

[54] MICROWAVE OVEN

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[63] Continuation-in-part of Ser. No. 163,764, July 19, 1971, abandoned.

Foreign Application Priority Data

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[51] Int. Cl. **H05b 69/06**

[58] Field of Search..... 219/10.55

[56] **References Cited**

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[57]

ABSTRACT

A microwave oven has a cabinet whose interior is divided by a baffle plate into an upper chamber and a cooking chamber. The baffle plate is composed of a dielectric material, such as polypropylene, capable of transmitting therethrough microwave energy and a microwave oscillator is mounted in the upper chamber and radiates microwave energy through the baffle plate into the cooking chamber to effect cooking of foodstuff placed in the cooking chamber. A thermal switch is mounted on the outer surface of a side wall of the cooking chamber and deenergizes the microwave oscillator when the side wall reaches a predetermined temperature.

1 Claim, 5 Drawing Figures

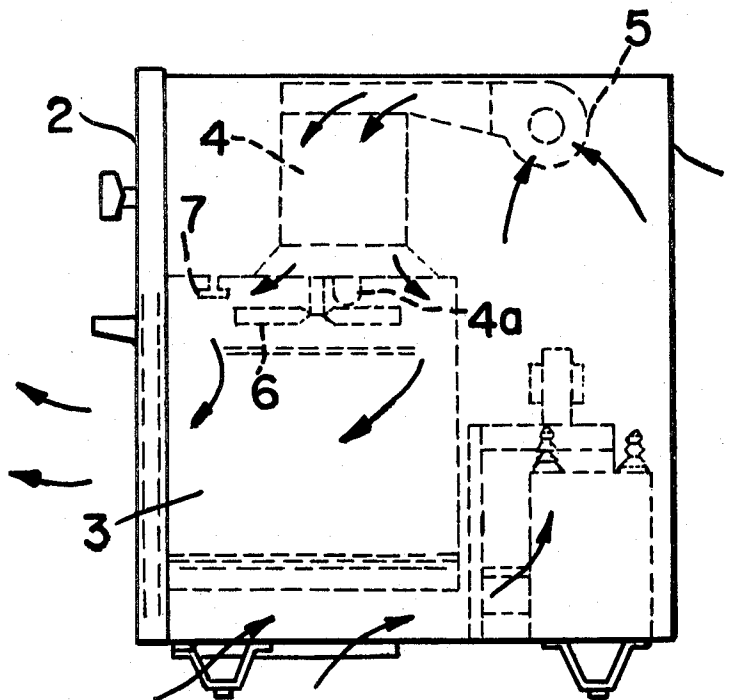


FIG. 3

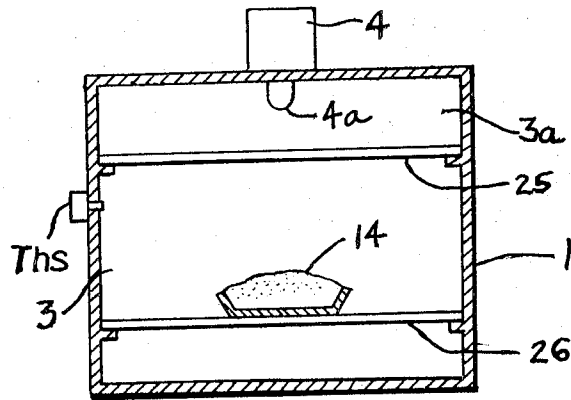


FIG. 4

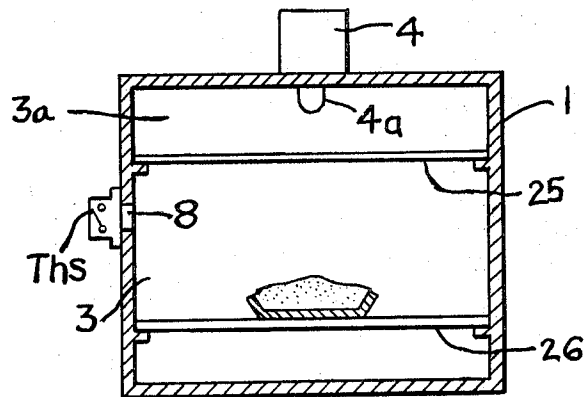
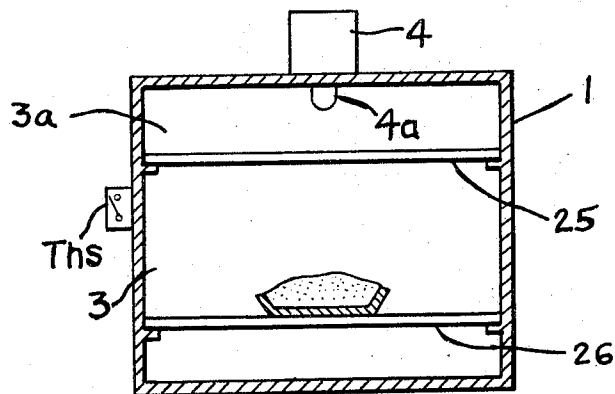


FIG. 5



MICROWAVE OVEN

This is a continuation-in-part application of copending application Ser. No. 163,764, filed July 19, 1971, entitled ELECTRONIC OVEN and now abandoned.

BACKGROUND OF THE INVENTION

This invention relates generally to high frequency heating apparatus, and more particularly to an electronic or microwave oven having improved protective devices.

In an ordinary electronic oven, where the high frequency oscillator such as a magnetron oscillator, is operated under no load or light load conditions due to the absence of a foodstuff in the oven, the high frequency electromagnetic wave energy radiated by the oscillator becomes excessive and the surplus wave energy is reflected back to the high frequency oscillator causing it to overheat. To prevent this, it has been proposed to install a thermal switch on the inner wall of the oven near the high frequency oscillator to detect the abnormal temperature rise thereof for deenergizing the high frequency oscillator or to install a fusible element on the inner side wall of the oven. By the former approach, the temperature of the high frequency oscillator rises to an abnormal value before the thermal switch can operate with the result that the operating life of the high frequency oscillator is greatly shortened whereas the latter approach requires repeated renewal of the operated fusible element.

Another problem of the an electronic oven involves the potential fire hazard which is caused by inflammable fumes generated by the foodstuff being cooked, or by an inadequate setting or fault of a timer which is used to control the cooking time of the oven. Since forced ventilation is generally used in the electronic oven, the flame once ignited will be blown out of the oven and such is very dangerous. According to one prior art approach, a thermal switch was installed near the outer wall of the oven for deenergizing the air circulating fan and the high frequency oscillator. However, since the switch is mounted on the outer wall of the oven, its response is slow. Furthermore, it is difficult to install the thermal switch at the most suitable position for detecting the occurrence of the flame since the position varies depending upon the property and the configuration of the foodstuff being cooked.

Should the operation of this flame responsive switch be delayed, the flame will be blown to the outside through the exhaust opening through the door or another portion of the oven by the circulating air. Moreover, continued operation of the air circulation fan supplies fresh air to the burning foodstuff thus maintaining the flame until the foodstuff completely burns out. As above described, the thermal switch associated with the high frequency oscillator is designed to respond to surplus or reflected electromagnetic wave energy and since the flame can not reach the thermal switch by being blown by the circulating air, the thermal switch can not reliably protect against a fire hazard.

SUMMARY OF THE INVENTION

It is an object of this invention to provide an improved high frequency heating apparatus for an electronic oven wherein a temperature responsive device is provided at a point which receives surplus high fre-

quency electromagnetic wave energy whereby the high frequency oscillator is deenergized in case of light or no load conditions of the oven thus increasing the operating life of the high frequency oscillator.

Another object of this invention is to provide a novel high frequency heating apparatus or oven which can promptly detect a fire hazard.

According to this invention, a microwave oven includes a cabinet having a top portion, a bottom portion and side wall portions, a baffle plate composed of dielectric material dividing the interior of the cabinet into an upper chamber and a cooking chamber for receiving therein foodstuff to be heated during use of the oven, a microwave oscillator including an antenna disposed in the upper chamber for radiating microwave energy into the cooking chamber through the baffle plate, electric circuit means for energizing the microwave oscillator, and a thermal switch mounted on the outer surface of one of the side wall portions of the cooking chamber and connected in the electric circuit means for opening the same to effect deenergization of the microwave oscillator when the one side wall portion reaches a predetermined temperature.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawing corresponding parts are designated by the same reference numerals, and

FIG. 1 is a schematic side view of an electronic oven employing a thermal switch responsive to the condition of the high frequency electromagnetic wave energy radiated into the cooking chamber;

FIG. 2 shows a wiring diagram of the control circuit used in the oven shown in FIG. 1; and

FIGS. 3, 4 and 5 show different arrangements of the thermal switch.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

An electronic or microwave oven embodying the invention is shown in FIG. 1 comprises a cabinet having a door 2, a heating or cooking chamber 3 in the cabinet 1, a source of high frequency electromagnetic wave, typically in the form of a magnetron or microwave oscillator 4, a fan 5 for cooling the oscillator 4 and circulating air through the cooking chamber, a stirrer fan 6 for stirring the air in the cooking chamber 3 and a temperature responsive device or thermal switch 7 located at a position to detect excessive temperatures caused by the surplus or reflected high frequency electromagnetic wave energy. The circulation of air is shown by arrows.

As is well known in the art, the foodstuff to be cooked is disposed in the bottom of the cooking chamber 3 and the high frequency electromagnetic wave energy radiated from a short antenna 4a is randomly scattered by the stirrer fan 6 toward the foodstuff located below it. Whenever the foodstuff is of a sufficient quantity, most of the radiated energy is absorbed by the foodstuff for heating the same. Whereas when the quantity of the foodstuff is small or there is no foodstuff in the cooking chamber 3, the energy will become surplus and the surplus electromagnetic wave energy is reflected by the foodstuff or by the bottom or side walls of the cooking chamber back to the antenna 4a thus overheating the high frequency oscillator 4. According to this invention, however, such reflected wave also reaches the temperature responsive device or thermal

switch 7 which detects such no load or light load conditions and effects deenergization of the high frequency oscillator.

FIG. 2 shows a wiring diagram of an electric control circuit of the electronic oven shown in FIG. 1. The circuit comprises a commercial power source PS, a magnetron or microwave oscillator Mag, a high voltage transformer TH for energizing the magnetron oscillator through a rectifier circuit including a diode rectifier SR shunted by a resistor R and a capacitor C₄. The cathode heater of the magnetron oscillator is energized from source PS through a source switch SW, a temperature responsive switch ThS₂ (corresponding to the thermal switch 7 shown in FIG. 1) and a low voltage transformer TL. A magnetic contactor MC with its normally open contacts MC-a₁ and MC-a₂ connected between the primary winding of the high voltage transformer TH and the power source PS is controlled by a cooking switch SW₁ which is closed at the time of cooking.

A timer T is provided to preset the energizing period of the magnetic contactor MC or the cooking time of the oven, and a time delay relay DRy is provided to delay the operation of the electronic oven by a time required to heat up the cathode heater of the magnetron tube. In series with the cooking switch SW₁ are connected a door switch DS₁ and a thermal switch ThS₁ responsive to the temperature of the magnetron oscillator. A motor FM for driving a cooling fan for the magnetron oscillator is connected in parallel with the primary winding of the low voltage transformer T_L. A motor SFM for driving the stirrer fan 6 and a timer driving motor TM are connected in parallel with the magnetic contactor MC. Further, a buzzer BZ is connected across the magnetic contactor MC through a normally open contact I-a of the timer. A second door switch DS₂ and fuses F are included in the primary circuit of the high voltage transformer TH.

In operation, the source switch SW is first closed to preheat the cathode heater of the magnetron tube through the normally closed temperature responsive switch ThS₂ and the low voltage transformer T_L. After the elapse of the preset time of the time delay relay Dry, the cooking switch SW₁ is closed to energize the magnetic contactor MC through the door switch DS₁ and the thermal switch ThS₁. When energized, the magnetic contactor MC closes its contacts MC-a₁ and MC-a₂ to energize the magnetron oscillator Mag through the high voltage transformer TH. Concurrently therewith, a contact MC-a₂ of the contactor MC is closed to establish a self-holding circuit for the magnetic contactor MC. When the cooking time preset by the timer T has elapsed, the timer opens its contact T-b to deenergize the magnetic contactor MC and hence the magnetron oscillator. At the same time, the timer contact I-a is closed to energize the buzzer BZ informing the termination of the cooking time.

The foregoing description relates to the normal operation of the electronic oven. However, when there is no foodstuff or but a small quantity of foodstuff in the cooking or heating chamber, the electromagnetic energy becomes excessive or surplus and such surplus energy is reflected back to the thermal switch ThS₂ to cause it to interrupt the electric power supplied to the electronic oven when the sensed temperature reaches a predetermined value. This switch also responds to abnormal temperature rises in the cooking chamber caused by the fault of the timer. In this manner, it is

possible to prevent overheating of the high frequency oscillator and burning of the foodstuff can be precluded.

In the embodiments shown in FIGS. 3, 4 and 5, the interior of the cabinet 1 is divided into an upper chamber 3a and a cooking chamber 3 by means of a baffle plate 25 made of heat-resistant dielectric material, for example, polypropylene, which has a microwave energy transmittance characteristic so that the dielectric material transmits therethrough the microwave energy radiated by antenna 4a. The antenna 4a and a stirrer fan, not shown, are located in the upper chamber 3a and protected from any fumes, moisture or flame generated by the foodstuff 14 contained in the cooking chamber. The foodstuff is supported on a shelf 26 made of heat-resistant glass.

According to this invention, a thermal switch Ths is mounted on the outside of one side wall of the cooking chamber 3 at a level lower than the baffle plate 25. As shown in FIG. 3 the thermal switch includes a bulb type temperature responsive element and an opening is formed through one side wall of the cooking chamber through which the bulb extends so that same partially protrudes into the cooking chamber through the opening.

If the thermal switch Ths is not provided with a temperature responsive element in the form of a bulb, an opening may or may not be provided in the side wall. As shown in FIG. 4, an opening 8 is provided through the side wall of the cooking chamber 3 to directly expose the thermal switch Ths to the environment within the cooking chamber. In the embodiment shown in FIG. 5, no such opening is provided and the thermal switch Ths is mounted on the outer surface of the side wall of the cooking chamber 3 and responds to the temperature of the side wall which is usually made of thin sheet metal.

What I claim is:

1. In a microwave oven; a cabinet having a top portion, a bottom portion and side wall portions; a baffle plate composed of dielectric material having a microwave energy transmittance characteristic for permitting transmission therethrough of microwave energy; said baffle plate extending horizontally across the width of said cabinet dividing the interior of said cabinet into an upper chamber and a cooking chamber for receiving foodstuff to be heated during use of the oven whereby products evolved in said cooking chamber during the cooking of the foodstuff are blocked by said baffle plate from reaching said upper chamber; a microwave oscillator including an antenna disposed in said upper chamber for radiating microwave energy through said baffle plate into said cooking chamber; electric circuit means for energizing said microwave oscillator; a thermal switch mounted on an outer surface of one of said side wall portions of said cooking chamber beneath a level of said baffle plate and connected in said electric circuit means for opening the same to effect deenergization of said microwave oscillator when said one wall portion reaches a predetermined temperature; means for defining an opening through said one side wall providing communication of the interior of said cooking chamber with said thermal switch thereby subjecting said thermal switch to the temperature in said cooking chamber through said opening and said thermal switch including a temperature-responsive switch element mounted on the outside of said one side wall portion adjacent said opening so as to directly respond to the temperature of the air in said cooking chamber which reaches said switch element through said opening.

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