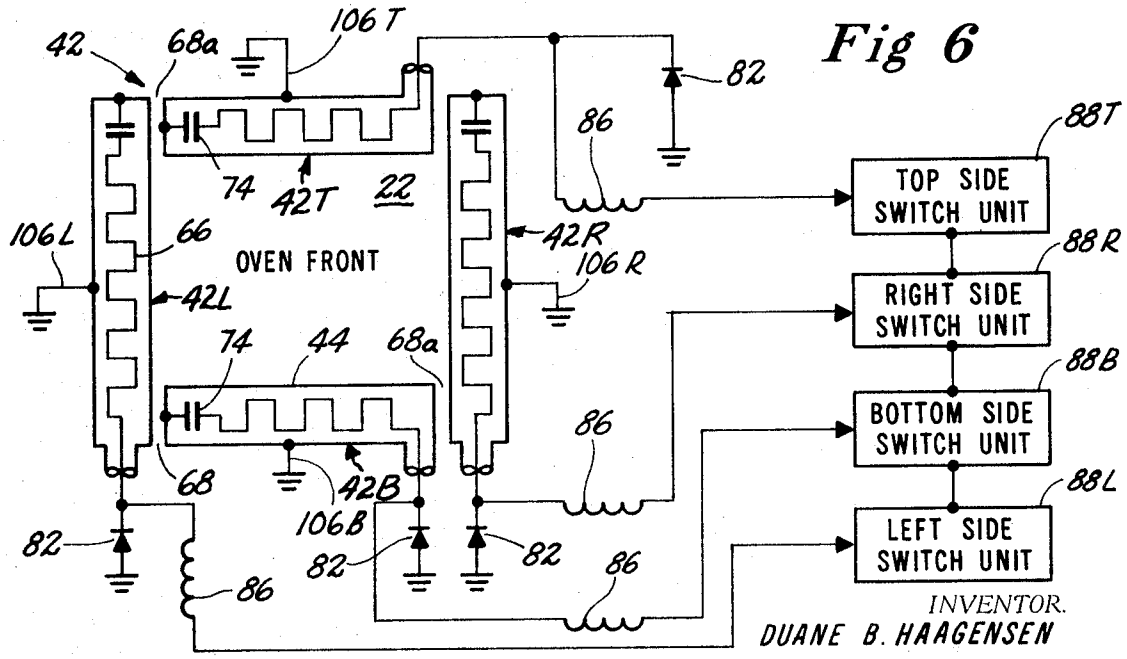


Fig 6



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MICROWAVE HEATING APPARATUS WITH RADIATION CONTROL AND MONITORING

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to electronic heating apparatus and more particularly to a safety device for controlling environmental microwave radiation.

2. Description of the Prior Art

In the past various attempts have been made to contain or reduce the amount of radiation leakage from the cavity of microwave ovens. The United States Radiation Control Act of 1968 has emphasized the importance of maintaining this leakage below an absolute level of 5 milliwatts per square centimeter at a distance of 5 centimeters from the oven. Accordingly, various types of door seals have been used in an attempt to meet this requirement. However, recent tests conducted by the Department of Health, Education, and Welfare have shown that these door seals are not sufficiently complying in all instances with the regulations set forth by the Radiation Control Act. During extended use of the oven, these seals begin to wear and deteriorate and thus the radiation leakage is allowed to exceed the permissible limit. Therefore, merely providing an effective radiation seal for a new product is not always adequate to maintain the safe level of 5 milliwatts throughout the useful life of the product.

Also, in the past an alarm or radiation detection means consisting of a loop of wires around the door of the oven has been used. However, studies of this particular detection arrangement have shown certain defects. The detector wires rely on a single polarization of the leaking energy, which is not always the case when a seal becomes ineffective due to wear or an abnormal operating condition. A faulty seal can cause an abnormal condition which allows energy of a different polarization to leak past the detector and into the environment. In addition, this particular alarm system provides no diversion or reduction of leaking energy. In the instance that the alarm system should ever fail, no protection is afforded the person using the oven. Thus, simply an alarm system dependent on a single polarization of the radiation has not proven capable of satisfactory environmental control of radiation.

The use of oven door interlocks for compliance with the requirements of the Radiation Control Act has also met with limited success. Since these interlocks are only able to insure the door being in a mechanically closed position and in many instances are not fail-safe, no protection is afforded when a door seal becomes worn or defective.

SUMMARY OF THE INVENTION

A general object of the present invention is to provide a means of controlling and monitoring environmental radiation from microwave heating apparatus.

A more specific object of the invention is to provide a microwave oven with an integral dissipative, conductive and detecting system which uses multiple reduction principles to insure a fail-safe control of environmental radiation.

A further object of the invention is to control environmental radiation from a microwave oven in which the control is sensitive to cross-polarized electric fields. A more specific aim of the invention is to provide a resistive cross-polarized wave trough antenna element which reacts in parallel with dissipative dielectric material contained within the wave trough, thereby furnishing a greater amount of attenuation and radiation protection.

Another object is to provide an environmental protective system for microwave ovens which is intrusion or tamperproof as far as the protective elements are concerned.

Another object is to provide a transmission circuit for the entrance of a microwave oven that is capable of absorbing excessively large amounts of microwave radiation.

Still another object is to provide additional attenuation of microwave energy escaping through the access opening of a microwave oven by serially or successively connecting together the individual wave troughs situated at the sides of the opening. More specifically, my invention recognizes that excessive leakage may occur at only one side of the oven's access door, and by feeding the radiated microwave power picked up by the particular wave trough at that side through the wave trough located where little or no leakage is taking place, a more effective attenuation is realized.

While it is planned that the various wave troughs be connected in series, as mentioned above, to obtain greater attenuation, it is within the purview of the invention to provide detection equipment for each trough, thereby enabling the user of the oven to determine whether the primary door seal at the right, left, top or bottom of the access opening to the cooking cavity is defective.

In a preferred embodiment of the present invention a dielectric material with a sufficient dielectric constant and loss factor is used to attenuate the flow of microwave power across and past a wave trough transmission line surrounding the periphery of an entrance to a microwave heating cavity, while simultaneously acting as a microwave phasing element for the integral microwave antenna circuit. The dielectric material is placed within a metallic trough which acts as a reflector element in conjunction with a microwave detector propagation circuit which may be slightly embedded or covered with appropriate insulation. The center conductor of the wave trough transmission line is orientated within the structure in such a manner as to intercept microwave energy having multiple electric field of propagation.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a microwave oven having an exemplary form of my control and monitoring device installed thereon;

FIG. 2 is an enlarged fragmentary perspective view of the lower right hand corner of the oven illustrated in FIG. 1 for the purpose of showing to better advantage certain details not clearly set forth in FIG. 1;

FIG. 3 is a top plan view of a portion of one of the printed circuit boards depicted in FIGS. 1 and 2, the board carrying a cross-polarized radiation antenna that plays an important role in the practicing of my invention;

FIG. 4 is a schematic diagram showing a plurality of units comprising my radiation monitoring device which units are connected in series with alarm circuitry shown at one end for warning the user when an excessive amount of leakage occurs, the antenna array having a high frequency short at its other end;

FIG. 5 is a diagrammatic view corresponding to FIG. 4 but illustrating an additional termination at the end to which the warning circuitry is connected, the additional termination absorbing any excess power that may be radiated from the oven into my device;

FIG. 6 is still another diagram showing how my invention may be employed, the four units at the sides of the access opening being individually connected to an alarm circuit so as to signify more precisely where the fault exists, and

FIG. 7 is a sectional view taken in the direction of line 7—7 in FIGS. 1 and 2 but illustrating a somewhat modified oven construction which embodiment has been used during actual tests of my invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

It will be helpful to preface the following detailed description of apparatus exemplifying my invention by stating that all parts hereinafter mentioned are of metal, preferably aluminum, unless otherwise stated.

Referring now to FIG. 1, a typical microwave oven has been denoted generally by the reference numeral **10**. The oven **10** includes a cabinet **12** containing a cooking cavity **14** therein. A microwave generator **16** appears at the rear and excites the cavity **14** through a wave guide **18**. The cabinet **12** has a front wall **20** with an access opening **22** therein. A door **24** provides

access to the cooking cavity **14** through the opening **22**. More specifically, the door **24** includes an overlapping or overlying marginal portion or border **26**, an offset panel portion **28** and a peripheral wall **30** that extends between the portions **26** and **28**. A hinge **31** permits the door **24** to be swung open in order to permit an article that is to be heated or cooked to be inserted through the opening **22** into the cavity **14**.

As explained above, the panel portion **28** is offset with respect to the overlapping or overlying marginal portion or border **26**. Actually, the panel portion **28** functions in cooperation with parts presently to be described to provide a primary radiation seal. In this regard, it will be perceived that a spring seal **32** extends around the access opening **22** and that the offset panel portion **28** bears thereagainst when the door **24** is closed. Inasmuch as the access opening **22** is rectangular, there are sections of the seal **32** at each side of the opening **22**. Accordingly, it is believed of assistance to assign specific distinguishing reference numerals to the portions of the spring seal **32** at each side of the access opening **22**. In this regard, it will be noted that the spring seal at the bottom of the access opening **22** has been given the reference numeral **32B**, the portion at the right the numeral **32R**, the portion at the top the numeral **32T** and finally the portion at the left the reference numeral **32L**. The spring seal **32** composed of the portions **32B**, **32R**, **32T** and **32L** is reversely folded or bent to form a mounting strip **34** and a diverging resilient or flexible sealing strip **36**. It is actually the strip **36**, there being a strip associated with each portion **32B**, **32R**, **32T** and **32L**, that is contacted or engaged by the door **24** when closed, more specifically the panel **28** thereof. A stiffener **33** is interposed between the mounting strip **34** and the diverging strip **36**. Any preferred number of mounting holes **38** (see FIG. **7**) can be provided in the mounting strip **34**, attaching screws **40** extending through these holes, through aligned holes in the stiffener **33** into tapped holes in the front wall **20** of the cabinet **12**; one such screw **40** can be seen in FIG. **2**.

The primary radiation seal that involves the door **24**, more specifically the panel portion **28** thereof, and the spring seal **32** is not per se novel. The difficulty experienced with such a seal, however, has entailed certain drawbacks and the present invention seeks to obviate the shortcomings of such an arrangement standing alone. In this regard, it will be appreciated that the spring contact method has resulted in leakage where the spring parts are not kept clean, thereby permitting an objectionable amount of radiation leakage to take place. Furthermore, when there is any appreciable discontinuity with respect to the engaging surfaces of a metal seal, such as that alluded to above, arcing has taken place with a concomitant deterioration of the seal itself. However, by combining the sealing construction described above (which is only typical of several primary radiation seals) with what will now be referred to results in a highly effective and safe sealing arrangement.

Playing a very important role in the practicing of my invention is a radiation or transmission line device designated generally by the reference numeral **42**. Actually, the radiation device **42** is composed of four individual units that may be arrayed in two different ways, as will become apparent as the description progresses. Once again, inasmuch as the access opening is rectangular and therefore has four sides, the individual units constituting the radiation device **42** have been labeled **42B**, **42R**, **42T** and **42L** (all four units appearing in FIG. **4**, as well as in FIGS. **5** and **6**), the letter designations corresponding to those employed in conjunction with the spring seal **32**. Each unit **42B**, **42R**, **42T** and **42L** includes a channel-shaped trough member **44** having spaced side walls **46**, **48** and a connecting wall **50**. The trough member **44** thus forms a longitudinal recess or groove **52** having an entrance slot **54** lying in the plane of the edges of the side walls **46**, **48**. The foregoing construction is pictorially represented in FIG. **2** and reference thereto will provide a ready understanding of the details involved. In this regard, it is to be observed that any preferred number of screws **56** passing through a corresponding number of holes **58** in the front wall **20** serve to anchor the radiation device **42** in place, the screws **56** being threadedly engaged with holes **60** in the side wall **46** of each trough member **44**. Actually, the radiation device **42** can be succinctly described as resembling a rectangular picture frame, the trough members **44** constituting the molding thereof.

It has already been stated that unless otherwise designated the materials used in constructing the various parts of not only the oven **10** but the additional parts comprising my invention are of metal. Consequently, the trough member **44** is of metal, preferably extruded aluminum, but the material contained therein, which has been indicated by the reference numeral **62**, is a dielectric material. Various synthetic resins may be used as the dielectric material **62**. For example, a number of synthetic resins are satisfactory, such as epoxy (Araldite), urea, phenolic, polyester or if desired a ceramic material may be employed. The specific type of dielectric material utilized during the testing procedures will be described hereinafter when referring to other data concerned with the actual testing of my radiation device **42**.

At this time, attention is directed to the level of the dielectric material **62** within the longitudinal recess or groove **52** of the channel-shaped trough members **44**. The dielectric material **62** does not completely fill the recess **52** to the level of the entrance slot **54**, but instead space is left for the emplacement of a printed circuit board **64**. The printed circuit board **64** includes a plastic substrate or base strip **65**, such as fiber glass epoxy, and has evaporated thereon or otherwise applied thereto a copper antenna **66** in the form of a flat ribbon. Inasmuch as the antenna **66** is a cross-polarized antenna, the specific configuration or pattern thereof is important and in this regard it will be discerned from FIG. **3** that the antenna **66** is composed of spaced longitudinal portions **66*a*** residing near the access opening **22** and alternately spaced portions **66*b*** spaced farther from the access opening **22** there being transverse portions **66*c*** connecting the various portions **66*a*** and **66*b*** together so as to provide a continuous transmission line. The actual dimensions of the antenna **66** will be given when describing the specific test embodiment. At this time, though, it should be recognized that the antenna **66** resides in a plane perpendicular to the plane of the access opening **22**. The plane of the antenna **66** also is perpendicular to the general plane of the door **24** when closed. It will be appreciated that the overlapping or overlying marginal portion or border **26** of the door **24** confronts the side wall **48** of each trough member **44** when the door **24** is closed. There is a small gap between the overlying portion **26** and the side wall **48**; therefore, the side wall **48**, that is the face thereof toward the overlying portion **26**, is coated with a suitable gasket type of material (not shown), which may be an epoxy resin. The use of gasket material on the side wall **48** is not necessary to the invention nor is it a novel idea. For instance, it could very well be added for more attenuation or prevention of intrusionary objects into the mentioned gap. To protect the cross-polarized radiation antenna **66** from wear, a somewhat similar covering or coating should be applied thereover; this coating has not been shown in the drawings but it should be a protective covering material that does not interfere with transmission circuits.

Quite obviously, the antenna **66** changes planes at the four corners of the access opening **22**. One such corner in both FIGS. **1** and **2** has been indicated by the reference numeral **68** and this same corner appears in the several schematic diagrams set forth in FIGS. **4–6**. However, a different mode of connection is resorted to in FIGS. **4** and **5** than appearing in FIG. **6**. It will be recalled that the radiation device **42** is composed of individual units **42B**, **42R**, **42T** and **42L**.

Referring to FIG. **4**, the various antennas **66** are connected at three of the corners **68** so as to provide a series-connected antenna array. In other words, the configuration or pattern shown in FIG. **4** results in a relatively long antenna composed of the various individual antennas **66** and to simplify the ensuing description one end of the antenna array has been given the reference numeral **70** and the opposite end thereof the reference numeral **72**. It will be noted from FIG. **4** that the end

70 is terminated by a capacitor 74 having one side or plate thereof connected to the end 70 and the other side or plate connected to the trough member 44 at 76. The various trough members 44 are grounded at 78. It will be recognized that the capacitor 74 provides a low impedance, actually a short circuit as far as microwave frequencies are concerned, to the metallic trough member 44. On the other hand, the capacitor 74 provides an isolated or open circuit as far as direct current is concerned.

The detection means for monitoring or sensing the amount of microwave energy picked up by the radiation device 42 will now be described. Accordingly, the other end 72 of the antenna array appearing in FIG. 4 is connected to the cathode of a diode 82, the anode thereof being connected to the trough 44 at 84. Also connected to the end 72 of the antenna array appearing in FIG. 4 is a high reactance microwave inductance labeled 86. The inductance 86 is connected to a signaling circuit denoted in its entirety by the reference numeral 88. The circuit 88 includes a potentiometer 90, the wiper arm thereof being connected to the inductance 86. The potentiometer 90 is in circuit with the gate of a silicon controlled switch 92, such as a General Electric type 3N58 series, the gate being identified by the numeral 94. It will be perceived from FIG. 4 that the anode of the switch 92 is connected to a relay coil labeled 96 having normally open contacts 98. In circuit with the normally open contacts 98 is a warning lamp 100 that is supplied from a source of power, such as the battery 102. Hence, when the relay coil 96 is energized, the contacts 98 close so as to energize the lamp 100, thereby providing the warning that an excessive amount of radiation is taking place.

As far as FIG. 5 is concerned, in the monitoring or sensing of the microwave energy the end 70 of the serially connected antenna array is connected in the same fashion as in FIG. 4, and therefore the capacitor 74 appears again in this figure. Likewise, the end 72 is connected through the same diode 82 to the trough member 44. The circuitry of FIG. 5 differs from that constituting FIG. 4 by virtue of an additional termination assigned the reference numeral 104. The additional termination 104 is in the form of an absorbing medium such as ferrite or graphite material, the additional termination being grounded at 105. In the embodiment of FIG. 5, the additional termination 104 assures the absorption of excessive amounts of power delivered to any of the antennas 66.

With reference to FIG. 6, this embodiment depicts an independent monitoring connection of the various wave troughs 44. More specifically, it will be observed that none of the corners 68 are electrically connected together and to distinguish them from the connected corners they have been labeled 68*a*. The purpose of the embodiment set forth in FIG. 6 is to specifically locate any fault that might occur, the signaling arrangement apprising the user as to which side of the access opening 22 the fault is located. In the carrying out of this objective, four capacitors corresponding to the capacitor 74 are utilized, there being one such capacitor for each antenna 66. Likewise, the end of each antenna 66 opposite or remote from the end to which the capacitor 74 is attached is connected directly to an individual signaling circuit 88. Inasmuch as the trough members 44 are electrically isolated from each other, a separate ground is provided at the locations 106B, 106R, 106T and 106L. Consequently, each circuit 88 has its own warning lamp 100. To conform with the plan adopted with respect to the several sides of the access opening 22, the various circuits 88 have been distinguished from each other by the letter suffix that has been used heretofore. Consequently, the circuit 88 for the bottom side of the access opening 22 has been assigned the reference numeral 88B, the circuit for the right side 88R, the circuit for the top the numeral 88T and the circuit for the left side the numeral 88L.

Operation

With the door 24 closed so that the access opening 22 is blocked, it will be appreciated that the offset panel portion 28 engages the spring seal 32, more specifically the resilient or flexible sealing strip 36. Consequently, the microwave energy provided by the generator 16 is, for the most part, confined to the cooking cavity 14. However, as pointed out when discussing the prior art, door seals of this type do not always sufficiently comply with the regulations specified under the Radiation Control Act.

Accordingly, any leakage escaping between the door 24 and the spring seal 32 is directed to the radiation device 42. The trough members 44, being metallic, reflect any leaking energy not first intercepted by the antenna 66. Owing to the somewhat lossy nature of the dielectric material 62, some of the microwave power is attenuated as it is reflected by the interior of the trough members 44. Due to the orientation of the antenna 66, being cross-polarized, the microwave energy that escapes past the primary seal is not only intercepted but is propagated along the antenna in a transmission line fashion. The serial connection depicted in FIG. 4 causes the attenuation to be accentuated, for whether the escape route is at the bottom, sides or top of the access opening 22, the energy is picked up and the entire device 42 serves to dissipate the energy picked up by the wave trough-type transmission line constituting the radiation device 42. This is true of either transverse electric or transverse magnetic waves, and the energy or power not dissipated is propagated through the entire antenna array to the capacitor 74. As previously pointed out, the capacitor 74 serves as a virtual short circuit for any energy reaching the end 70 of the antenna array depicted in FIG. 4. If the escaping radiation exceeds a predetermined level, this level being selectable through the agency of the potentiometer 90, then a triggering signal is applied to the gate 94 of the silicon controlled switch 92 which results in the energizing of the relay coil 76 and the simultaneous closing of the normally open contact 98. This causes the warning lamp 100 to be illuminated and the user is thereby apprised that the oven 10 is not functioning properly. The contacts 98 can also be used to disable the microwave generator 16 so as to completely inactivate the oven 10 and prevent further use thereof until the leakage situation has been corrected.

As an added precaution, the load referred to as the additional termination 104 will be effective in absorbing any microwave power that would not be dissipated when utilizing the circuit arrangement of FIG. 4. Otherwise, the embodiment of FIG. 5 functions in the same manner as the embodiment of FIG. 4.

As far as FIG. 6 is concerned, each radiation unit 42B, 42R, 42T and 42L is responsible for dissipating any leakage radiation that is received by the particular unit. The distinct advantage when utilizing the teachings of FIG. 6 is that the particular lamp 100, that is the lamp 100 associated with the circuit 88B, 88R, 88T or 88L, localizes the fault and advises the user of the particular location so that the fault in the primary sealing arrangement can be promptly corrected.

It will be appreciated, though, that no objectionable levels of radiation can take place into the ambient surroundings. This is true irrespective of both the magnitude and the polarization of the microwave power.

DESCRIPTION OF TEST EMBODIMENT

Although closely resembling the construction of the oven 10, the test embodiment differs in certain respects and therefore the modified oven of FIG. 7 bears the reference numeral 110. The oven 110 includes a cabinet 112 containing a cooking cavity 114. A front wall 120 provides the access opening 122. The flat surface labeled f on the front of the oven 110, this being the forwardly facing surface of the front wall 120, equals about 2 inches. In other words, the border is approximately 2 inches wide that extends about the access opening 122.

The door identified by the numeral 124 in FIG. 7 differs somewhat from the door 24. The door 124 includes a marginal portion or border 126, an offset panel portion 128 and a peripheral connecting wall 130.

The spring seal **132** includes a mounting strip **134** and the diverging sealing strip corresponding to the previously mentioned strip **36** is composed of two sections **136***a* and **136***b*. The section **136***a* actually diverges away from the strip **134**, whereas the section **136***b* is parallel to the strip **134**. The width of the section **136***b* has been indicated by the letter *k* and equals 0.7 inch on the test oven **110**. A stiffener **133** is interposed between the mounting strip **134** and the sections **136***a*, **136***b*. The overlapping or overlying marginal portion or border **126** has a width of approximately 1 inch.

With respect to the radiation device **42**, this device as shown in FIG. **7** corresponds closely to what has been illustrated in FIGS. **1** and **2**. It will perhaps be well, though, to list the dimensions of the trough member **44**. The inside dimensions of the trough member **44**, that is of the recess or groove **52**, have been identified by the letter h and the width by the letter w. In the test embodiment, $h = \frac{1}{2}$ inch and $w = \frac{1}{2}$ inch.

As far as the dielectric material **62** is concerned, the actual material used possessed a dielectric constant of **11.2** and a dielectric loss tangent of 0.04 as measured by the Massachusetts Institute of Technology when subjected to a frequency of 3,000 mHz. The material was a polyester resin marketed by Ashland Chemical Company, a division of Ashland Oil & Refining Company, and modifications of this material are aptly described in their technical bulletin 1148 of June 1968. Such materials are highly desirable in that they contain moisture on the order of 50 percent on a weight basis.

For an operating frequency of 2,450 ± 20 mHz., the antenna **66**, which is detailed in FIG. **3**, had the following dimensions:

a = 0.268 inch
b = 0.268 inch
c = 0.300 inch
d = 0.032 inch
e = 0.437 inch

It will be appreciated that *e* in the above listing is the width of the printed circuit board **64**. Missing from the above tabulation is the thickness of the copper circuitry constituting the antenna **66**; in practice it was 0.0028 inch. The thickness of the substrate **65** was 0.023 inch.

The silicon controlled switch **92** has already been identified as a General Electric type 3N58. However, the diode **82** has not been identified. This diode constituted a Hewlett-Packard series 5082 rectifier of the epitaxial, planar, passivated diode type whose construction utilizes a combination of both a conventional PN junction and a Schottby barrier. This rectifier, quite desirably, has the high breakdown and temperature characteristics of silicon, the turn on voltage of germanium, and the speed of a Schottby barrier, majority carrier device.

As far as the cooking cavity **114** is concerned, the dimensions of this cavity were 30 cm. (depth) by 39 cm. (width) by 24 cm. (height). The cavity power supplied by the generator 16 was 700 watts. The frequency, as indicated above, was 2,450 ± 20 mHz.

Radiation Test Results

Although extensive tests were made under different conditions, only a summary thereof is believed necessary in order to appreciate the benefits to be derived from a practicing of my invention. Accordingly, the summarized radiation survey and sequence of operation included the following modes of operation:

1. 700 watts into 275 cc. load of water Normal Door Closure
2. 700 watts into empty oven Normal Door Closure
3. 700 watts into 275 cc. load of water Abnormal Door Closures - against 0.050" paper shim (2.0 inches by 1.25 inches) placed at right, left, top and bottom positions
4. 700 watts into empty oven Abnormal Door Closures - against 0.050" paper shim (2.0 inches by 1.25 inches) placed at right, left, top and bottom positions

Without the use of this invention, conditions (3) and (4) in which the door seals were faulted gave radiation levels in excess of 20 milliwatts per square centimeter at a distance of 5 centimeters from the oven. With the installation of the wave trough transmission system all tests for each mode of operation were below the maximum radiation level prescribed by Federal Radiation Standards. Additionally, provision was made for disabling the apparatus if objectionably high voltages appeared, but the sensed voltages simply did not reach environmental hazard levels due to the effectiveness of my method.

I claim:

1. Microwave heating apparatus comprising a cabinet having a cooking cavity therein, means for supplying microwave power to said cavity, and an access opening in one wall thereof through which an article to be heated is inserted, a door overlying the marginal portions of said cabinet wall that reside adjacent said access opening, and a radiation sealing device extending along at least one side of said opening which includes metallic trough means providing an elongated recess open at the side thereof nearer said access opening to form a slot having a width extending in a transverse direction between said cabinet wall and door, said radiation sealing device further including antenna means disposed in said recess to receive radiation leakage.

2. Microwave heating apparatus in accordance with claim **1** in which said radiation device is disposed at a location between said wall and a confronting portion of said door.

3. Microwave heating apparatus in accordance with claim **2** in which said radiation device includes a dielectric material contained in said recess for supporting said antenna means.

4. Microwave heating apparatus in accordance with claim **3** in which said antenna means constitutes an element having a first series of spaced portions thereof located nearer said cavity, and a second series of alternate spaced portions thereof located nearer said door and a third series of connecting portions extending between said first and second portions.

5. Microwave apparatus in accordance with claim **1** in which said first and second spaced portions are parallel to each other and said third portions are perpendicular thereto.

6. Microwave heating apparatus in accordance with claim **5** in which said antenna element is in the form of a flat ribbon residing in a plane perpendicular to the plane of the access opening.

7. Microwave heating apparatus in accordance with claim **4** in which said radiation device includes termination means at one end thereof providing a relatively low impedance path between said antenna means and said trough means.

8. Microwave heating apparatus in accordance with claim **7** in which said termination means includes a capacitor for shorting high frequency power from said antenna means to said trough means.

9. Microwave heating apparatus in accordance with claim **7** including detection means connected to the other end of said radiation device for monitoring the amount of microwave energy picked up by said radiation device.

10. Microwave heating apparatus in accordance with claim **9** in which said detection means includes a control switch and means for rectifying a portion of the microwave power picked up by said radiation device to supply direct current to said control switch and cause operation thereof when the direct current supplied thereto reaches a predetermined level.

11. Microwave heating apparatus in accordance with claim **8** in which said radiation device includes a plurality of antenna elements connected in series and said capacitor is connected at one end of said serially connected antenna elements.

12. Microwave heating apparatus in accordance with claim **11** including an additional termination means at the other end of said serially connected antenna elements, said additional termination means being capable of absorbing excessive amounts of power delivered to said plurality of antenna elements.

13. Microwave heating apparatus comprising a cabinet having a cooking cavity therein and an access opening in one wall thereof through which an article to be heated is inserted, a

door overlying the marginal portions of said cabinet wall adjacent said access opening, primary radiation sealing means attached to the marginal portions of said cabinet wall in a proximal relationship to said access opening and engageable by said door, and radiation means attached to the marginal portions of said cabinet wall outwardly of said primary sealing means for dissipating microwave power leaking past said primary sealing means when said door is closed, said radiation means further including a cross-polarized antenna element disposed generally in the plane of the open side of the trough member with which it is associated.

14. Microwave heating apparatus in accordance with claim **13** in which said trough members are joined to form a serially connected trough configuration extending along the sides of said access opening and in which said individual antenna elements are also serially connected to form a unitized construction, and means connected between one end of the thus formed antenna array and one of said interconnected trough members for dissipating at least some of the microwave power radiated to said antenna array which power has leaked past said primary sealing means.

15. Microwave heating apparatus in accordance with claim **14** including means connected to the antenna array for sensing the amount of microwave power radiated to said antenna array.

16. Microwave heating apparatus in accordance with claim **15** in which said sensing means is connected to the other end of said antenna array.

17. Microwave heating apparatus in accordance with claim **15** including means connected to said antenna array for absorbing excessive amounts of power radiated to said antenna array.

18. Microwave heating apparatus in accordance with claim **17** in which said absorbing means is connected to the other end of said antenna array.

19. Microwave heating apparatus in accordance with claim **13** including respective means connected between one end of each antenna element and the trough member with which that antenna element is associated for dissipating at least some of the microwave power radiated to said antenna elements.

20. Microwave heating apparatus in accordance with claim **19** including respective means connected to the other end of said antenna elements for sensing the amount of microwave power radiated to each antenna element.

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