

[54] **MICROWAVE OVEN DOOR SEAL**
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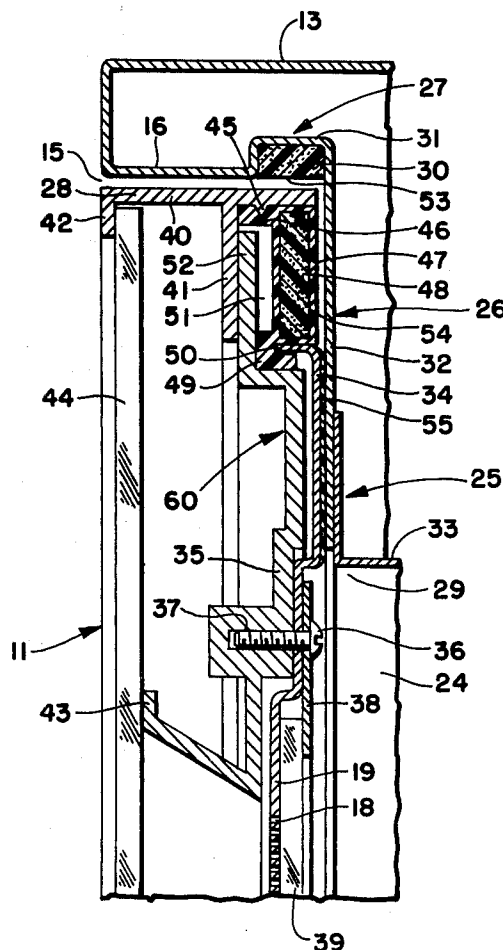
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[58] **Field of Search**..... 219/10.55, 10.55 D

[56] **References Cited**
UNITED STATES PATENTS

2,920,174	1/1960	Haagensen.....	219/10.55
3,525,841	8/1970	Haagensen et al.....	219/10.55
3,731,035	5/1973	Jarvis et al.....	219/10.55
3,803,377	4/1974	Nakano.....	219/10.55
3,809,843	5/1974	Takayama.....	219/10.55 D

[57] **ABSTRACT**
An electronic device, such as an electronic oven or other device in which electromagnetic radiation is used, has primary, secondary, and tertiary radiation seals for preventing radiation leakage from the device. In one form of the invention a microwave oven has a primary capacitive radiation seal formed between the oven body and the hinged oven door with a secondary radiation absorbent seal in the door about the oven access opening and a tertiary radiation seal including radiation absorbent material in the oven body about the access opening except proximate the hinged edge of the door where the hinge itself forms the tertiary seal.

16 Claims, 4 Drawing Figures



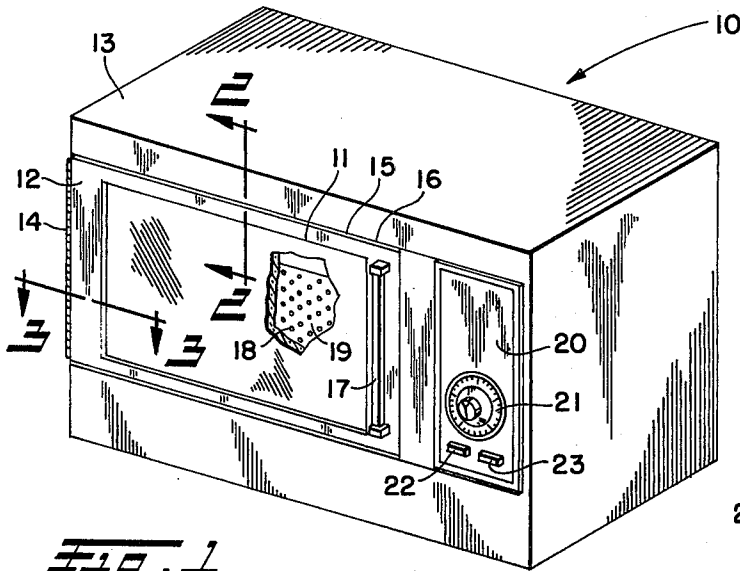


FIG. 1

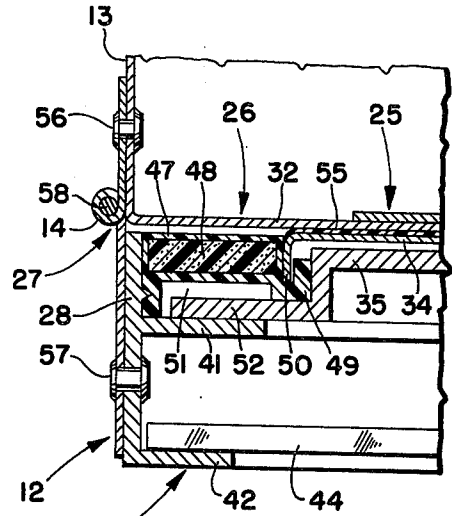


FIG. 3

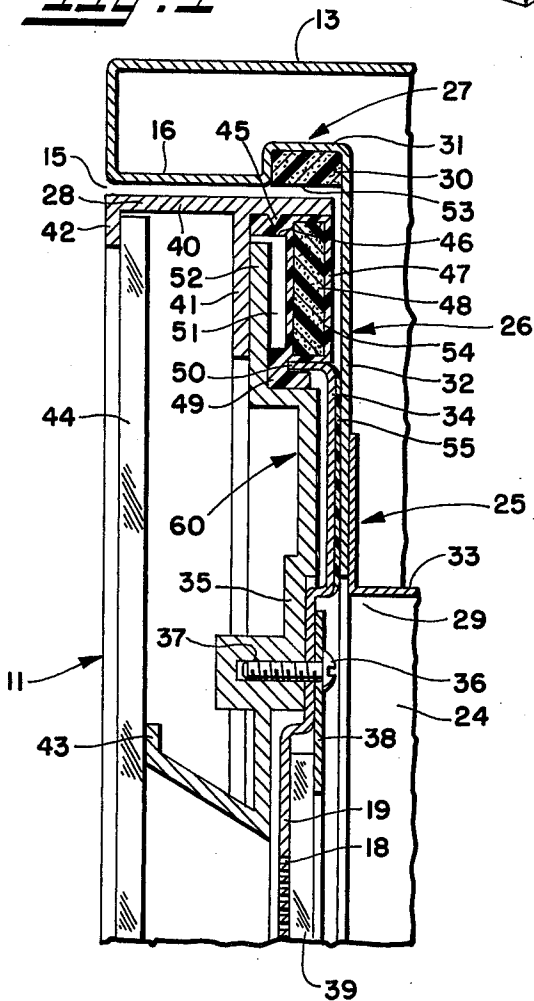


FIG. 2

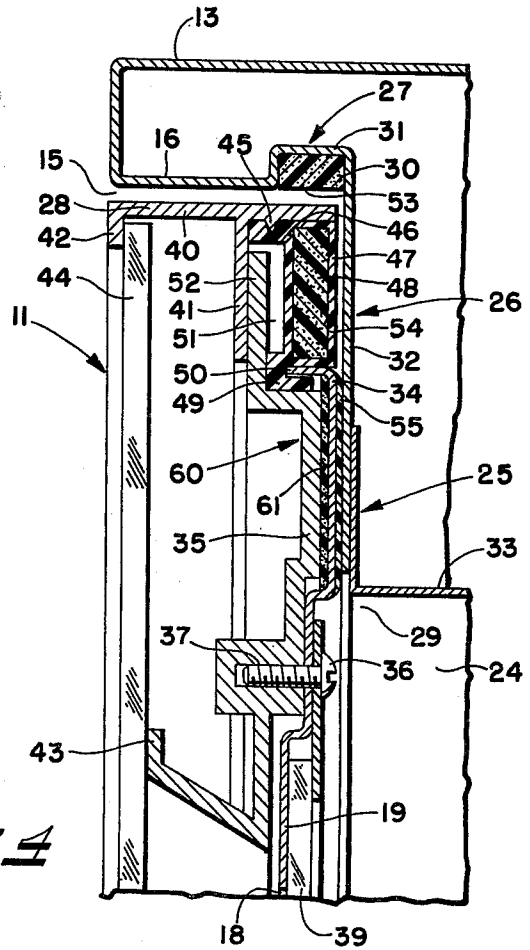


FIG. 4

MICROWAVE OVEN DOOR SEAL

BACKGROUND OF THE INVENTION

Electronic devices, such as ovens including microwave ovens and other high frequency ovens in which electromagnetic radiation is used to cook food, have employed various types of seals to prevent radiation leakage from the oven cooking cavity. Prior art radiation seals have included choke type seals, radiation absorbent seals, as well as capacitive type seals. One problem experienced in prior art electronic oven seals has been the occurrence of radiation leakage due to the failure either in whole or in part of one or more seals due to dirt accumulation thereon, arcing, or accidental destruction thereof, such as for example by scraping a dish or pot across the surface of a capacitive seal or the breaking of a radiation absorbent seal. Also, the accumulation of food particles in the seal region of an electronic oven keeps the oven door slightly ajar during operation and causes the seal to be ineffective permitting radiation leakage.

SUMMARY OF THE INVENTION

Accordingly, the primary object of the invention is to provide a safe seal for preventing radiation leakage from an electronic oven or other device in which electromagnetic radiation is used.

Another object of the invention is to provide an electronic oven with capacitive and absorbent electromagnetic radiation seals for preventing radiation leakage.

An additional object of the invention is to provide a plural stage seal for preventing radiation leakage from electronic ovens and the like.

A further object of the invention is to provide a safe door closure and seal for preventing radiation leakage from electronic ovens and the like.

Still another object of the invention is to provide a combination capacitive and absorbent seal for preventing radiation leakage from electronic ovens and the like.

Still an additional object of the invention is to provide secondary radiation seals for supplementing the radiation sealing capacity of a primary radiation seal to prevent radiation leakage from electronic ovens and the like.

These and other objects and advantages are realized in the instant invention which comprises an electronic oven having an oven body, oven cooking cavity, access opening for the oven cooking cavity, a door for closing such access opening, and a plural stage radiation seal for preventing radiation leakage from the oven cooking cavity, including a primary capacitive radiation seal, a secondary absorbent radiation seal, and a tertiary radiation seal.

To the accomplishment of the foregoing and related ends, the invention, then, comprises the features hereinafter fully described, the following description and the annexed drawing setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but several of the various ways in which the principals of the invention may be employed.

BRIEF DESCRIPTION OF THE DRAWING

In the annexed drawing:

FIG. 1 is an isometric view partially broken away of an electronic oven using a radiation seal;

FIG. 2 is a section view of a radiation seal taken along the line 2—2 of FIG. 1;

FIG. 3 is a section of a radiation seal and door hinge taken along the lines 3—3 of FIG. 1; and

FIG. 4 is a section view of a modified form of radiation seal in accordance with the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing wherein like reference numerals refer to like elements in the several figures, the invention will be described hereinafter as relating to a radiation seal for use in a specific type of electronic oven, viz. a microwave oven, although the invention may be used with various types of electronic ovens or other devices in which electromagnetic radiation is used.

Turning to FIG. 1, a microwave oven generally indicated at 10 includes an oven cooking cavity open at the front and closed by an oven door 11 secured at its left edge 12 to the oven body 13 by an electrically conductive continuous elongated piano type hinge 14, and the door is recessed within the front of the microwave oven body at its other three edges defining narrow gaps or spaces 15 between such other three edges and the overlapping framing portion 16 of the oven front. A handle 17 is located on the right front side edge of the door, and small perforations 18 in the main door panel 19 permit viewing into the oven during operation without leakage therethrough as is conventional. A control panel 20 including a timer 21 and several control buttons 22, 23 for controlling oven operation are located at the right side portion of the oven.

Referring now more specifically to FIG. 2, the oven door 11 and the oven body 13 proximate the upper door edge are illustrated and are exemplary of the oven body 13, oven cooking cavity 24, and oven door 11 proximate the three non-hinged door edges. The primary 25, secondary 26, and tertiary 27 electromagnetic radiation seals are illustrated and extend about the entire periphery of the oven cavity front access opening the latter seal being varied at the hinged door edge 12. Also, the narrow gaps 15 formed between the three non-hinged planar recessed door edges 28 and the overlapping framing portions 16 of the oven body define a further or fourth stage capacitive radiation seal as will become more apparent as the description proceeds. The oven body 13 and oven door 11 at the hinged door edge 12 are illustrated in FIG. 3 in which the primary 25 and secondary 26 radiation seals, similar to those at the non-hinged edges, are shown with the electrically conductive piano type hinge 11 effectively forming a tertiary seal 27 to block any radiation not blocked by the primary nor absorbed by the secondary radiation seals.

In FIG. 2 the oven door 11 is shown in closed position to cover the access opening 29 to the oven cooking cavity 24 and recessed within the oven body 13, the planar edge 28 of the door being parallel and proximate the overlapping framing portion 16 of the oven body forming the gaps 15 described above. Adjacent the narrow gaps 15 is positioned a quantity of electromagnetic radiation absorbent material 30, which exhibits lossy properties, and may be, for example, ferrite in a rubber binder, powdered iron in bakelite or phenolic, or a similar substance for absorbing electromagnetic radiation. The radiation absorbent electromagnetic radiation.

The radiation absorbent material 30 is mounted within a recess 31 formed in the overlapping framing portion 16 of the oven body proximate the plane defined by the vertically extending walls 32 surrounding the access opening 29. The vertically extending walls 32 may be, for example, magnetic stainless steel, which is electrically conductive and exhibits lossy properties; and the oven cooking cavity 24 is defined by walls 33 formed, for example, of non-magnetic stainless steel or other suitable material for reflecting electromagnetic radiation throughout the same.

The main door panel 19, which may be made of steel or other strong electrically conductive material, is stamped in relief to form a flat central part and a pressure plate portion 34, the former having the perforations 18 therein. If desired, the door 19 may be substantially planar, although such design may tend to reduce the effective volume of the oven cooking cavity. The door panel 19 is secured to an electrically conductive door frame extrusion 35, defining a substantially rectangular door frame, by fasteners 36 threaded into recesses 37 formed within the latter, the fasteners also connecting a retaining plate 38 to the door frame extrusion for holding an inner protective transparent plate 39 in position within the door. The transparent plate 39 may be, for example, glass or other suitable material which permits viewing the oven cooking cavity from outside the oven while eliminating oven dirt from depositing on the door panel 19 during oven operation.

The door frame extrusion 35 forms one part of the door frame for the door, the other part being formed by an electrically conductive trim piece 40, which has a coupling extension 41 to mate with the door frame extrusion. Both the door frame extrusion 35 and the trim piece 40 may be formed, for example, of aluminum or similar material, and are fastened together by welding or other suitable means. The trim piece 40 has a front flange 42 which cooperates with a projecting support part 43 of the door frame extrusion 35 to maintain an outer protective transparent plate 44 in position in the door. The outer protective transparent plate 44, may be, for example, glass or other suitable material which prohibits insertion of objects through the perforations 18 in the door panel 19, eliminates dirt accumulation within the door and oven, and permits viewing the oven cavity from the outside. If desired, the perforations 18 in the door panel 19 as well as the protective transparent plates 39, 44 may be eliminated, being replaced by other nonconductive, non-transparent, protective material such as, for example, plastic sheet material positioned at least on the front side of the door remote from the oven cavity.

The trim piece 40 also has a locking protrusion 45 which projects into a recess formed in an upper extent 46 of a seal cover 47 made of plastic or other suitable material for holding radiation absorbent material 48 similar to that described above and extending about all four edges of the door. A lower portion of the seal cover has a flanged lip 49 for locking in position under the terminal edge 50 of the door panel 19. A space 51 is formed behind the seal cover 47 between it and a section 52 of the door frame extrusion 35, although, if desired, the cover may be enlarged to fill the space, increasing the amount of radiation absorbent material required to fill the seal cover as well. It has been determined, however, that the radiation absorbent material most proximate the electromagnetic radiation absorbs

the majority of such radiation; therefore, the use of an enlarged seal cover to fill the space would require unnecessary additional radiation absorbent material. The radiation absorbent material 30, 48 in the recess 31 about the three non-hinged door edges and in the seal cover 47 about all four door edges have relatively large surface areas 53, 54 for absorption of electromagnetic radiation, each of such radiation absorbent material forming a supplemental radiation seal to absorb radiation leaking passed the primary radiation seal 25 to be described in more detail hereafter. While the radiation absorbent materials 30, 48 have been described above as being located in the oven body and oven door, respectively, it is contemplated that such materials may alternatively be positioned respectively in the opposing surfaces of the door or body. Also, if desired, both such materials may be in the oven door or in the oven body.

The primary radiation seal 25 for the microwave oven 10 is formed by the door panel pressure plate portion 34 proximate all four door edges, which is coated on one surface with a hard dielectric material 55. The pressure plate portion 34 with the coating thereon is urged, when the door is closed, into abutment with the vertically extending walls 32 of the oven body to form a capacitive radiation seal therewith. The dielectric material 55 coating the door panel pressure plate portion may be, for example, epoxy paint, which is electrically non-conductive, strong and adherent, to separate the electrically conductive pressure plate portion and the vertically extending walls of the oven body, thus defining a capacitive area therebetween. If desired, the dielectric material may be located on the vertically extending walls 32 opposite the pressure plate portion 34, or on both such surfaces. Alternatively, the pressure plate portion 34 of the door panel or the vertically extending walls 32 of the oven body 13 may be formed of anodized aluminum, the coating on such aluminum being electrically non-conductive and forming the dielectric material between the aluminum and the other surface thereby forming the primary capacitive radiation seal 25. The purpose of the dielectric coating is to insure proper spacing of the conductive sides of the seal and to prevent arcing therebetween.

The access opening 29 for the oven cooking cavity 24 defines a first plane, and the vertically extending walls 32 of the oven body 13 are positioned parallel to such plane. The primary capacitive radiation seal 25 effectively surrounding the access opening, of course, is preferably located along such plane, and the enlarged surface area 54 of the radiation absorbent material 48 forming the secondary radiation seal 26 substantially surrounding the access opening is also located substantially parallel to such plane. The radiation absorbent material 30 forming the tertiary radiation seal 27 of the three non-hinged door edges is in a second right angle plane defined by the narrow gaps 15 and has at least a portion of its enlarged surface area 53 intercepting the first noted plane, and the hinge 14 forming the tertiary seal at the hinged door edge 12 is effectively in the first mentioned plane. Thus, the elongated and folded path which radiation must follow to escape the oven together with the plural stage radiation seal comprised of the primary, secondary, and tertiary seals insures that no radiation leakage will occur.

The oven door 11 connected to the oven body 13 by the electrically conductive continuous piano type hinge 14 which is fastened to the body and the left hand door.

edge 12 by rivets 56, 57, illustrated in FIG. 3, is rotatable about a central pin 58. At the hinged door edge the door panel 19, door frame extrusion 35, screw fasteners 36, trim piece 40, and the primary and secondary radiation seals 25, 26 are similar to those shown in FIG. 2 representative of the non-hinged door edges. At the hinged door edge 12, however, the hinge 14 itself prevents any radiation leaking beyond the primary radiation seal 25 and the secondary radiation seal 26 from escaping the oven and thus forms the tertiary radiation seal 27 along that edge. In the event that a non-continuous hinge is desired, such may be substituted for the continuous hinge, and in this configuration the hinged outer edge 12 should be recessed within the framing portion 16 of the oven body with the cross section of that hinged edge being as illustrated in FIG. 2 to provide for tertiary radiation sealing protection.

In operation of the microwave oven 10, the timer 21 is properly adjusted and the start button is depressed to permit energization of a magnetron tube or other device for providing electromagnetic radiation to the oven cooking cavity 24. During operation the oven cooking cavity 24 may be viewed through the transparent plates 39, 44 and the perforations 18, which are sufficiently small to enable the door panel to prevent radiation leakage from the oven, as is known in the art.

The door 11 is preferably spring loaded or otherwise locked into closed position during operation, whereby the pressure plate portion 34 and the coating 55 thereon are urged uniformly into abutment with the vertically extending walls 32 of the oven body thus forming the primary capacitive radiation seal 25 about the entire periphery of the oven access opening 29. The capacitive seal forms a relatively low impedance for the electromagnetic radiation in the oven cooking cavity thereby providing a short circuit between the pressure plate portion 34 of the door and the vertically extending walls 32 of the oven body to prevent any radiation from escaping beyond such primary seal. Also, the vertically vertically extending walls provide for some absorption of radiation due to lossy characteristics of the magnetic stainless steel of which it is formed.

Occasionally a small food particle or other material may become lodged between the two disengageable surfaces forming the primary capacitive radiation seal 25, which particle then permits a small amount of electromagnetic radiation to pass beyond such seal, and the majority of this leaking radiation is absorbed by the secondary radiation seal 26. Such radiation passes through the secondary radiation seal lossy material 48 being absorbed thereby, and that radiation which completely penetrates the latter is reflected by the section 52 of the electrically conductive door frame extrusion positioned behind the seal cover 47 back through the radiation absorbent material 48 for further absorbence. The tertiary radiation seal 27 lossy material 30 absorbs any radiation avoiding absorbence by the secondary radiation seal along the three non-hinged door edges. Any radiation bypassing this latter seal is at a very low power level, and a fourth stage capacitive radiation seal formed at the narrow gaps 15 between the planar edges 28 of the door and the overlapping framing portion 16 of the oven body 13 prevents such radiation from leaking. This last capacitive seal does not require a dielectric material other than air because the power level of any radiation reaching the area of such capacitive seal is so low as to be unable to cause arcing.

Sealing against radiation leakage at the hinged side 12 of the oven and door is similar to that described above with reference to primary and secondary radiation seals 25, 26 at the other three recessed non-hinged edges of the door. At the hinged edge 12, however, the piano type hinge 14 blocks a flow path for any radiation not having been blocked by the primary capacitive radiation seal 25 or absorbed by the secondary radiation seal 26.

In the alternative embodiment illustrated in FIG. 4, sealing at all four door edges is accomplished as described above, and an additional radiation seal 60 defined by the further radiation absorbent material 61 positioned behind the pressure plate portion 34 of the door plate 19 absorbs any radiation finding its way behind such portion, for example between the lower portion of the seal cover 47 and the terminal edge 50 of the door plate.

Thus, as now may be understood, the instant invention provides a plural stage radiation seal including at least primary, secondary, and tertiary portions, for preventing electromagnetic radiation leakage from microwave ovens or other similar devices which use such radiation.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. An electronic device in which electromagnetic radiation is used, comprising an oven body, a cooking cavity in said oven body, an access opening to said cooking cavity, a door coupled to said oven body and movable between an open position for access to said cooking cavity through said access opening and a closed position closing said access opening, said door having at least three edges recessed within an overlapping portion of said oven body when said door is in such closed position, said door having an inwardly facing substantially planar portion generally parallel to the plane of said access opening, and electromagnetic radiation seal means for preventing radiation leakage from said cooking cavity through said access opening when said door is in said closed position, said electromagnetic radiation seal means comprising a capacitive seal adjacent said access opening, said capacitive seal including said substantially planar portion of said door and an opposed portion of said oven body, said portions being electrically conductive, and electrically non-conductive material positioned therebetween and adhered to at least one of said portions, a first electromagnetic radiation absorbent seal including electromagnetic radiation absorbent material in a hollow part forming an indentation in at least one of said door and oven body following said capacitive seal, and a second electromagnetic radiation absorbent seal including electromagnetic radiation absorbent material in a hollow part forming an indentation in at least one of said oven body overlapping portion and door edges following said first electromagnetic radiation absorbent seal.

2. An electronic device as set forth in claim 2, wherein said electrically non-conductive material comprises epoxy material coating said portion of said door.

3. An electronic device as set forth in claim 1, wherein one of said electrically conductive portions comprises anodized aluminum, the coating thereon comprising said electrically non-conductive material.

4. An electronic device as set forth in claim 1, said capacitive seal and said first and second electromagnetic

netic radiation absorbent seals being positioned proximate the plane of said access opening.

5. An electronic device as set forth in claim 4, said recessed door edges and said overlapping portion of said oven body defining a gap therebetween, said second electromagnetic radiation absorbent seal being positioned proximate said gap, and said recessed door edges and said overlapping portion of said oven body bounding said gap defining a further capacitive seal.

6. An electronic device as set forth in claim 7, wherein said first and second radiation absorbent material comprise lossy material.

7. An electronic device as set forth in claim 6, wherein said lossy material comprises ferrite material in a rubber binder.

8. An electronic device as set forth in claim 6, wherein said lossy material comprises powdered iron in a plastic binder.

9. An electronic device as set forth in claim 1, wherein said door comprises a conductive door panel mounted on a door frame, said door panel including a raised portion forming one electrically conductive side of said capacitive seal, said electrically non-conductive material comprising epoxy material coating one surface of such raised portion for restraining the latter from direct contact with said opposed portion of said oven body, the latter forming the other conductive side of said capacitive seal.

10. An electronic device as set forth in claim 10, further comprising radiation absorbent material positioned behind the other surface of said raised portion

of said door panel.

11. An electronic device as set forth in claim 9, wherein said door panel comprises a perforated door panel, and further comprising inner and outer substantially transparent protective means positioned on either side of said door panel, the latter for preventing entry through said perforated door panel to said oven cavity during oven operation and the former for preventing dirt from accumulating on said perforated door panel.

12. An electronic device as set forth in claim 9, further comprising protective electrically non-conducting material positioned on said door panel on the side remote from said oven cavity.

13. An electronic device as set forth in claim 1, further comprising a continuous hinge pivotally securing said door to said oven body at an edge thereof, said second electromagnetic radiation absorbent seal being positioned proximate the other of the door edges, and said capacitive seal and said first electromagnetic radiation absorbent seal being positioned about said access opening proximate all of said door edges.

14. An electronic device as set forth in claim 1, said first radiation absorbent material being positioned in said door.

15. An electronic device as set forth in claim 14, said second radiation absorbent material being positioned in said oven body.

16. An electronic device as set forth in claim 1, said second radiation absorbent material being positioned in said oven body.

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