

Nov. 1, 1960

D. E. HAHN
ELECTRONIC OVENS

2,958,754

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2 Sheets-Sheet 1

Fig. 1

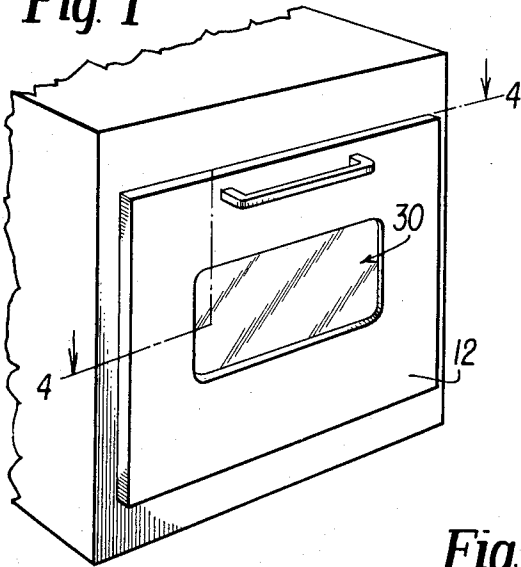


Fig. 2

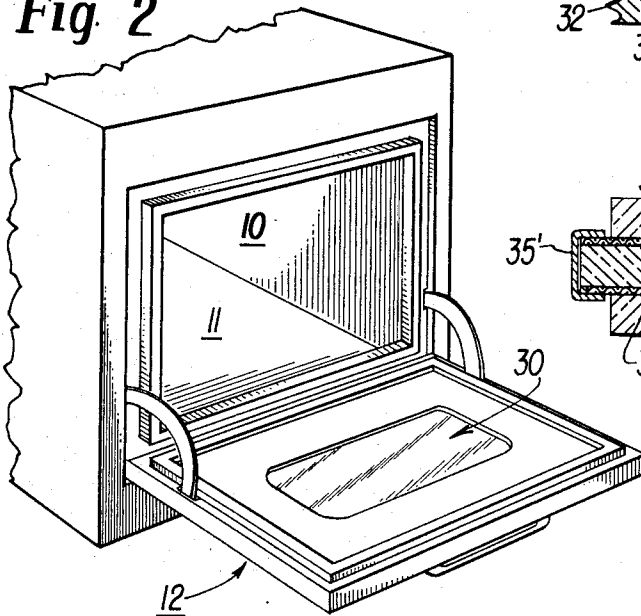


Fig. 3

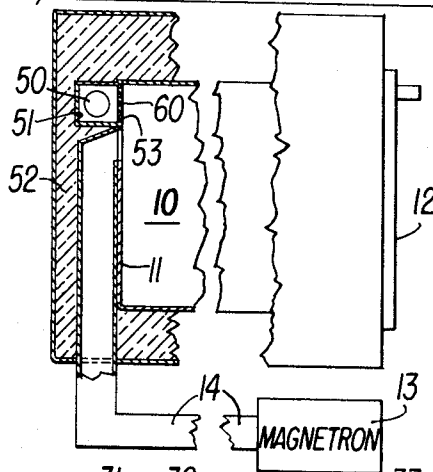


Fig. 5

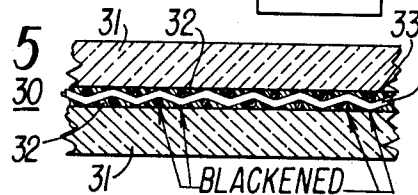


Fig. 6

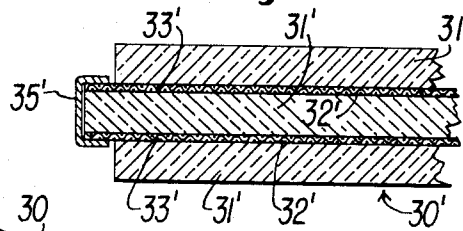
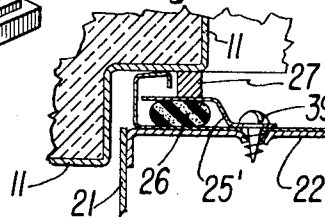


Fig. 7



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Fig. 4

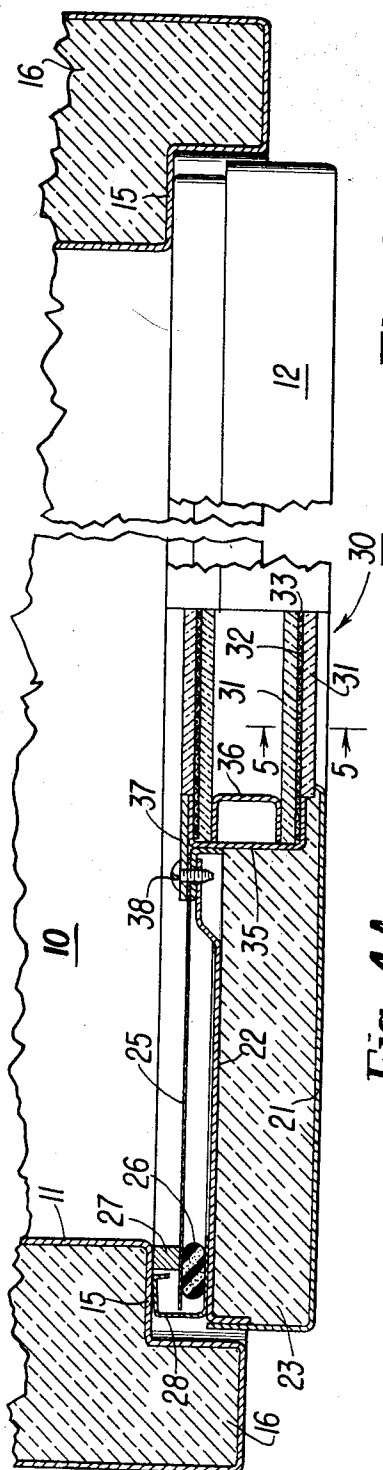


Fig. 4 B

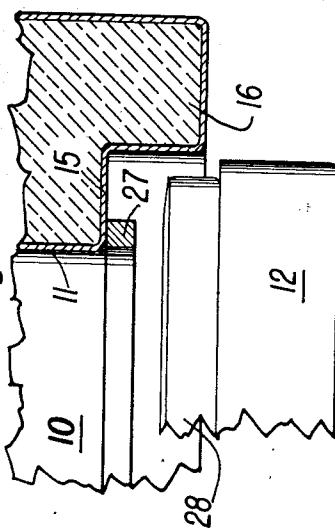
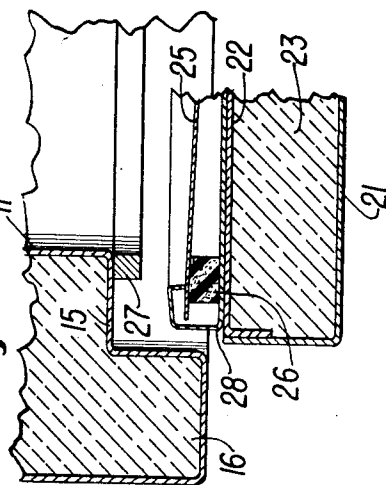


Fig. 4A



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2,958,754

ELECTRONIC OVENS

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9 Claims. (Cl. 219—10.55)

The present invention relates to electronic ovens, and more particularly to improved window and door constructions for such ovens.

It is a general object of the invention to provide an improved door for an electronic oven which permits viewing of the interior of the oven and provides a closure which is substantially leak-proof to microwave radiation.

Another object of the invention is to provide an improved viewing window for an electronic oven which permits a high degree of visibility of the oven interior while effectively barring the passage of microwave radiation.

Still another object of the invention is to provide an improved door seal for the door of an electronic oven which does not impede the opening and closing of the door while still effecting a seal which is substantially leak-proof to microwave radiation.

A further object of the invention is to provide an improved electronic oven having various of the features and advantages recited above while being durable, efficient and economical to manufacture.

In accordance with one embodiment of the invention a viewing window is arranged in the door and has a metallic screen embedded in the glass pane thereof, the metallic screen cooperating with certain portions of the door and an improved door seal for providing with the basic oven shell a cooking chamber which is substantially leak-proof for microwave radiation. The door may be of the conventional hinged type or it may form the front panel of a drawer. In either case, a door constructed in accordance with the preferred embodiment of the invention permits viewing of the interior of the oven and permits opening and closing of the door by application of no more than the conventional opening and closing force while at the same time effecting a closure of the oven which is substantially leak-proof for microwave radiation. While several features of the preferred embodiment of the invention cooperate to produce these desired effects, it is to be understood that the various features are useful individually.

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:

Fig. 1 is a front perspective view of an electronic oven embodying the present invention;

Fig. 2 is a similar perspective view of the oven but with the door in its opened position;

Fig. 3 is an elevational view, partially in cross section, illustrating the general arrangement of the oven, the source of microwave radiation and the interconnecting wave guide;

Fig. 4 is a cross-sectional view of the front portion of the oven, taken in the direction of the arrows along the line 4—4 in Fig. 1;

Figs. 4A and 4B are partial cross-sectional views showing the left and right hand ends, respectively, of the

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front portion of the oven, as in Fig. 4, except showing the door slightly ajar;

Fig. 5 is a partial cross-sectional view of a viewing window of the oven, taken in the direction of the arrows along the line 5—5 of Fig. 4;

Fig. 6 is a partial cross-sectional view similar to Fig. 5 but illustrating another embodiment of the invention; and,

Fig. 7 is a partial cross-sectional view similar to Fig. 4A, but illustrating a different embodiment of the invention.

Referring now to Figs. 1 to 3, inclusive, of the drawings, the electronic oven there illustrated, and embodying the features of the present invention, comprises an oven chamber 10 defined by electrical conductive walls, and particularly by a metallic shell 11 and a metallic door 12. In Fig. 3, a magnetron 13 is schematically illustrated, and is shown connected to the oven chamber 10 by a suitable wave guide 14. The magnetron 13 which serves as a source of microwave energy for the oven chamber 10 is of conventional form and may have an operating frequency of 2450 megacycles; and likewise the wave guide 14 may be of conventional construction and arrangement. Also, in passing, it is noted that the dimension of the oven chamber 10 in each direction (height, width and depth) is substantially greater than the wave length of the microwave energy supplied thereto from the magnetron 13; whereby centimeter standing waves are provided in the oven chamber 10.

As will be apparent by reference to Figs. 1 and 2, the door 12 of the illustrated embodiment of the invention is hinged. However, as will subsequently become apparent, the various features of the present invention are equally applicable to a door which constitutes the front panel of a drawer. In either case, it is, of course, desired that the oven shell 11 be of metal and form a continuous, closed box except for the duct opening and the door opening, and that the door effectively close the latter opening against leakage of microwave radiation when the door is in its closed position. At the same time, it is desired that a viewing window be provided, preferably in the door, and that the seal between the door 12 and the oven shell 11 require no special fastening or manipulation, whereby the door may be opened and closed with the application of nothing more than conventional opening and closing forces.

Referring now to Figs. 4, 4A and 4B, it will be seen that the oven shell 11 turns outwardly at the mouth of the oven to form a flange 15 against which the door closes. The flange 15 preferably extends entirely around the mouth of the oven and constitutes a continuation of the metallic shell 11, being either integral therewith or connected thereto such that the shell 11 and the flange 15 form a continuous metallic wall. Beyond the flange 15, the metallic sheet may be arranged as shown to provide a recess for the door 12 and to enclose heat insulating material 16.

The door 12 includes a basic construction comprising an outer wall 21, an inner wall 22 and enclosed heat insulating material 23. This portion of the door may be of conventional construction and in accordance with the embodiment of the invention illustrated in Fig. 4 need not be relied upon to bar the passage of microwave radiation from the oven to the surrounding space. In accordance with this embodiment of the invention, a metal sheet 25, preferably of stainless steel, is arranged on the door 12 and serves as a barrier to passage of microwave radiation. It is to be understood, however, that the metal sheet 25 may, in part, comprise or be replaced by the inner wall 22 of the door 12 without departing from the spirit of the invention.

Near the periphery of the door the metal sheet 25

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overlies a resilient pad 26 which extends entirely around the mouth of the oven and is preferably formed of polyurethane foam, this material having the desired flexibility and resilience and being capable of withstanding the oven heat. Immediately opposite the pad 26 and mounted on the flange 15 is a metallic gasket 27 which also extends entirely around the mouth of the oven and projects outwardly from the flange 15. This annular member is metallic in order to reflect microwave radiation and is secured to the flange 15 in such a manner as to provide therewith an unbroken metallic wall, to the effect that microwave radiation may not pass therebetween.

Arranged immediately beyond the edge of the metal sheet 25 is an annular member 28 which is secured to the door 12 and which extends entirely around the outer edge of the metal sheet 25 and the mouth of the oven. This annular member 28 extends from the door 12 toward the flange 15 and has a free edge projecting toward the center of the door and overlying the edges of the sheet 25 such that the edges of the metal sheet are concealed. Still further, this member has a re-entrant lip, whereby the edge of this member is also substantially concealed, all as shown in Figs. 4 and 4A.

When the door 12 is in its fully closed position, as illustrated in Fig. 4, the annular member 28 engages the flange 15. However, prior to the door reaching its fully closed position, and when the annular member 28 is spaced a short distance from the flange 15, the gasket 27 makes engagement with the metal sheet 25. Further closing movement of the door causes compression of the pad 26 and yielding of the sheet 25 from the condition illustrated in Fig. 4A to the condition illustrated in Fig. 4. The sheet 25 is preferably thin (of the order of .010" thick) in order to facilitate the required bending or yielding thereof. Such compression of the pad 26 and yielding of the sheet 25 permit this further closing movement of the door such that the annular member 28 may be brought into engagement with the flange 15.

In Fig. 4 it may be seen that a double seal is thus effected at the juncture of the door and the oven shell. More particularly, a first seal comprises the gasket 27 and the metal sheet 25. A tight seal is obtained between these parts by virtue of the resilience of the pad 26 and the sheet 25. A second seal is effected between the flange 15 and the annular member 28. Preferably, the annular member 28 is resilient and somewhat flexible in order that it may make good contact with the flange 15.

It should be noted further that any microwave radiation which might pass between the gasket 27 and the metal sheet 25 does not have direct access to the joint between the annular member 28 and the flange 15, but instead would tend to be trapped by the annular member 28. Attention is further directed to the fact that this double seal requires no manipulation of parts by the operator and requires no more than the conventional opening and closing forces. In order that the resilient pad 26 may be compressed during the final closing movement of the door 12 to assure engagement of the annular member 28 with the flange 15, it is desirable that the door 12 be biased toward closed position by a small force. It is conventional, however, in oven construction to provide the oven door with a significant closing bias. Where the oven door is hinged it is usually biased in a closing direction during the final closing movement by weights or springs. Where the oven door is in the form of the front panel of a drawer, it is conventionally biased toward closed position during the final portion of the closing movement by gravity. Such closing bias is desirable since it eliminates the necessity of a door latch, all as is well understood and conventional in the art. Conventional door closing bias is sufficient to provide compression of the resilient pad 26 and assure engagement of the annular member 28 with the flange 15. If desired, the metal sheet 25 may extend uninterrupted

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over the mouth of the oven and, more particularly, over the area defined by the resilient pad 26 or the gasket 27.

In the illustrated embodiment of the invention, however, a viewing window 30 is provided through which the operator may view the interior of the oven. It is necessary, of course, that the window 30 effectively bar the passage of microwave radiation and that it be connected directly or indirectly with the metal sheet 25 to effect a continuous barrier to the passage of microwave radiation.

In the embodiment of the invention illustrated in Fig. 4 the window 30 comprises two panes which may be identical, two panes being provided in order to minimize the escape of microwave radiation. The construction of these panes is best illustrated in Fig. 5. It will there be seen that the pane is laminar in construction, including two sheets 31 of heat-resistant glass and an inner lamination 32 of any suitable material such as a thermoplastic or thermosetting resin or other suitable plastic material. It is necessary, of course, that the material of which this inner lamination is composed be capable of withstanding oven heat without detrimental effect. Since laminated glass is well-known in the art, the specification of particular materials is unnecessary in the present application.

Embedded within the inner lamination 32 is an aluminum wire screen 33 which is preferably of at least 12 to 13 mesh. It is preferred, also, that the side of the screen 33 facing outwardly of the oven be blackened for improved visibility of the interior of the oven. As will be obvious to those skilled in the art, such blackening of the aluminum wire screen may be accomplished by various processes which would result in oxidizing or sulfurizing the surface of the aluminum wire. Blackening of the outer side of the screen greatly reduces the reflection of outside light and thereby improves visibility of the interior of the oven from the outside.

It has been found that a relatively fine screen having approximately 150 openings per square inch and providing approximately 50% clear opening permits good visibility of the interior of the oven under normal conditions when a double pane is employed, as shown in Fig. 4. It has been found also that a double pane employing such a screen bars the passage of microwave radiation to such an extent that the leakage falls substantially below the maximum specified by the Federal Communications Commission.

It has also been found that with the screen having a given percentage of clear space the fineness of the screen has relatively little effect on radiation leakage. However, a relatively fine screen, such as the suggested screen having 150 openings per square inch provides improved visibility over a relatively coarse screen. For this reason, it is recommended that the screen be at least 12 to 13 mesh.

As is best seen in Fig. 4, the wire screens 33 are made to extend beyond the edge of at least one of the glass sheets 31 of the associated pane in order that they may be engaged by a U-shaped member 35 which extends entirely around the window 30. Preferably, the inner or facing sheets 31 of the two panes extend beyond the outer sheets thereof and are spaced apart by another U-shaped member 36 which also may extend entirely around the peripheral portion of the window 30. An annular plate 37 also extends entirely around the window 30 and is clamped to the body of the door 12 as by screws 38. The plate 37 is preferably welded to, or integral with, the U-shaped member 35 and overlies the inner edge of the metal sheet 25 as shown.

With this arrangement the window 30 is brought into effective engagement with the metal sheet 25 to complete the closure of the oven against leakage of microwave radiation. More particularly, the oven shell 11, the metal gasket 27, the metal sheet 25 and the window 30 form a continuous and effective barrier against the leakage of microwave radiation. The only openable joint in

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this barrier is that between the metal gasket 27 and the metal sheet 25, and this joint is backed up by a second seal, namely the seal between the annular member 28 and the flange 15, which is staggered or out of alignment with the first seal. It should be noted further that the entire radiation barrier is in firm electrical contact whereby any induced currents in any part of the radiation barrier may readily be grounded by a single ground connection.

An alternative embodiment of the viewing window is illustrated in Fig. 6. Here the window 30' consists of three sheets 31' of glass with two intermediate laminations 32' of plastic material and two embedded wire screens 33'. With this arrangement only a single pane is required, this single pane having two wire screens and therefor having the same effectiveness as a radiation barrier as the double pane of Fig. 4. With the window construction of Fig. 6 the central glass sheet and the two wire screens preferably extend beyond the two outer glass sheets, and the two screens are engaged by a U-shaped member 35' which preferably extends entirely around the periphery of the window 30'.

For the purpose of illuminating the oven chamber 10, an electric lamp 50 is arranged in a reflector 51 disposed in the space between the inner shell or liner 11 and the outer wall of the oven 10 and embedded in the surrounding heat insulation 52 disposed therebetween. More particularly, the reflector 51 communicates with an opening 53 provided in the adjacent portion of the liner 11, which opening 53 is suitably closed by a removable window 60 accommodating the ready passage of light from the electric lamp 50 into the oven chamber 10. Preferably the window 60 is also of the construction and arrangement of the viewing window 30 that is incorporated in the door 12, and as previously described. This arrangement of the window 60 prevents the microwave energy in the oven chamber 10 from entering the reflector 51, so as to eliminate the possible induction of parasitic microwave electric currents in the components of the electric lamp 50.

It may now be seen that the metal sheet 25 need not necessarily extend from the pad 26 and the gasket 27 to the edge of the window 30. If the inner wall 22 of the door 12 is of metal, a metal sheet 25' of relatively narrow annular construction may be employed as illustrated in Fig. 7. Its outer edge portion overlies the pad 26 and its inner edge portion is secured to the inner wall 22 of the door as by screws 39. In this case the inner wall 22 of the door serves as the primary radiation barrier extending outwardly of the oven door window, if a window is employed, and the metal sheet 25' serves merely as a flexible continuation thereof to cover the flexible pad 26 and to make contact with the metal gasket 27. In other words, the inner wall of the door and the narrow annular sheet 25' serve, together, as the metallic sheet 25 of the embodiment shown in Fig. 4.

An electronic oven has now been disclosed having an improved door seal and an improved, cooperating viewing window. These two features of the invention permit a readily openable door and a viewing window which substantially eliminate leakage of microwave radiation. It will be apparent that the door seal and the viewing window have utility separate of each other, if desired. The door seal may for example be used with a door having no viewing window, and the improved viewing window may be employed separately of the improved door seal and may be used on a fixed wall of an electronic oven.

Various modifications of the disclosed embodiments of the invention will be apparent which fall within the spirit of the invention. For example, the gasket 27 may, if desired, be integral with the flange 15 or the shell 11 or both, in which case it continues to form and serve as a gasket.

Accordingly, while there has been described what are at present considered to be the preferred embodiments of the invention, it will be understood that various

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modifications may be made therein, and it is intended to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. An electronic oven comprising a metallic shell defining an oven cavity adapted to be supplied with microwave energy, said shell having an opening therein for providing access to said oven cavity and including an outwardly facing flange defining said opening, a door for closing said opening, a metallic gasket surrounding said opening and projecting outwardly from said flange, a continuous resilient pad arranged on the inner side of said door to face said gasket when said door is in closed position, a metallic sheet on the inner side of said door overlying said pad and extending toward the center of said door, an annular metallic member secured to said door and projecting toward said flange, said gasket being engageable with said metallic sheet as said door closely approaches its closed position, said pad being compressible to permit further door closing movement whereby said annular member may engage said flange outside and closely adjacent to said gasket, and a viewing window in said door, said window comprising a pane of heat-resistant glass with a wire screen embedded therein, said wire screen being exposed at the edges of said pane, and said metallic sheet extending to and engaging the edges of said screen.

2. An electronic oven comprising a metallic shell defining an oven cavity adapted to be supplied with microwave energy, said shell having an opening therein for providing access to said oven cavity and including an outwardly facing flange defining said opening, a door for closing said opening, a metallic gasket surrounding said opening and projecting outwardly from said flange, a continuous resilient pad arranged on said door to face said gasket when said door is in closed position, a metallic sheet on the inner side of said door overlying said pad and extending toward the center of said door, an annular metallic member secured to said door and projecting toward said flange and having a free edge projecting toward the center of said door to overlie the edges of said sheet, said gasket being engageable with said metallic sheet as said door closely approaches its closed position, said pad being compressible to permit further door closing movement whereby said annular member may engage said flange outside and closely adjacent to said gasket, and a viewing window in said door, said window comprising inner and outer facing panes each comprising a pane of heat-resistant glass with a wire screen embedded therein, said wire screens being exposed at the edges of said panes, and said metallic sheet extending to and engaging the edges of said screens.

3. In an electronic oven comprising a metallic shell defining an oven cavity adapted to be supplied with microwave energy, said shell having an opening therein for providing access to said oven cavity and including an outwardly facing flange connected to said shell and defining said opening, a door for closing said opening, a metallic gasket surrounding said opening and projecting outwardly from said flange, a continuous resilient pad arranged on said door to face said gasket when said door is in closed position, a metallic sheet on the inner side of said door overlying said pad and extending toward the center of said door, an annular metallic member secured to said door and projecting toward said flange, said gasket being engageable with said metallic sheet as said door closely approaches its closed position, said pad being compressible to permit further door closing movement whereby said annular member may engage said flange outside and closely adjacent to said gasket, and a viewing window in said door, said window comprising a pane of heat-resistant glass with a wire screen embedded therein, said wire screen being exposed at the edges of said pane, and said metallic sheet extending to and engaging the edges of said screen.

4. An electronic oven comprising a metallic shell defining an oven cavity adapted to be supplied with microwave energy, said shell having an opening thereinto affording access to said oven cavity and including an outwardly facing boundary flange surrounding said opening, a door for closing said opening, a metallic boundary gasket carried by said shell and surrounding said opening and projecting outwardly from said boundary flange, a compressible boundary pad carried by the inner side of said door and facing said boundary gasket when said door is in its closed position, a resilient metallic boundary member carried by the inner side of said door in surrounding relation with respect to said boundary pad, and a flexible metallic sheet carried by the inner side of said door and overlying said boundary pad and extending toward the center of said door, said boundary gasket engaging and flexing said metallic sheet as said door closely approaches its closed position and said boundary pad being compressed by the flexing of said metallic sheet to permit further closing movement of said door, said boundary member engaging said boundary flange outside of and closely adjacent to said boundary gasket and being deformed into fitting relation with said boundary flange when said door is in its closed position.

5. The electronic oven set forth in claim 4, wherein said door includes a metallic inner wall, said boundary pad is carried by the boundary portion of said inner wall, the outer portion of said metallic sheet overlies said boundary pad, and the inner portion of said metallic sheet is secured to the central portion of said inner wall.

6. The electronic oven set forth in claim 4, wherein said boundary member has boundary edges projecting toward the center of said door and overlying the boundary edges of said metallic sheet, the boundary edges of said metallic sheet being flexed by engagement with said boundary gasket from normal engagement with the boundary edges of said boundary member.

7. An electronic oven comprising metallic walls defining an oven cavity adapted to be supplied with micro-

wave energy, one of said walls having an opening therein, a metallic frame carried by and electrically connected to said one wall and arranged in said opening about the boundary thereof and defining a window accommodating viewing from the exterior of the interior of said oven cavity, and a pane supported by said frame and closing said window, said pane including a body of heat-resistant transparent glass and a metallic screen embedded therein, the boundary edges of said screen being electrically connected to said frame, said screen being of a mesh effective to preclude escape of microwave energy from said cavity through said window without substantial interference with viewing through said pane.

8. An electronic oven comprising metallic walls defining an oven cavity adapted to be supplied with microwave energy, one of said walls having an opening therein, a metallic frame carried by and electrically connected to said one wall and arranged in said opening about the boundary thereof and defining a window accommodating viewing from the exterior of the interior of said oven cavity, and a pane supported by said frame and closing said window, said pane being of sandwich structure including outer sheets of heat-resistant transparent glass and an inner layer of heat-resistant transparent plastic material and a metallic screen embedded in said inner layer, the boundary edges of said screen being electrically connected to said frame, said screen being of a mesh effective to preclude escape of microwave energy from said cavity through said window without substantial interference with viewing through said pane.

9. The electronic oven set forth in claim 8, wherein said screen is of at least 12 mesh.

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