

[54] **MICROWAVE OVEN AND DOOR  
STRUCTURE FOR MINIMIZING  
LEAKAGE**

[72] Inventor: Edward Z. Krajewski, Camarillo, Calif.

[73] Assignee: Bowmar/Tlc, Inc., Newbury Park, Calif.

[22] Filed: Apr. 12, 1971

[21] Appl. No.: 133,307

[52] U.S. Cl. ....219/10.55, 126/190

[51] Int. Cl. ....H05b 9/06

[58] Field of Search ....219/10.55; 126/190

[56] **References Cited**

**UNITED STATES PATENTS**

2,956,143 10/1960 Schall .....219/10.55  
3,525,841 8/1970 Haagensen et al. ....219/10.55

Primary Examiner—J. V. Truhe

Assistant Examiner—Hugh D. Jaeger

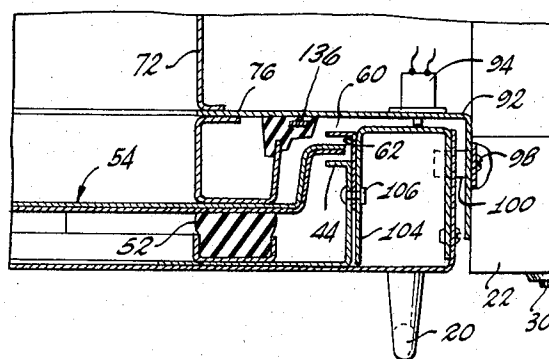
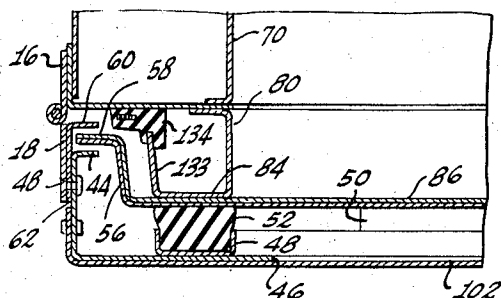
Attorney—Perry E. Turner

[57]

**ABSTRACT**

An oven structure has a front flange plate on which is a raised member that frames the oven cavity, and which has an outermost surface parallel to the flange plate. A door hinged at one end to the oven structure carries a floating pan which, via biasing elements shown as compressed rubber strips, is normally biased against a stop when the door is opened. The outer face of the pan is coated with dielectric material. When the door is closed, the coated face of the pan is brought in face-to-face engagement with the outermost surface of the frame member. The inward travel of the door upon closure causes the rubber strips to be further compressed and the lip of the pan to move free of the stop. The pan is sufficiently thin to conform to the outermost surfaces of the frame member contacted thereby, thus permitting a capacitive seal to be formed which is effective to keep leakage around the door edges to less than a milliwatt of power. In addition, the portion of the frame adjacent the flange plate is surrounded by lossy gasket material in which is embedded ferrite or other suitable microwave energy absorbing material. A door closure mechanism is shown that employs a cam which operates in conjunction with the pan biasing elements to effect desired latching of the door.

**7 Claims, 9 Drawing Figures**



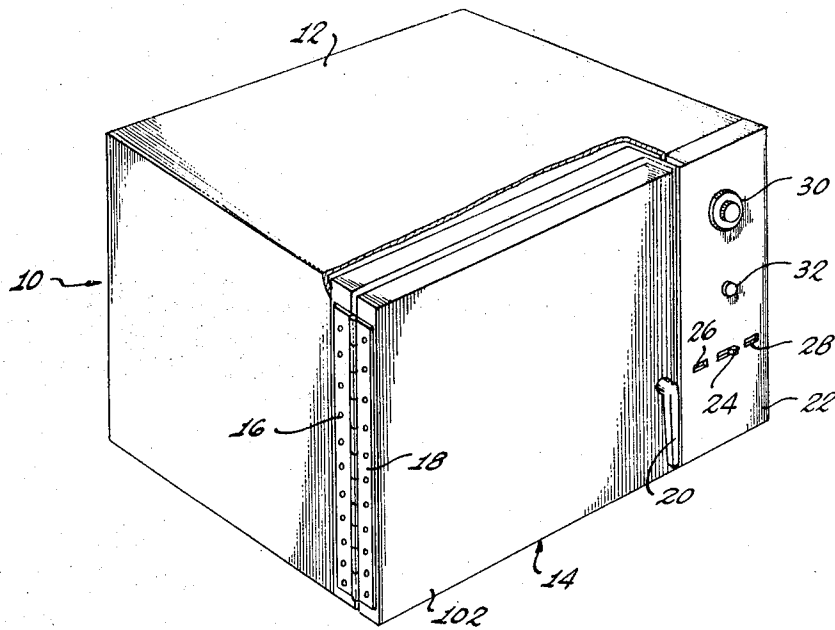


*Fig. 1*

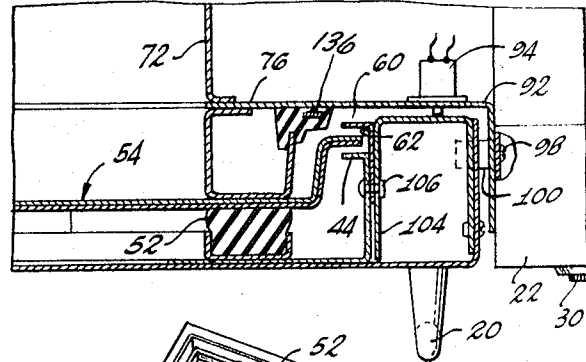
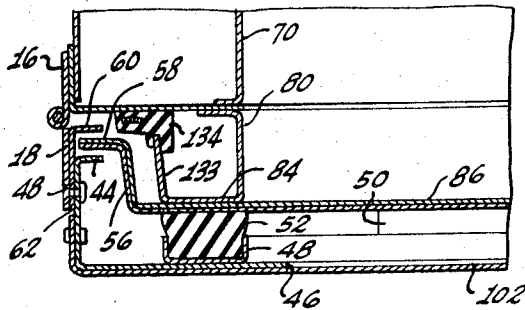


*Fig. 2*

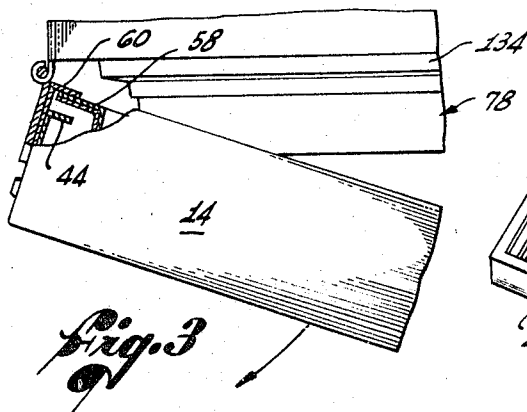


*Fig. 3*

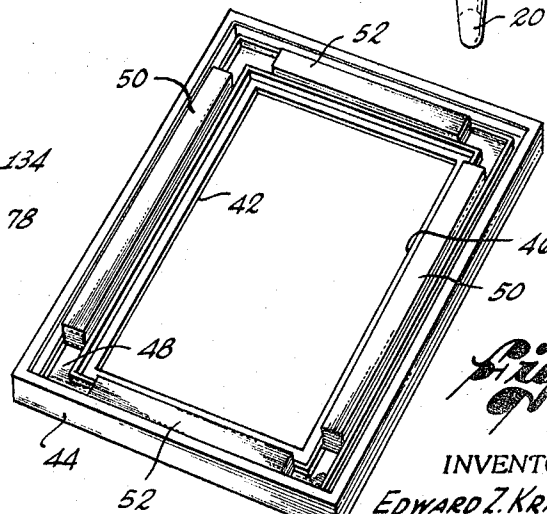


*Fig. 4*

INVENTOR.  
EDWARD Z. KRAJEWSKI  
BY  
BERRY E. TURNER  
ATTORNEY

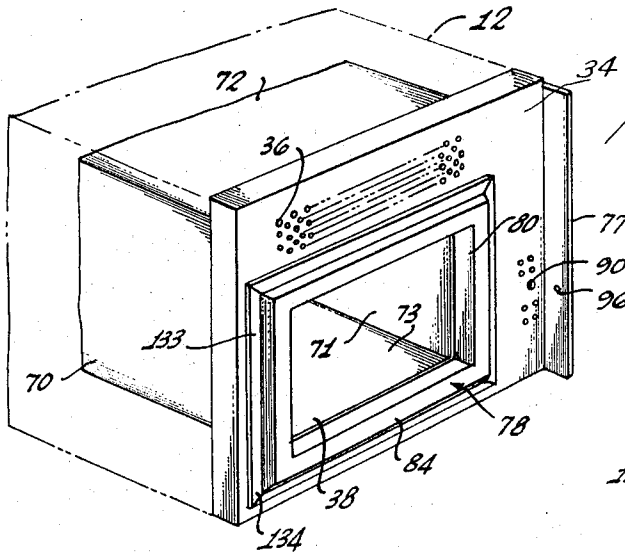


*Fig. 5*

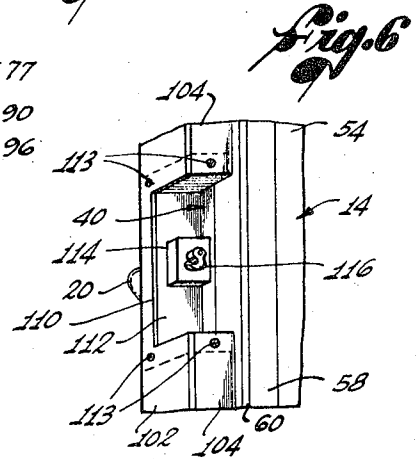


*Fig. 6*

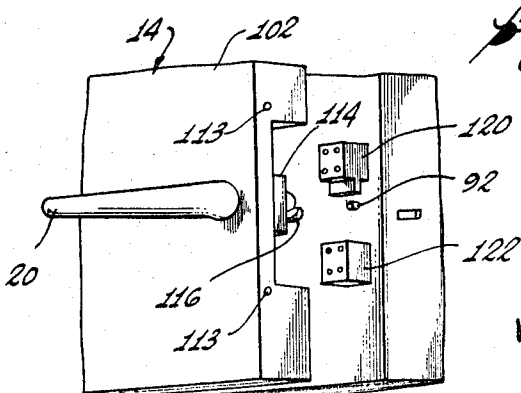


*Fig. 7*

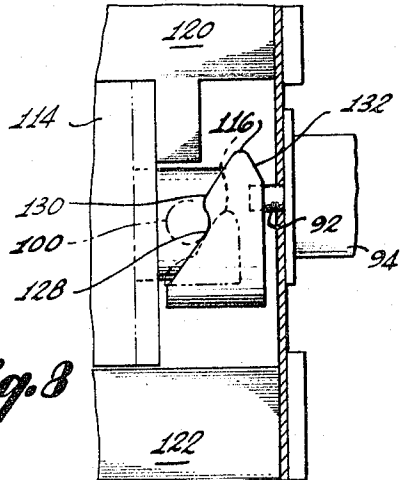


*Fig. 8*

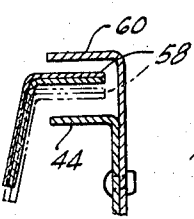


*Fig. 9*

INVENTOR.  
EDWARD Z. KRAJEWSKI  
BY *Perry E. Turner*  
ATTORNEY

# MICROWAVE OVEN AND DOOR STRUCTURE FOR MINIMIZING LEAKAGE

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

This invention relates to microwave ovens and door structures.

### 2. Description of the Prior Art

Considerable time, effort and expense have been devoted to research and development in solving the problems of leakage of microwave energy around the edges of doors of microwave ovens. Typically, provision is made for the inner metal surface of the door when closed to overlap the metal surface of the oven adjacent the cavity by a quarter of a wavelength of the second harmonic of the frequency of the plane polarized energy that tends to be radiated around the door edges. In addition to this arrangement for preventing leakage of even harmonics, the same overlapping portions are utilized to form a choke for the fundamental and odd harmonics, e.g., as by forming a groove of a quarter of the wavelength of the fundamental frequency in the door, or by forming recesses of this length and/or width in both the door and the oven face.

Such approaches as heretofore known require that parts be machined to extremely close tolerances. If any such parts are even slightly outside the desired tolerances, they must be discarded because it is too time consuming, troublesome and expensive to alter them on a custom basis so as to make them function as desired.

## SUMMARY OF THE INVENTION

This invention embraces an oven and door construction wherein the door is provided with a floating metal pan coated with dielectric material and constantly biased outwardly against a stop, and wherein the oven face has a raised portion around the cavity which has a continuous coplanar surface against which, when the door is closed, the pan is forced by the biasing means to form a continuously effective capacitive seal. Further, this invention embraces lossy gasket means releasably retained by the raised portion, and which contains microwave energy absorption material adjustable in amount to achieve maximum reduction of such small leakage as escapes past the capacitive seal. Energy sealing is maintained by such arrangements despite variations in tolerances of parts beyond limits which cannot be tolerated with prior art structures.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of an oven and door structure in accordance with this invention;

FIG. 2 is a sectional view taken along the line 2—2 of FIG. 1;

FIG. 3 is a fragmentary sectional view, like FIG. 2, showing the position of the floating pan when the door is open;

FIG. 4 is a perspective view of the main frame portion of the door, and the channel and rubber blocks positioned therein;

FIG. 5 is a perspective view of the basic oven, showing the raised rib or frame on the front flange plate, and the basket strip attached to and surrounding the raised frame;

FIG. 6 is a fragmentary perspective view of the free end of the door, showing the cam used for latching the door in closed position;

FIG. 7 is a fragmentary perspective view of the outer portion of the door, showing blocks on the oven flange plate with which the cam support block cooperates;

FIG. 8 is a fragmentary end elevation view of the door at closure, showing the cam operation for latching the door in place and operating a door interlock switch; and

FIG. 9 is a fragmentary sectional view of an edge portion of the door to aid in explaining the movement to which the floating pan is subjected by operation of the cam and the pan biasing rubber blocks.

## DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

Referring to FIG. 1, a microwave oven 10 is shown having a housing 12 wherein a door 14 covers the oven cavity, one end of the door being hinged at 16, 18 to the housing. The door is provided with a handle 20 for operating a mechanism to latch the door in closed position, and for releasing the door so that it can be swung open. Also shown adjacent the free end of the door is a control panel 22 having a power control toggle switch 24; an indicator light 26 to signify that the door is closed and the oven is readied for cooking; an indicator light 28 to signal the end of a cooking cycle; a cooking cycle selection dial 30; and a pushbutton 32 for initiating the selected cooking cycle.

As FIG. 5 illustrates, the housing 12 is a skin that surrounds the basic oven structure wherein the walls terminate in a front flange plate 34. The upper portion of the flange plate has a plurality of openings 36 in communication with the interior of the cavity 38, so that vapor or steam generated during cooking will pass through the openings 36 to the exterior of the oven. The portion of the door 14 confronting the openings 36 is spaced from the flange plate so as not to impede the escape of moisture.

Referring to FIGS. 2 and 4 along with FIG. 1, the door 14 in this example has a main support frame 40 having walls extending from a flat base 42 and terminating in an intumed lip or flange 44. The base 42 may be a solid plate, but preferably, as best seen in FIG. 4, is shaped from a plate that has its center portion removed, thereby defining a frame having a central opening 46. As will be apparent, this permits the weight of the door to be kept to a minimum.

Positioned in the frame 40, and on the base 42 thereof, is a rectangular channel 48. Fitted in the side portion of the channel are elongated bars or blocks 50 of silicone rubber or other suitable compressible material, and similar blocks 52 are fitted in the ends of the channel. Seated on the blocks 50, 52 is a shallow metal pan 54 having a skirt 56 that terminates in an outer flange 58 that is spaced above the flange 44. As shown the flanges 44, 58 are in overlapping relation.

The pan flange 58 is located between the flange 44 and the intumed edges or lips 60 of plates 62. The plates 62 are L-shaped plates that are secured to the sides and ends of the support frame 40. When the door is open, the rubber blocks 50, 52 force the pan 54 to the position wherein the flange 58 abuts the lips 60 (see FIG. 3). In assembly, the pan is forced inwardly and held while the plates 62 are secured in place. The positions of the lips 60 are such that the blocks 50, 52 are compressed when the flange 58 engages them.

Again referring to FIG. 5, the side walls of the cavity are indicated at 70, 71, and the top and bottom walls are indicated at 72, 73. The left, top and bottom portions of the flange plate are bent back and welded at the left upper and lower corners. The right portion 76 of the flange plate is bent forwardly to provide a support strip 77 for part of the door latch means to be described. The outer surface of the flange plate 34 is provided with a frame-like raised portion 78, which in this example is shown having a continuous inner wall 80 coplanar with the cavity walls, a continuous inner wall 82 that is secured, as by welding, in surface-to-surface engagement with the outer face of the flange plate, and a continuous outer wall 84 that is parallel to the surface of the flange plate.

The outer surface of the pan 54 is coated with dielectric material, e.g., epoxy paint, indicated at 86. When the door is closed, the dielectric surface of the pan closes in surface-to-surface contact with the outer wall 84 of the raised frame 78. Such contact is made before the door closure is completed, i.e., before the handle 20 has fully moved to the closure position. After such contact is made, and while the handle 20 is moving to closure position, the base 40 continues moving inwardly, thereby further compressing the rubber blocks 50, 52. Accordingly, the lips 60 of the plates 62 move away from the flange 58 of the pan. When the door is fully closed, as illus-

trated in FIG. 2, the pan is free of contact with any part except the wall 84 and the compressed biasing means which keep it forced firmly against such wall.

Reference will be made to FIGS. 5 and 8 along with FIG. 2 for explaining latch means for effecting door closure. In this particular example, the latch means is also used also to effect operation of a door interlock switch. In this connection, and referring to FIG. 5, the front face of the flange plate 34 is provided with an opening 90 through which protrudes the plunger button 92 (FIG. 2) of a microswitch 94. The support strip 77 of the flange plate is provided with an opening 96 through which a screw 98 extends to support a roller 100.

A cam mechanism is used to effect latching engagement with the roller 100, and also to depress the switch plunger 92. As best seen in FIGS. 1, 2 and 6, the door is provided with an outer skin 102 covering the main frame 40. At the latch end of the door, the skin 102 extends around a tubular element 104 which is fastened at 106 to the main frame and plate 62, and to which the skin is secured at 108.

As shown in FIG 6, there are two spaced tubular elements 104. The skin 102 has a U-shaped notch 110, and a U-shaped block 112 is positioned with its ends inserted in the adjacent ends of the tubular elements 104 and suitably secured thereto as indicated at 113. The center portion of the block 112 is nested in the space between the skin and the main frame 40.

Seated on the inner surface of the block 112 is a latch support block 114. The shaft of the handle 20 extends through the blocks 112, 114, and a cam element 116 is formed on a hub that is secured to the inner end of the shaft. When the door is moved to closure position, the upper and lower surfaces of the latch support block 114 register with respective lower and upper surfaces of a pair of blocks 120, 122 that are secured to the flange plate. The front face of the latch block 116 also engages a vertical surface of a finger extension 124 of the upper block 120 (see FIG. 8). In this position of the latch support block 116, the cam element 116 is positioned so that the inner surface thereof (i.e., adjacent the face of the block 114) will engage the roller 100, as indicated in the dotted line position of the cam element in FIG. 8. Such inner surface of the cam is shaped with a notch 128 intermediate its ends, and the latching position of the handle (the vertical position shown in FIG. 1) is that in which the roller 100 is latched in the notch 128.

As shown in FIG. 8, the inner surface of the cam that rides against the roller is of gradually increasing dimension, and has a crest 130 preceding the notch. Accordingly, the cam causes the door to move inwardly past its latching position, and then to move outwardly to the position where the roller 100 is in the notch. Such movement is facilitated by the rubber blocks 50, 52.

In this latter connection, and as previously explained, the rubber blocks are compressed when the door is assembled, and the flange 58 of the pan is firmly biased against the lips 60 of the plates 62. Referring to FIG. 9 along with FIGS. 2 and 8, the flange 58 is shown in solid lines in the position in which the door is latched, i.e., as shown in FIG. 2. The phantom position of the flange 58 in FIG. 9 is the over-travel position to which the pan is moved as the crest 130 on the cam 116 contacts the roller 100. At this point, the rubber blocks 50, 52 are under maximum compression. Accordingly, upon further rotation of the cam, the bias exerted by the rubber blocks causes the cam and roller to interact so that the pan is urged outwardly to the solid line position of the flange 58.

For operating the switch plunger 92, the outer surface of the cam 116 is shaped with an inclined cam surface 132 that engages the plunger as the cam is being forced inwardly by its engagement with the roller 100. After such cam surface passes the plunger, the outer end of the plunger rides on a flat surface of the cam. The dimensions of the cam are such that the plunger is maintained in its switch actuating position after the of the roller is latched in the notch 128.

As previously mentioned, the outer face of the wall 84 of the raised frame 78 provides substantial surface area that is

contacted by the pan. In one example, the width of the wall 84 is approximately 1.0-in. In such example, this width is less than a quarter of a wavelength. Nevertheless, it has been found that leakage at the door edges in such construction is less than 1 milliwatt. In other words, it has been found with this construction that the capacitive seal between the overlapping surfaces of the pan and the wall 84 is sufficient to maintain the leakage below this small amount.

These significant advantages are obtained by virtue of the floating pan construction. In this connection, the pan is relatively thin, e.g., 0.032-in. stainless steel, covered with a 0.005-in. coating of epoxy paint. Since the biasing means directly acts against the portion of the pan that is thrust against the wall 84 of the raised frame 78, this arrangement insures that the pan throughout conforms to the outer surface of the wall 84. In this manner, any slight variations in surface contour of the wall 84 are assumed by the pan. The integrity of the capacitive seal throughout of the width of the wall 84 is thereby maintained.

A significant result of the above-described arrangement is that the desired sealing effect is obtained despite variations in tolerances of the parts which could not be permitted in prior art structures. Thus, while it is desired that the outer surfaces of the walls be coplanar throughout, the desired shielding is obtained even though there may be slight deviations from the desired condition. Accordingly, this invention facilitates volume production and assembly of doors made of parts which would have to be discarded in prior art arrangements, yet which will provide a more effective seal than many prior art doors which are made to exacting requirements and adherence to extremely close tolerances.

This invention also includes means to further reduce the leakage around the edges of the door to substantially less than 0.5 milliwatt. Referring to FIGS. 2 and 5, the outer wall 84 terminates in a lip 132 that is substantially parallel to the skirt 56 of the pan. The edge of the lip is spaced from the flange plate, and serves as a rib onto which to anchor a strip 134 of lossy gasket material. As shown, the gasket 134 extends outwardly along the flange plate, so as to span the space between the lip 132 and the skirt of the pan. Further, this portion of the gasket has an internal opening which is filled at 136 with microwave absorbing material, e.g., ferrite (FIG. 2). In one example, the gasket 134 is formed of four strips which are shaped to form mitered joints at the corners, and ferrite rods are inserted in the strips. With such an arrangement, it has been found that the leakage at the edges of the door is approximately only 0.3-milliwatt.

Further, it has been found that the gasket 134 and absorbing material 136 provides means for additionally adjusting or tuning for maximum reduction of any leakage that may exist around the capacitive seal. In this connection, for a given type of absorbing material 136, such additional reduction is variable in accordance with the amount of the material. Further, it has been found that with rods of such material, the ends of the rods at the corners of the gasket can be adjustably overlapped in initial assembly to achieve the desired leakage reduction effects.

The oven and door structure of the invention also lends itself to formation of harmonic chokes. The width of the wall 84 may be made a quarter of a wavelength of the second harmonic so as to minimize radiation of even harmonics. For odd harmonics, the skirt 56 of the pan and lip 133 of the raised frame 78 may be dimensioned to form a choke. Additionally, the choking may be more finely adjusted by varying the lengths and types of material 136 embedded in the lossy gasket 134.

It will be understood that the above-described oven includes means for injecting microwave energy into the cavity. Such means is prevented from effecting microwave cooking except when the door is closed and magnetron control circuits are rendered operable by closure of one or more interlock switches. Such arrangements are well known in the art, and may include an interlock switch operable by the hinged end of

the door. Details of magnetrons and control circuits with such switches are not shown, since reference can be made to various patents, technical articles, and operating manuals for the teachings thereof.

I claim:

1. In combination:

- a microwave oven structure defining a cavity,  
 said structure including a front plate having an opening  
 through which to insert foodstuff into the cavity,  
 said plate having a raised portion framing said opening;  
 a base member hinged at one edge to said plate and  
 releasably latchable at its opposite edge to said plate;  
 compressible means carried by said base member;  
 and a metal pan to close said opening and having a dielectric coating to be brought into engagement with said raised portion,  
 said pan being mounted on said compressible means,  
 said base member during movement toward its latched position undergoing movement relative to said pan after said pan engages said raised portion,  
 whereby said compressible means is compressed between said pan and base member in said latched position so as to keep said pan forcibly biased against said raised portion.
2. The combination of claim 1, wherein the surfaces of the raised portion engaged by said pan are parallel to said opening.

3. The combination of claim 2, wherein said base member has a lip overhanging the peripheral edge of said pan, said compressible means causing said peripheral edge to be biased against said lip when said base member is unlatched from said plate.

4. The combination of claim 2, further including a strip of lossy gasket material against said plate which encircles said raised portion;

and microwave energy absorbing material carried by said gasket strip.

5. The combination of claim 4, wherein said raised portion outboard of the parallel surfaces thereof has a reentrant wall terminating adjacent said plate,

said gasket strip being releasably anchored on the edge of said reentrant wall.

6. The combination of claim 5, wherein said pan has a skirt outboard of said raised portion that terminates in a flange, the peripheral edge of said flange being that which is biased against said lip in the unlatched position of said base member.

7. The combination of claim 6, wherein said gasket strip is in sections, and wherein said microwave absorbing material is in the form of rods inserted in said sections, said rods being frictionally held by said gasket material, but being adjustable in assembly.

\* \* \* \* \*

30

35

40

45

50

55

60

65

70

75