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CABINET AND DOOR CONSTRUCTION FOR MICROWAVE HEATING APPLIANCES

Filed Aug. 23, 1966

FIG. 1

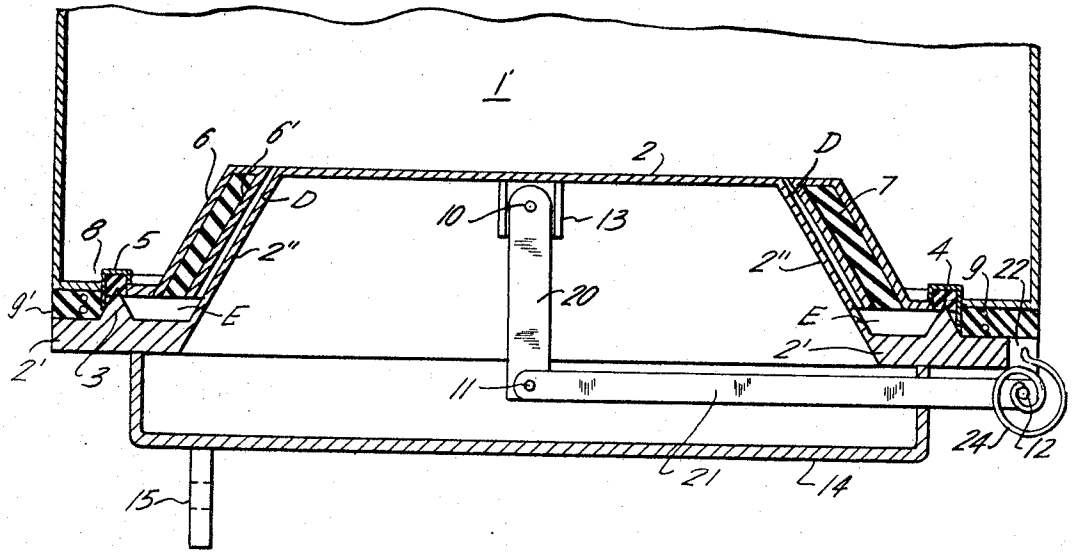
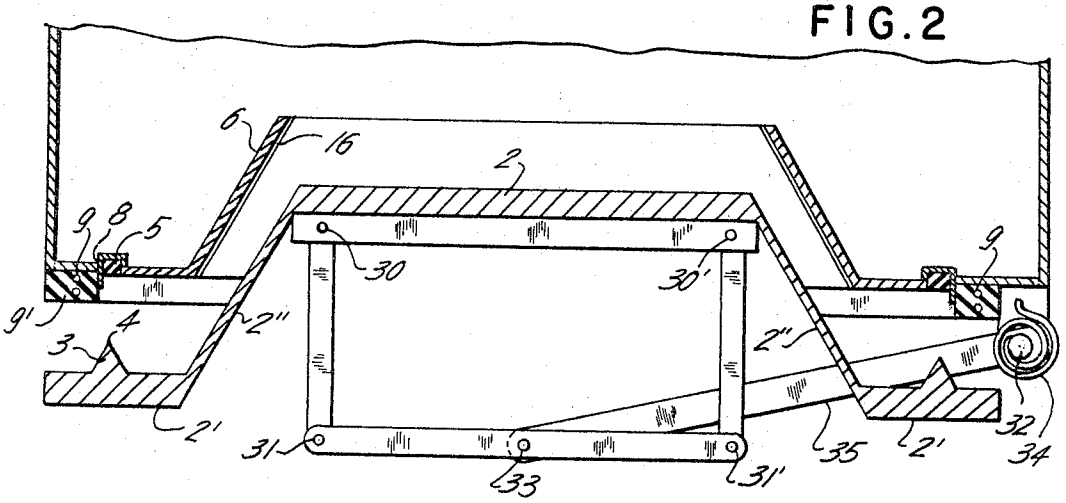


FIG. 2



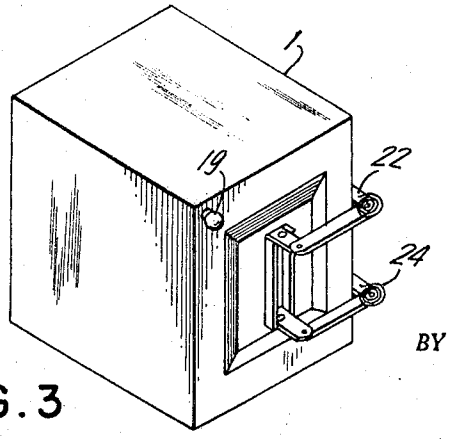


FIG. 3

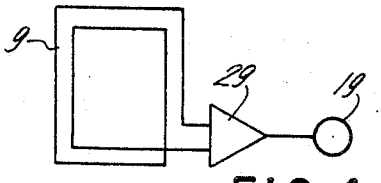


FIG. 4

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CABINET AND DOOR CONSTRUCTION FOR MICROWAVE HEATING APPLIANCES

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U.S. Cl. 219—10.55 6 Claims

ABSTRACT OF THE DISCLOSURE

The door is formed with a projection, and the cabinet, in the region surrounding the door, has a lip which is spaced to form a wave guide of a characteristic impedance much lower than the resistance of the space within the cabinet, to detect still leaking radiation from the door, a radiation pickup loop, in the form of a conductor, is located on the cabinet just beyond the outer edge of the door opening, surrounding the door opening. For positive seating and minimum leaking, the door is hinged to the cabinet by a linkage which permits swinging of the door for a major extend, and perpendicular motion of the door with respect to the cabinet just before closing.

The present invention relates to microwave ovens, and more particularly to a cabinet and door construction for microwave ovens.

Heating by microwaves is particularly suitable to defrost frozen food and to obtain quick and uniform heating throughout the food. Microwave ovens are, however, expensive; the frequency used is required to be high, in the order of 20 cm. or less and the frequency band width must be small. Lowering the frequency could effect economy, but it is then difficult to provide a radiation tight door closure.

Frequencies having a wavelength in the order of 30 to 40 cm. have the advantage that the surface layer of the food within the cabinet is penetrated better, apart from the fact that the cost of the apparatus is lower. If the wave length of the radiation within the cabinet is, however, of about the same order of magnitude as a dimension of the space itself, the first harmonic will be the primary radiation therein. It is difficult to manufacture doors, particularly in mass production, which seal such longer wave radiation to the inside of the cabinet and effectively prevent escape of any radiation to the outside. The amount of permissible stray radiation is very small, without exceeding safety and interference limits; it may be only as little as 10^{-8} watts. These safety and manufacturing difficulties have heretofore prevented acceptance of microwave ovens utilizing such higher frequencies.

It is an object of the present invention to provide a cabinet and door construction which meets the above requirements, which can be manufactured in mass production processes, and can be hung inexpensively.

In spite of precautions taken to provide a radiation seal to the outside, it is possible that radiation in excess of that permitted can escape. According to a feature of the invention, a radiation monitoring arrangement may readily be combined with the door construction to give an alarm when the radiation leaking to the outside of the cabinet exceeds a predetermined and safe limit.

Briefly, in accordance with the present invention, the cabinet is formed with a lip surrounding the door opening, which lip extends inwardly, preferably in the form of a truncated cone or pyramid, like a funnel; the door fits into the truncated funnel, with matching sides, spaced a very small distance apart. The spacing may be determined by

a plastic coating, applied to the door or to the cabinet lip. A metallic contact is provided by the door against the cabinet on the outside, that is beyond the termination of the parallel sides of door projection and lip.

The door projection and the lip together form a wave guide having a characteristic impedance 100 to 1,000 times, that is 2 to 3 orders of magnitude (on a decimal scale) lower than the internal impedance of the cabinet. Thus, a discontinuity of impedance is formed within the cabinet in the region of the juncture of door projection and lip, which discontinuity will cause reflection, rather than penetration into the low impedance wave guide. Such penetration as does occur will be of such low power that the metallic contact at the outside of the wave guide, between door and cabinet, can readily short circuit the still transmitted radiation.

Without providing the wave guides, the danger may exist that if the contact between frame and door is not absolutely perfect, hot spots may develop, including possibly points causing arcing over due to energy transmitted to the points of poor contact. By reflecting the energy within the cabinet away from the metallic contact, the energy at the metallic contact will be low and slight imperfections or misalignment arising in manufacture, or in use, will not cause harmful results or leakage of radiation.

In order to provide for location of the door within the lip with the same alignment, time after time, the door is suspended by means of a linkage arrangement, for example a parallelogram arrangement to provide for parallel seating at the final point of travel of the door within the lip.

The polarization of waves leaving the interior of the cabinet is normally approximately vertical to the surface of the door or its frame. It is therefore simple to provide an antenna, such as a wire or a number of wires looped around the door, mounted in an insulating material, such as a plastic bead or strip, to pick up radiation leaking beyond the seal. These monitoring wires, acting like antennas, are then connected to an alarm device, for example over an amplifier. The alarm device can give an audible, visual, or other signal to warn of excessive radiation beyond the cabinet, and further may actuate a safety switch to disconnect the radiation generator and prevent damage or hazards.

The spacing between the internally projecting lip surrounding the door opening, and the matching projecting portions of the door itself, may be in the order of 1 mm. or so; if a plastic liner is used, either on the door or on the lip, the resistance of the wave guide formed by door and lip will be in the order of about 1 ohm or less. The wave resistance of the cabinet iself may vary from about 100 ohms to an average of several hundred ohms to in excess of thousand ohms. Thus, severe discontinuities of resistance will occur just at the point where reflections are desired, and little radiation will escape in the space formed by the wave guide between door and cabinet.

The structure, organization and operation of the invention will now be described more specifically in the following detailed description with reference to the accompanying drawings, in which:

FIG. 1 is a cross sectional view illustrating the door construction, and adjacent parts of the cabinet, in section;

FIG. 2 is a view similar to FIG. 1, showing an alternative embodiment of door construction, with the door partly open;

FIG. 3 is a pictorial view of a cabinet with a door of a construction similar to FIG. 1; and

FIG. 4 is a schematic circuit diagram of the control circuit.

The cabinet 1, having a space 1' therein, which space is intended to be subjected to microwave energy, is closed

off by a door having a bottom or base plate 2 and side flanges 2'. The base of the door 2 is projecting from the side flanges 2', by having inwardly tapering or slanting walls 2'' so that the entire construction is in the form of a truncated, closed funnel. Outwardly of the projection 2, the flange 2' is formed with an inwardly extending projection 3, extending on all sides of the flange 2'. Projection 3 comes to a point 4. When the door is seated within the cabinet, as shown in FIG. 1, projection 3 with its point 4 will bear against a seal 5, shown as a plastic seal with metallized surface, or covered with flexible wire netting, and further on the side against a metal strip 8, connected to the housing 1 of the cabinet. Strip 8 may be a single unit, or formed with a spring overlay to make good electrical contact with projection 3.

The door opening of cabinet 1 matches the truncated funnel shape of the door. In particular, a lip, formed by a pair of slanting walls 6, 6' surrounds the door opening; between the walls 6, 6', which may be formed by folded material so as to present a re-entrant fold, insulating material 7 may be located which may be a dissipating substance.

The door is supported on door hinges; a bracket 22 (FIG. 1, FIG. 3) extends from the cabinet to hold the hinge mechanism. The link 20, extending generally perpendicularly from base 2 of the door, and hinged at 10 thereto, is hinged at 11 to a second link 21, again extending perpendicular to link 20. Link 21 is hinged at 12 to bracket 22. By suitable design of the length of brackets 22 and link 20, a toggle action can be obtained so that the door will snap shut into the door opening formed by re-entrant walls 6, 6'. A spring 24 is further provided, shown connected with hinge 12 in order to keep the door in a closed position. A cover plate 14 closes off the mechanism, to which a handle 15 may be attached. FIG. 3 shows the door construction with cover plate 14 and handle 15 removed.

FIG. 2 shows an alternative form of door holding construction, using a parallelogram arrangement, having pivot points 30, 30' and 31, 31', hinged at 33 to a link 35 which, in turn, is hinged at 32 to the door bracket 22. A spring 34 again tends to hold the door in closed position. Again, by suitable choice of the length of the links and of the bracket, respectively, the arrangement can function as a toggle to snap shut. FIG. 2 also shows an embodiment in which the door opening is defined by a single wall 6, rather than by the double, re-entrant construction including walls 6, 6' of FIG. 1.

The sidewalls 2'' of the door and wall 6 (or 6') of the cabinet are separated by a small distance, for example in the order of 1 mm. or so. This separation can be obtained, for example by covering either the door sidewalls 2'', or the cabinet door opening wall 6 (or 6') by a thin plastic liner, shown at 16 in FIG. 2 (and omitted from FIG. 1 for purposes of clarity). Separating walls 2'' and 6, rather than providing a short-circuited electrical contact, will form between walls 2'' and 6 a wave guide having a characteristic impedance very much less than the characteristic impedance of the interior of the cabinet. A severe discontinuity will thus result at the edge of the thus formed wave guide indicated at D (FIG. 1) causing reflections of waves internal of the cabinet and preventing transfer of energy to the region between door and cabinet. Any remainnig energy that is not reflected will be conducted along the wave guide. The lvel of this energy will be so low that it can be short-circuited easily and without danger of arcing or flash-over at the contact between metal strip 8 and projection 3; or between contact springs conductively connected, for example riveted to metal bracket 8, so as to form a good and resilient contact with projection 3. The particular hinge arrangement shown in FIG. 1, or the parallelogram arrangement of FIG. 2 (which requires more hinge points than FIG. 1) is provided in order that the door sides 2'' may seat parallel to the matching walls of the cabinet. Bracket 13 (FIG. 1) and cover plate 14 limit the side excursion of links 20, 21 and thus provide for limited parallel motion at the final travel of the door towards their seating position; while unrestricted hinge 12 (FIG. 1) and 32 (FIG. 2) permits unlimited swinging movement to open the door to any desired position. A mere hinging arrangement of the door is not desirable, however, in order to prevent damage to the side walls upon final seating and to effect parallel seating of sidewalls 2'' with the interior walls 6, or 6', respectively, of the cabinet.

It is possible that a small amount of radiation may still escape. In order to detect possible leakage of radiation larger than that permissible, a simple and effective detection arrangement is incorporated in the construction according to the present invention. Plastic bead 9' contains a pair of wires 9, looped around the door opening, which will act as an antenna and pick up any radiation not bypassed or completely short-circuited by contact of metal part 8 against projection 3. Radiation so picked up can be amplified in an amplifier 29 (FIG. 4) which, when the permissible limit of radiation received by wires 9 exceeds a certain limit, can be arranged to give an alarm, for example by triggering an audible or visual indicator 19 (FIG. 3, FIG. 4) and simultaneously operating a relay to disconnect power to the input of the microwave generator supplying energy to the cabinet.

The walls 6 (or 6') of the cabinet form a lip extending around the door opening, converging at an angle to match the angle of convergence of the sum of the funnel shaped projecting section of the door. The dielectric 7 within the re-entrant portion 6, 6' can act as a dissipating section to dissipate radiation along the wave guide formed therebetween, for any radiation not reflected at point D and reaching point E within the door and the cabinet structure. In most instances, however, a single wall 6, to which a dielectric such as plastic coating 16 is applied, both for spacing as well as for mechanical sealing purposes, will suffice. The energy reaching point E is usually so low that it can readily be short-circuited by contact between projection 3 and cabinet contact member 8.

I claim:

1. In a microwave heating appliance, a cabinet and door construction arranged to prevent escape of radiation from within the cabinet, said cabinet and door construction comprising a lip formed on the cabinet surrounding the door opening and extending inwardly of the cabinet; a projection formed on said door, extending parallel to said lip and spaced closely therefrom when said door is closed, said lip and said projection jointly forming a wave guide having a characteristic resistance which is 100 to 1,000 times lower than the resistance of the space within the cabinet, and forming an electrical contact between the door and the cabinet adjacent said door opening and substantially at the outer end of the thus formed wave guide, the abrupt transition of impedance from within the cabinet to the impedance of the thus formed wave guide causing reflections and preventing escape of radiation outside of said cabinet in the region of said door within said door opening; and radiation pickup means located outside of said cabinet and adjacent said electrical contact forming means to detect radiation leaking from within said cabinet and not bypassed by said contact forming means.

2. A construction as claimed in claim 1 wherein said radiation pickup means includes a loop of conductors located on the cabinet just beyond the outer edge of the door opening and surrounding said door opening.

3. A construction as claimed in claim 1 including alarm means connected to said radiation pickup means, said alarm means being operative upon detection of radiation in excess of a predetermined level by said radiation pickup means.

4. A construction as claimed in claim 1 including support and operating means to interconnect said door and said cabinet, said support and operating means including a linkage means permitting swinging movement of said

door with respect to said cabinet for a major extent and movement of said door perpendicular to said cabinet just before closing, so that said lip and said projection will seat in parallel.

5. A construction as claimed in claim 4 wherein a first link is provided extending generally perpendicular to the door and mounted for limited swinging movement thereon; a second link extending generally parallel to said door and mounted for limited swinging movement with respect to said first link at one end thereof, and secured for swinging movement at the other end thereof to said cabinet.

6. A construction as claimed in claim 4 wherein said linkage means are a parallelogram attachment secured to said door at one fixed parallel side; and holding links secured to the other of said parallel sides and interconnecting said other parallel side and said cabinet.

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U.S. Cl. X.R.

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