

Nov. 25, 1969

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3,480,753

ELECTRONIC OVEN

Filed Feb. 16, 1968

3 Sheets-Sheet 1

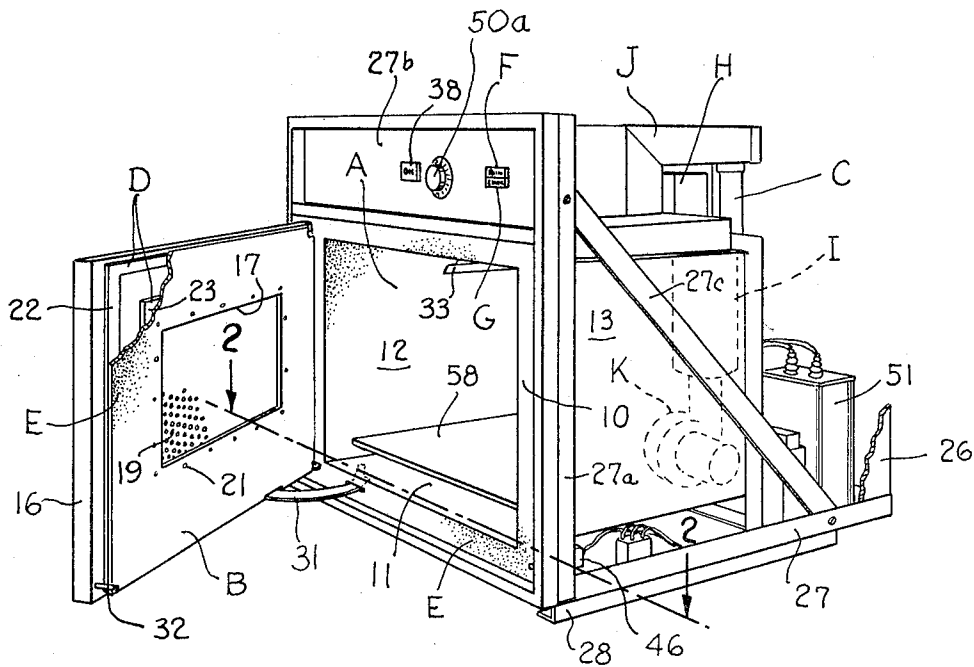


Fig. 1.

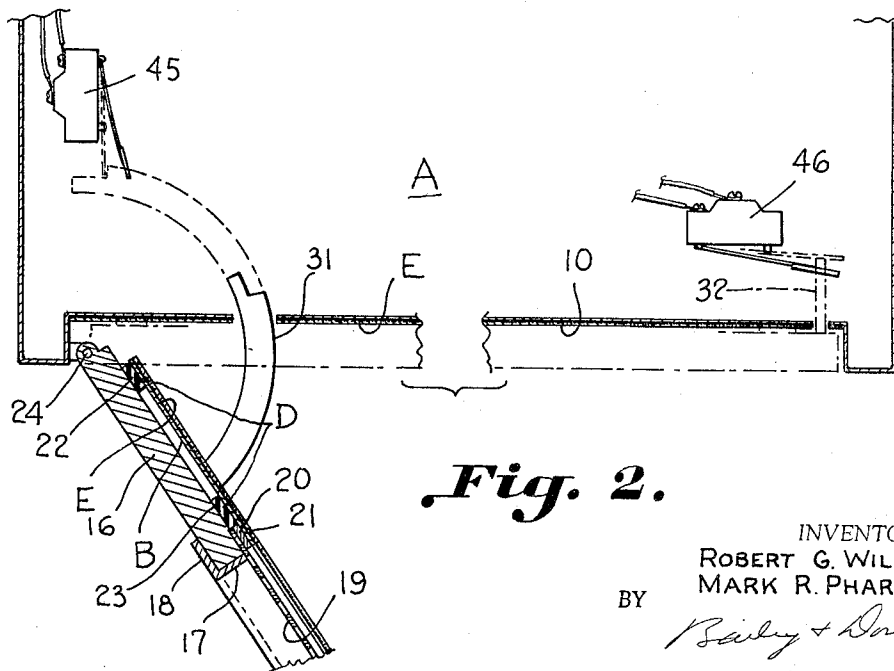


Fig. 2.

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3 Sheets-Sheet 2

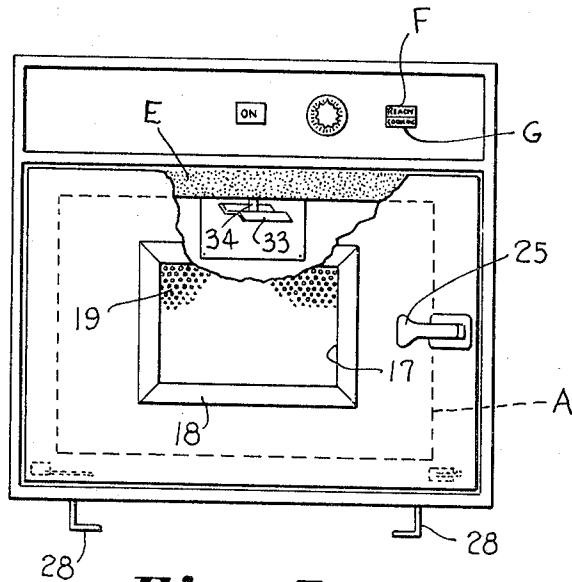


Fig. 3.

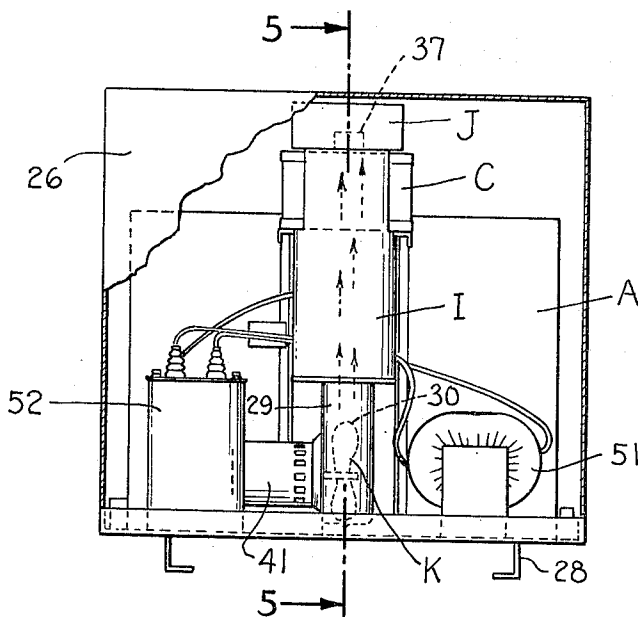


Fig. 4.

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3 Sheets-Sheet 3

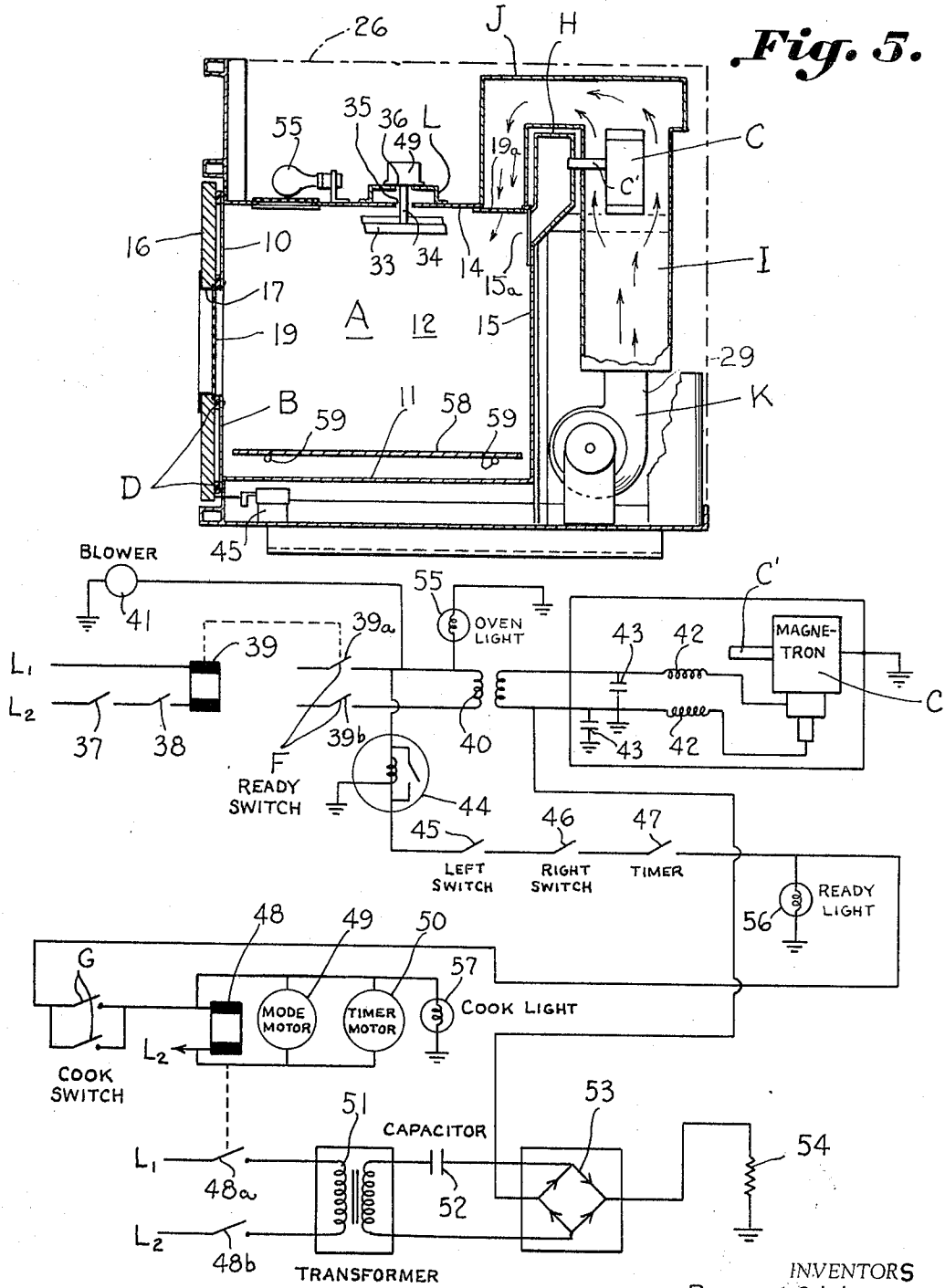


Fig. 6.

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ELECTRONIC OVEN

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U.S. Cl. 219—10.55

4 Claims

ABSTRACT OF THE DISCLOSURE

An oven having a cavity receiving high frequency electromagnetic wave energy for heating edibles is provided with a loosely mounted closure means. The oven is provided with a coating of Teflon and the like, between the closure means and cavity wall forming a capacitance coupling therebetween when the closure means is resiliently urged toward the wall. Thus, leakage of energy about the closure means is controlled, while arcing is avoided and cleaning facilitated. A timer arrangement is provided which permits a proper warm-up period for the magnetron while assuring proper timing of the edible heating operation.

This invention relates to an improved electronic oven including novel closure means, component mounting arrangements, and positive timing system.

Electronic ovens have heretofore had limited application, due in part to the complexities of avoiding the leakage of high frequency electromagnetic wave energy. Such leakage was not only dangerous to persons attending such ovens, but also occasioned expense and damage to the oven. Attempted solutions employing wave traps and the like, have met with limited success. Where closely fitting doors have been employed arcing frequently resulted, marring the cavity wall and door.

The magnetron, which is the usual source of high frequency energy for such ovens, requires a warm-up time before being subjected to load conditions. Heretofore, a timer has been actuated prior to actual cooking when initiating a warm-up period. If the attention of the operator became distracted so that an inordinately long time elapsed prior to initiation of the cooking operation, the cooking operation would be cut short.

The magnetron must be mounted with its cathode connectors pointed downwardly and with its output connector or coupling in a horizontal position. Prior mountings satisfying the conditions have resulted in excessively large oven cabinets or housings. The mounting problem is aggravated by the necessity for providing a blower to maintain the temperature of the magnetron, mounted within a chamber or air duct, within operating limits. The usual interference filter requires several inches of vertical space below the cathode connectors. The output connector must enter a wave guide for introducing the energy generated by the magnetron into an upper portion of the oven. It is also necessary to position a relatively large filament transformer and capacitor within the assembly. In prior arrangements the blower has been beside the magnetron or behind the magnetron requiring a longer cabinet. If the blower is mounted beside the magnetron, there is no room beside the magnetron for the transformer and capacitor requiring that they be mounted behind the blower necessitating a longer cabinet.

The rotating piece of metal included in mode stirrers requires support upon a dielectric material having a low dielectric loss factor. A shaft constructed of polystyrene or polypropylene, for example, requires entrance into the cavity through a relatively large opening to avoid binding. The shaft must be relatively large to support the load

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imposed thereon by the mode stirrer. Thus, the large opening in the cavity wall bordering the shaft would permit the escape of inordinately large amounts of high-frequency energy.

Accordingly, it is an important object of this invention to provide a novel high frequency oven with improved means to avoid leakage around the closure, while avoiding arcing and permitting easy cleaning.

Another important object of the invention is the provision of an improved control system assuring proper closure of the cavity and proper timing of the heating of edibles.

Another very important object of the invention is to provide an improved mounting arrangement for the various oven components wherein the size of the cabinet is minimized and air circulation within the oven is facilitated.

Another important object of the invention is to provide an improved mounting arrangement for a mode stirrer wherein a rugged mount is provided while high frequency energy leakage is controlled.

Still another object of the invention is the provision of a more economical oven capable of maximum utilization of component capabilities.

The construction designed to carry out the invention will be hereinafter described, together with other features thereof.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings forming a part thereof, wherein an example of the invention is shown and wherein:

FIGURE 1 is a perspective view illustrating an electronic oven constructed in accordance with the present invention looking toward the front right-hand side thereof, with the door open and with parts broken away,

FIGURE 2 is an enlarged sectional plan view taken on the line 2—2 in FIGURE 1, further illustrating closure structure,

FIGURE 3 is a front elevation further illustrating the electronic oven illustrated in FIGURES 1 and 2,

FIGURE 4 is a rear elevation still further illustrating the oven component mounting arrangement, with parts omitted,

FIGURE 5 is a transverse sectional elevation taken on the line 5—5 in FIGURE 4, and

FIGURE 6 is a schematic circuit diagram illustrating the operation of various electrical and electronic components of the oven.

The drawings illustrate an oven including a cavity A for receiving edibles having a front wall defining an opening therein, and a loosely mounted closure means B. A source of high frequency radiation C is provided, and such radiation is introduced into the oven cavity A. Resilient means D urge the closure means, when in closed position, toward the wall for a close fitting relationship thereto, blocking high frequency radiation. The closure means and the front wall are constructed of conductive material capable of blocking high frequency radiation for retaining same within the cavity. A coating E of Teflon and the like, is carried by the oven between the closure means B and the front wall maintaining same in spaced relationship, creating a capacitance coupling therebetween when the closure means is in closed position. Thus, arcing between the closure means and the front wall with the consequent damage thereof, is avoided and cleaning of the oven is facilitated.

A ready switch F is provided for connecting the magnetron C to a supply of electrical energy for warming up the magnetron responsive to moving the "on-off" switch to the "on" position. A timer is actuated by said ready switch for warming up the magnetron for a predetermined time. A signal producing means is actuated responsive to

said timer. A manually operated cook switch G again connects the magnetron C to the supply of electrical energy for cooking. A timer is actuated by the cook switch for cooking for a predetermined time, whereby proper cooking time may be assured.

The cavity A is carried by a suitable support. The cavity has top and rear walls. A vertical wave guide H extends through the rear wall in an upper portion of the cavity for introducing high frequency radiation into the cavity. A vertical chamber I is positioned rearwardly of the wave guide. The magnetron C has its cathode connectors pointed downwardly and a horizontal inwardly extending output connector carried within an upper portion of said chamber with the output connector extending into the wave guide H. An interference filter is also positioned within said vertical chamber I below the magnetron. An air duct J is connected to said upper portion of said chamber and passes around the wave guide, and is connected in an upper portion of the cavity. A blower K is carried by the support and has connection with the vertical chamber for introducing air therein and for supporting same. Thus, the magnetron is cooled and excess moisture vented from the oven while minimizing the overall size of the oven.

A mode stirrer blade is carried within the cavity on one side of an oven wall. A motor mounted on the exterior of the cavity on the other side of the wall is provided for driving the mode blade. A shaft connects the blade to the motor and passes through an aperture in the wall which is larger than the shaft. The shaft is constructed from dielectric material. A second cavity L is constructed of material capable of blocking the passage of high frequency radiation and has an aperture therein through which the shaft extends. Thus, the amount of high frequency radiation escaping around the shaft is minimized.

The cavity A has a front wall 10, a bottom 11, sides 12 and 13, a top 14, and a rear wall 15. The oven also has a loosely mounted closure means B which forms a part of a door which includes a frame 16 having an open control portion 17. The opening 17 is defined by a border strip 18 which confines a foraminous portion 19 constructed of conductive material between it and a second frame portion 20. The member B is attached to the frame portion 20 as by rivets 21 located near the opening 17. The closure means B is a flexible metal element and resilient means in the form of sponge rubber strips 22 and 23 are spaced between the flexible member B and the frame member 16 adjacent the margin thereof for as by hinges 24. The door is provided with suitable fastening means including a handle 25. The hinge 24 and the fastening means fix the door when in closed position so that the sponge rubber strips are in compression about the entire marginal portion of the closure means B.

A source of high frequency radiation C, such as a magnetron, is provided, and such radiation is introduced into the oven cavity A. The magnetron illustrated is manufactured by the Amporex Corporation in Hicksville, N.Y., and bears Model No. DX260. Resilient means D in the form of sponge rubber blocks or strips 22 and 23 urge the closure means B when in closed position to overlie the wall 10 for a close fitting relationship thereto for blocking high frequency radiation. The closure means B and the front wall, as well as the other inner surface forming members of the cavity, are constructed of conductive material capable of blocking high frequency radiation, for retaining same within the cavity.

A coating E of Teflon and the like, is carried by the oven between the closure means B and the front wall maintaining same in spaced relationship creating a capacitance coupling therebetween when the closure means B is in closed position. The use of Teflon and the like, between the closure means and the front wall of the cavity is important from the standpoint of cleaning and from the standpoint of its insulating value. The Teflon

provides a dielectric and a separation so that the front plate of the oven, which is constructed of conductive material, such as aluminum, and the closure means of the door become, in effect, two separate plates of a capacitor. The capacitor provides capacitive coupling to couple the door closure means B to the face plate electromagnetically and, thus provides essentially a short circuit at the frequency at which the oven operates, in the range of about 2,450 megahertz.

If there were no dielectric or separation between the closure means and the face of the oven, arcing which burns the metal would occur. It is, therefore, desirable to separate these two metallic surfaces by a distance which is adequate to provide insulation at the highest potentials which are likely to exist. These potentials may run into a very high range, especially under a no-load oven condition. If desired, both the face plate and the door shield may receive the Teflon coating E and the same may extend entirely throughout the interior of the oven cavity. Thus, by making the effective size of the plates large and making a space between them very small, and the dielectric constant high, as by the use of Teflon, maximum capacitance and effective coupling between the closure means and the face plate is provided.

The ready switch F contains a signal lamp for indicating when such has been closed. This switch F connects the magnetron C to a supply of electrical energy for warming up the magnetron. A timer is actuated by the "on-off" switch for warming up the magnetron for a predetermined time. A signal producing means is actuated responsive to the timer and a manually operated cook switch G, which also contains a suitable signal lamp, again connects the magnetron C to the supply of electrical energy for cooking. A timer is actuated by the cook switch for cooking for a predetermined time. This arrangement, which will be described in greater detail below in connection with the circuit diagram, permits flexibility in the operation of the device so that the operator's attention need not be constant. In devices of former manufacture, the operator would initiate the timing mechanism by pressing a button at the same time the warm-up or ready switch means is actuated.

The magnetron C must be mounted with its cathode connectors pointed downwardly and with the R.F. output coupling C' in a horizontal position. The interference filter, which will be described in greater detail below, is made up of several coils of wire, and capacitors, and occupies about three to four inches of vertical space in the air chamber I. It will be noted that the R.F. output coupling projects into a vertical wave guide H which extends through the rear wall 15 in an upper portion of the cavity for introducing radio frequency radiation into the cavity. A plastic protective screen 15a is carried over the exit of the wave guide 11, and such permits the passage of R.F. energy therethrough.

The particular positioning of the parts shown in the drawing has been found especially advantageous from the standpoint of economizing on space and materials. In addition, the particular arrangement of parts shown in the drawing and described above, and in greater detail below in connection with the circuit diagram, permits the induction of air used to cool the magnetron and associated parts back into the top of the oven, thus maintaining free circulation of air throughout the oven. It will be noted that a thermoswitch, to be described in greater detail below, is mounted on top of the magnetron on the air outlet side. The thermoswitch in this particular assembly senses the temperature of the magnetron assembly, and also to some extent, senses the temperature of the exit air to disconnect the operating mechanism should the temperature exceed the rated temperature of the operating components.

These components, together with a transformer and a capacitor to be described in greater detail below, are positioned within a relatively small cabinet 26. The cabi-

net 26 is carried by a suitable base support member 27, which has legs 28 supporting same. It will be observed that the support 27 includes a vertical portion 27a which carries a front panel 27b supported by suitable bracing 27c. The vertical air chamber I is connected to a blower K which includes a housing 29 and a fan 30.

It will also be observed that the door assembly adjacent the hinge 24 carries an arcuate switch operator 31. An inwardly projecting pin 32 is provided adjacent the edge of the door remote from the hinge 24 for operating a second safety switch. The purpose of these right and left switches is to assure that the door is in closed position when the electronic mechanism is operating.

Referring now especially to FIGURE 5, it will be noted that a mode stirrer blade 33 is carried by a shaft 34 constructed of dielectric material. The blade should be a piece of sheet metal from about 6" to 8" long, and about 1" to 2" in width. In the embodiment illustrated the shaft is constructed of polystyrene and such must be about $\frac{3}{8}$ " in diameter in order to support the load. This necessitates cutting a hole 35 about $\frac{1}{2}$ " in diameter in the cavity wall 14 in order to avoid binding. Such would permit escape of an excessive amount of R.F. energy through the hole. A small metal box L, preferably of aluminum is also provided with a $\frac{1}{2}$ " hole 36, and is suitably secured to the top wall to support the shaft 34 and the motor for driving the shaft. The box L acts as a wave trap for R.F. energy entering through hole 35 around shaft 34, and minimizes the escape of R.F. energy.

The mode stirrer is of a standard design, and is used to periodically break up or move standing waves. The movement of the standing waves will tend to integrate the effect of hot and cold spots over a large area of the material being heated, thus producing uniform heating.

As outlined on page 112 of the magazine entitled "Electronics" dated Sept. 7, 1964, other methods can be used to achieve uniform heating in a cooking cavity. One such method employs a broadband coupling technique for delivering magnetron energy to the cooking cavity.

It should be noted that glass may be used in lieu of the foraminous member 19 carried in the central portion of the closure means B. The glass should have the same characteristics in terms of reflecting the microwave energy. The perforated metal member 19 permits the passage of air for carrying out the oven venting operation and vents must be provided elsewhere should the glass be employed. It is important that the glass reflect wave energy so that conducting glass must be coupled to the face plate, either through a capacitance technique or some other similar technique, as was used in connection with the perforated screen. The conducting glass should have openings preferably less than $\frac{1}{4}$ " between the cross wires thereof, and such should be welded at junctures.

If desired, a source of radiant or thermal energy may be employed in the oven in order to carry out a browning operation on the edibles being heated.

CIRCUIT DIAGRAM

The lines L1 and L2 are connected to a suitable source of electrical energy, preferably 230 volts. Such is applied through the thermoswitch 37 mounted on the top of the magnetron (see FIGURE 4), and through the "on-off" switch 38 to the solenoid of the relay 39. Since the thermoswitch 37 is mounted on the top of the magnetron C, it senses the magnetron temperature and the thermoswitch is always closed unless the magnetron temperature exceeds its operating limits in which case the thermoswitch opens deenergizing all functions of the oven.

When the relay 39 is energized the contacts 39a and 39b are closed providing line voltage to the filament transformer 40, carried beside the blower 29, and to the blower motor 41. The blower motor provides air which circulates around the magnetron keeping its temperature from exceeding operating limits, and the exhaust from the

magnetron is ducted through the duct H to the cavity of the oven and out the front door through the foraminous member 19 in order to provide air circulation within the oven. A foraminous member 19a similar to member 19, is carried at the exit of duct H for preventing R.F. energy from entering the duct from the cavity.

The filament lines go into the air chamber I and air duct below the magnetron which carries the interference filter therebelow. The interference filter contains a series inductance 42 and a shunt capacitor 43 in each leg of the filament line leading to the magnetron C. The purpose of this interference filter is to reduce spurious radiation generated by the magnetron which may cause harmful interference to television sets, communication systems, and the like. Since it is necessary for the magnetron filaments to warm-up at least 10 seconds prior to applying the high voltage thereto, at the same time that the relay 39 is energized supplying voltage to the filaments of the magnetron, it also supplies energy to the thermo-delay relay 44. This thermo-delay relay provides delay protection to the magnetron to allow its filaments to warm-up. Once the thermo-delay relay times out, power is then routed through the left door interlock switch 45, through the right-door interlock switch 46, and through the timer switch 47 (see FIGURES 2 and 6) to establish a ready condition. When the circuit is in ready condition the ready light on the front panel of the oven is energized indicating that the oven is ready to begin cooking. This indication also records that both interlocks are closed and that the timer has been moved from its "off" position. Once the ready light burns and the operation is prepared to energize the oven for cooking the cook button is depressed. When the cook button is depressed it energizes the relay 48 by providing voltage from the line L1 through the thermo-delay relay and the left and right interlock switches and timer switch to one side of the relay 48. The other side of the solenoid of the relay 48 is returned to L2, thus providing 230 volts across the relay 48. When the relay 48 is energized voltage is also applied to the mode stirrer motor 49 which causes it to begin rotating and to the timer motor 50 which causes it to begin timing out. The timer motor is controlled by a setting knob mechanism 50a permitting predetermined heating periods to be set.

The primary function of the relay 48 and its associated contacts 48a and 48b is to provide line voltage through the contacts to the high voltage transformer 51. The secondary of the high voltage transformer 51 provides A.C. voltage which is routed in series through the resonant capacitor 52 into the bridge of the full wave rectifier 53. The purpose of the resonant capacitor is to smooth out normal power supply variations so that essentially a constant input is assured. The output voltage of the transformer 51 is supplied to the full wave rectifier bridge 53 in a conventional manner. The full wave rectifier bridge has two outputs, one of which goes to ground through a resistor 54. The purpose of this resistor is to provide an easy method for service technicians or a manufacturer's inspector to ascertain by measurements thereacross that current flow through the magnetron cathode is proper.

The high voltage output from the full wave bridge rectifier 53 is below ground potential or minus D.C. voltage, and is a supply back to one of the terminals of the filament transformer thus placing the entire filament transformer and interference filter magnetron filament circuit many volts below chassis or ground potential. The application of this voltage causes the magnetron to oscillate. It consumes D.C. power and gives off microwave energy at a desired frequency for energizing the oven cavity.

The oven light 55 is energized by closing the switch 38. The lamp indicating ready condition is indicated at 56 while the cook light also previously mentioned, is designated at 57.

If desired a shelf 58 may be positioned as by support means 59 in the lower portion of the cavity A for carry-

ing edibles. Such permits the edibles to receive better wave distribution and facilitates cleaning.

While a preferred embodiment of the invention has been described using specific terms, such description is for illustrative purposes only, and it is to be understood that changes and variations may be made without departing from the spirit or scope of the following claims.

What is claimed is:

1. In combination with an oven including a cavity for receiving edibles having a front wall defining an opening therein and a loosely mounted thin flat metallic closure means carried by said oven for closing said opening, the improvement comprising: a source of high frequency radiation introducing such radiation into the oven cavity; resilient means for urging the closure means when in closed position toward the wall for a close fitting relationship thereto blocking high frequency radiation; said closure means and said front wall being constructed of conductive material capable of blocking high frequency radiation for retaining same within the cavity; and a Teflon coating carried by the oven between the closure means and said front wall maintaining same in spaced relationship creating an effective capacitor when said closure means is in closed position for preventing said high frequency radiation from escaping from said oven, said thin flat metallic closure means acting as one plate of said capacitor, said front wall acting as the other plate of said capacitor and said Teflon coating acting as a dielectric therebetween, whereby arcing between the closure means and the front wall with the consequent damage thereof is avoided and the coating may be easily cleaned.

2. A high frequency oven comprising: a cavity defined by walls including, a rear wall and a front wall having an opening therein for providing access to said cavity; a thin flat metallic closure means carried adjacent said opening in said front wall for closing said opening; resilient means for biasing said closure means towards said wall providing a close fitting relationship between said front wall and said closure means when said closure means is in a closed position, said closure means and said front wall being constructed of conductive material capable of blocking high frequency radiation for retaining same within said cavity; a Teflon coating carried by the oven between the closure means and said front wall for creating an effective capacitor when said door is in a closed position for preventing said high frequency radiation from escaping from said oven, said thin flat metallic closure means acting as one plate of said capacitor, said front wall acting as the other plate of said capacitor and said Teflon coating acting as a dielectric therebetween; a vertical wave guide extending through said rear wall, a

magnetron provided for supplying high frequency radiation to said wave guide into said cavity; an air duct enclosing said magnetron and communicating with said cavity; a blower for supplying air to said air duct in order to cool said magnetron and force excess moisture from said oven; a mode stirrer blade carried within said cavity; a motor carried on the exterior of said cavity; a shaft connecting said blade to the motor passing through an aperture in the wall, said shaft being constructed from dielectric material; and a second cavity constructed of material capable of blocking the passage of high frequency radiation and having an aperture therein surrounding the shaft, whereby the amount of high frequency radiation escaping from said oven is minimized.

3. The oven as set forth in claim 1 comprising; a supply of electrical energy, a manually operated switch for connecting said magnetron to the supply of electrical energy for warming up the magnetron, a timer actuated by said switch for warming up said magnetron for a predetermined time, a signal producing means actuated responsive to said time, a manually operated cook switch for again connecting said magnetron to the supply of electrical energy for cooking, and a timer actuated by said cook switch for cooking for a predetermined time, whereby proper cooking time may be assured.

4. The oven as set forth in claim 2, wherein an exit port is carried in one of said walls, said port has a foraminous screen positioned thereon for preventing the passage of high frequency radiation while permitting the passage of air so that excess moisture can be forced from said oven by said blower.

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