Oct. 22, 1968 R. L. GREENBERG 3,407,279

HIGH FREQUENCY HEATING APPARATUS

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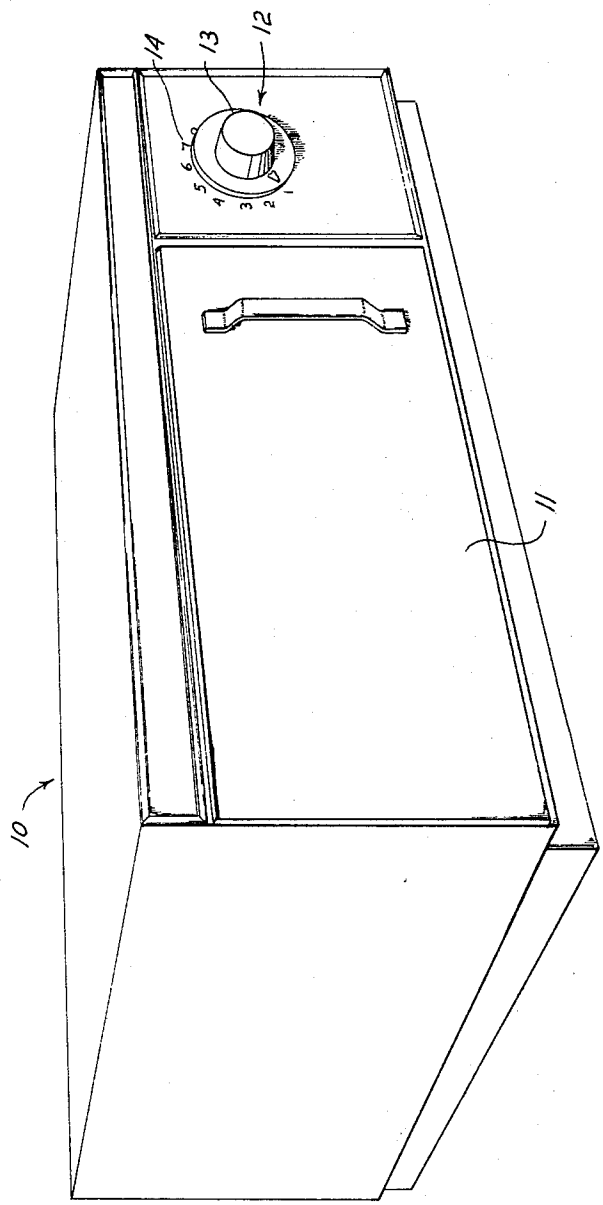

Fig-1

INVENTOR.
ROBERT L. GREENBERG
BY
Synnestvedt & Lechner
ATTORNEYS

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Fig. 2

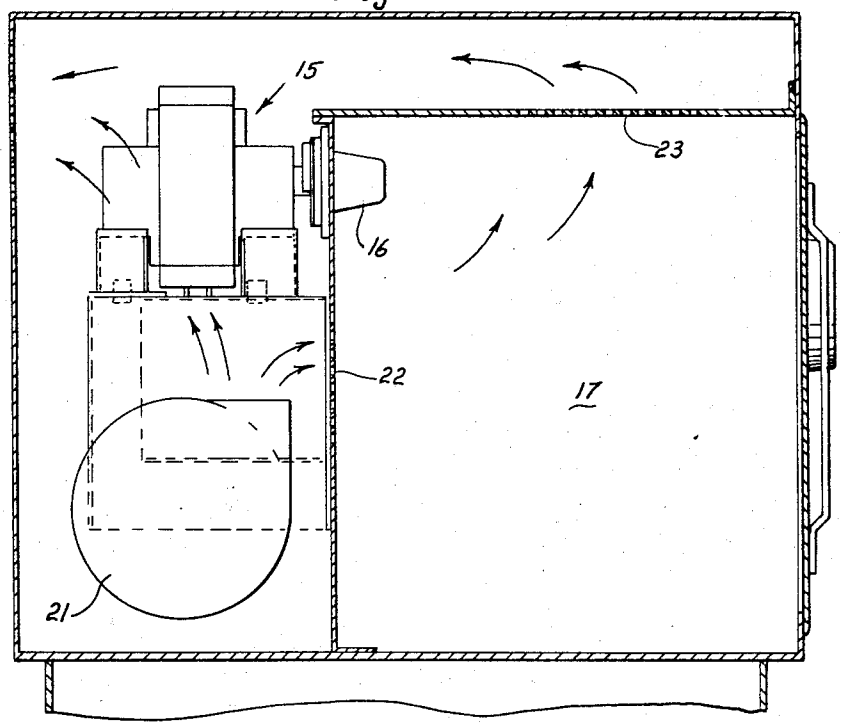
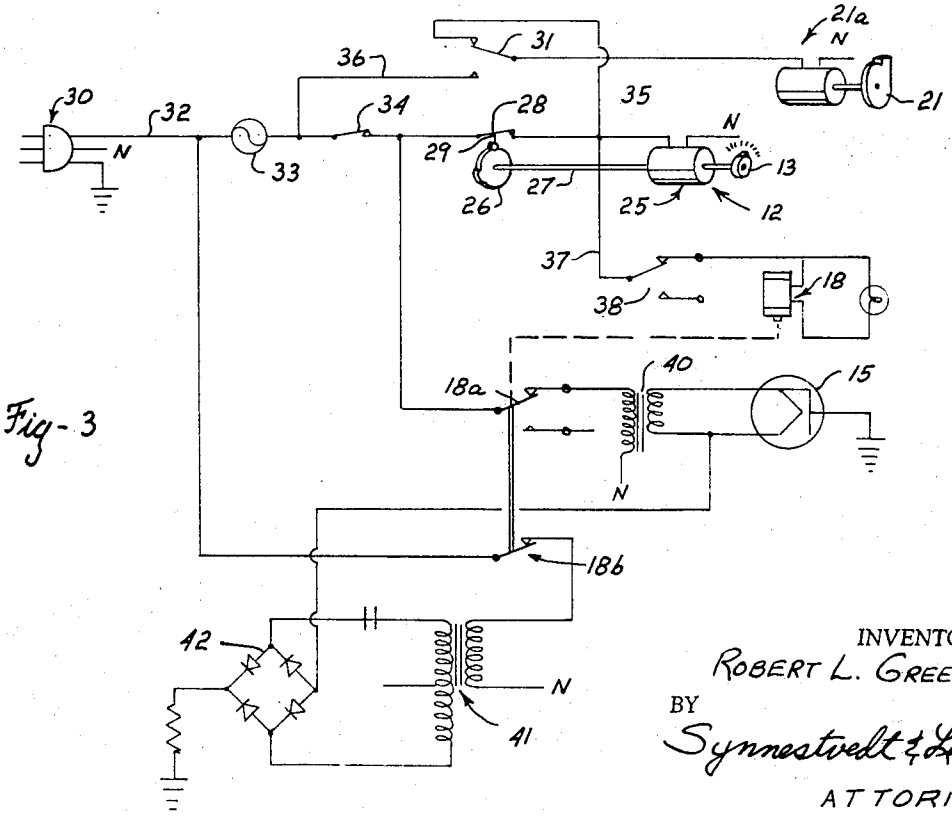


Fig. 3



INVENTOR.
ROBERT L. GREENBERG
BY
Synnestvedt & Lechner
ATTORNEYS

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HIGH FREQUENCY HEATING APPARATUS

Robert L. Greenberg, Merion Station, Pa., assignor to Rudd-Melikian, Inc., Warminster, Pa., a corporation of Pennsylvania

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ABSTRACT OF THE DISCLOSURE

High frequency heating apparatus and control circuitry includes circuit for maintaining a low voltage on magnetron filament at all times when circuit is energized and timer responsive circuits for raising filament voltage and simultaneously applying an anode voltage to magnetron. Interrelated timer and door responsive circuits control a blower for cooling the magnetron during cooking cycle and exhausting steam and food vapors at completion of cooking cycle.

This invention relates to high frequency heating apparatus, and more particularly to improvements in control circuitry and equipment for regulating the cyclic operation of the high frequency energy source used in such apparatus.

The invention is especially useful when incorporated in the operating circuits of micro-wave ovens, such ovens being widely used in association with vending machine equipment in restaurants, snack bars and institutional cafeterias.

These micro-wave ovens have, in recent years become widely used in installations of the aforementioned type because the speed with which heating is accomplished makes it possible to not only reheat precooked foods, but also to produce freshly cooked dishes in a fraction of the time required for conventional cooking.

The use of these ovens in association with vending machines for cooking and reheating vending machine foods, while highly advantageous, has produced certain problems of concern both to manufacturers and users of the equipment alike. One of the most troublesome problems arises from the fact that the magnetron tube which is used for generating the microwave energy is turned off and on each time a dish of food is cooked. This continual cycling of the tube shortens tube life markedly, especially in the case of an oven which may be operated at somewhat irregular intervals a hundred or more times during a day. Frequent tube replacement is costly and the time lost when the oven is inoperable due to a burnt out tube results in inconvenience to the customer and loss of income to the vending machine or restaurant operator.

In addition to the foregoing, it has been found that in a vending machine installation in a busy snack bar or the like, it is extremely difficult to keep the oven clean and free of grease and food particles. The grease not only gives rise to objectionable odors, but actually absorbs the microwave energy during a cooking cycle, reducing the amount of energy available for cooking the food parcels placed within the oven.

The present invention provides a simple and effective solution to each of these problems.

Accordingly, an important object of the invention is the provision of novel control circuitry, which serves to minimize the deleterious effects of continual cycling on tube life.

Another important object of the invention is the provision of tube control circuitry, which markedly shortens the time required to cook a given food dish.

Still another object of the invention is the provision of apparatus, and control circuitry, which minimizes the accumulation of dirt and grease within the cooking chamber of the oven.

The foregoing and other objects of the invention are achieved by a circuit for the power supply of the magnetron tube which includes a timer and switching circuit used for operating the oven for predetermined time intervals. The control circuitry includes means for supplying voltage to the magnetron filament at a level below the operating potential of the tube at all times except when the oven's heating cycle is initiated. Upon initiation of such a cycle the control circuitry increases the filament voltage to the operating potential and also supplies the requisite high voltage to the magnetron plate. The timer also controls means for preventing overheating of the tube during the operating cycle, including a blower which cools the tube during the operating cycle. At the end of the operating cycle the operation of the blower is controlled so that the bulk of the air flow is directed through the oven cavity instead of over the magnetron.

How the various objects and advantages of the invention are achieved will become fully apparent from the following detailed description of an illustrative embodiment, when taken in light of the accompanying drawings, in which:

FIGURE 1 is a perspective view of a microwave oven formed in accordance with the present invention;

FIGURE 2 is a sectional view of the oven shown in FIGURE 1; and

FIGURE 3 is a wiring diagram in schematic form, used for controlling the microwave heating apparatus of the present invention.

Turning now to FIGURE 1, a microwave oven **10** is shown which has a door **11** leading to a conventional cooking chamber shown in FIGURE 2. The control for initiating a cycle of operation of the oven includes a timer **12**, having a presettable indexing knob **13** for selecting the appropriate duration of the heating cycle. A scale **14** provided with suitable indicia is arranged around the knob **13**.

As shown in FIGURE 2, the oven is provided with a microwave energy source **15**, which typically includes a magnetron tube of the type manufactured by the Amperex Corporation under No. (DX 260). The energy projecting portion of the tube **16** extends into the heating chamber or cavity **17**.

The present invention controls the operation of the magnetron tube by constantly supplying a low A-C voltage to the tube filament. This voltage is maintained at a level which is just below the normal operating filament voltage for the tube. In the illustrative embodiment, about two volts is applied to the filament to heat the filament to a level slightly below the operating level. Upon initiation of a cooking cycle the filament voltage is increased to raise the temperature of the filament and simultaneously the plate is connected to its voltage source. The filament voltage is controlled by the timer **12**, also shown in FIGURE 3, which completes a connection to a control relay **18** to increase the tube filament voltage in a manner described in more detail hereinafter. At that time the relay also connects the tube plate to a high voltage D-C power supply. When the cooking cycle is initiated, a centrifugal blower **21**, shown in FIGURES 2 and 3 is also connected to line voltage. This centrifugal blower circulates air upwardly, as viewed in FIGURE 2, over the tube, thereby cooling the magnetron during the operating cycle. At the same time, a portion of the air circulated by the blower passes through suitable portage **22**, in the rear wall of the cooking chamber, and this air is circulated out through vent openings **23** at the top of the chamber, conveying away vapors given off by the food as it is cooked. When the cooking cycle is completed, the timer breaks a circuit connection to relay **18**, which disconnects the magnetron plate and reduces the filament voltage to the 2 volt level. At the end of the cooking cycle, as the

customer opens the oven door, a door controlled switch reconnects the blower motor **21***a*, and substantially all of the capacity of the blower is diverted through the cooking chamber and out through the open door.

Turning now in more detail to FIGURE 3, the timer **12** includes generally, the operating knob or dial **13**, a synchronous motor **25**, and a cam **26**, mounted on a shaft **27** driven by the motor. Timer **12** is of conventional construction, the shaft **27** being rotatable by the dial **13** a selected amount, in the clockwise direction as viewed in FIGURE 1. The motor **25** thereafter drives the shaft in the reverse direction at a constant rate of speed. Cam **26** controls a switch **28** which is provided with a follower **29**, riding on the control surface of the cam. Switch **28** is in the open position when the timer is in its initial position, and when closed connects the motor **25** with the A-C power source schematically indicated by the plug **30**. When the motor drives the cam back to the initial position, switch **28** is opened by operation of the follower riding up onto the rise of the cam and the motor is shut off.

A door controlled switch **31** connects the blower **21** with the power supply **30**, through lead **32**, a fuse **33**, a thermally operated switch **34**, located adjacent the magnetron, the cam controlled timer switch **28**, a lead **35**, and the switch **31** which is moved from the lower position as viewed in FIGURE 3 when the oven door is open to the upper position when the oven door is closed. When the oven door is opened, and the switch **31** is in the lower position, the blower motor **21***a* is connected to the power supply through the switch **31** by means of a lead **36**. Thus, the blower will be operated whenever the timer is set, or when the oven door is opened.

Closure of the timer switch **28** also completes a circuit to the aforementioned relay **18** through a line **37** and a second door operated switch **38**. Relay **18** controls ganged switches **18***a* and **18***b* and when energized, the relay moves the switch arms to the upper position as viewed in FIGURE 3. Switch **18***a* is connected to the primary of a transformer **40**. When the switch is in the lower position, which is the position it assumes when the relay is de-energized, the 2 volt signal is applied to the filament of the magnetron **15**. Upon energization of the relay **18** the filament receives the operating potential which in the illustrative embodiment is about 3 volts. Energization of the relay **18** simultaneously closes the switch **18***b*, which completes a circuit to the primary of a high voltage transformer **41**. This transformer delivers a high voltage, about 5000 volts, when the Amperex tube mentioned above is used. A conventional bridge type rectifier **42** interconnects the transformer and the tube plate and provides a D-C voltage at the plate.

To summarize the operation of my invention, predetermined minimum voltage is always applied to the filament of the magnetron. When a customer places a dish of food within the cooking chamber and sets the timer, the filament voltage is increased and the plate voltage is applied. The blower starts operating at the same time, thereby cooling the tube. Because the filament is already relatively warm, the tube becomes operational much more quickly, and the cooling cycle may be accordingly shortened. The operation of the blower during the heating cycle prevents overheating of the tube.

In short, the use of the blower for cooling and the provision of circuitry for constantly applying a low voltage to the tube filament combine to moderate the extremes of tube temperature, and I have found that this moderating effect provides a substantial increase in tube life. Moreover, the importance of the operation of the blower after the oven door is opened at the close of a heating cycle cannot be overstressed. The door, in effect acts as a valve, since it offers a low resistance path for the air to follow. Thus, the steam and food vapors are carried out of the oven at the end of a heating cycle in an extremely efficient manner. When using such an arrangement it has been found that the problem of greasy food particles accumulating within the heating chamber is substantially eliminated.

I claim:

1. In an oven having a cooking chamber, said chamber having a door,
   - means for heating food within said chamber comprising an electron discharge device for radiating electromagnetic energy into said chamber;
   - a power supply for said discharge device;
   - control circuitry for interconnecting said discharge device and said power supply;
   - said circuitry including a presettable timer for controlling operation of the discharge device for preselected time intervals;
   - a blower for circulating air over said discharge device and through said chamber; and
   - circuit means for operating said blower including a first blower circuit energized when said timer is operating and a second blower circuit energized when said door is open.

2. An oven of the high frequency electromagnetic heating type comprising, an oven chamber, said chamber having a door providing communication with the interior of the oven chamber for the insertion of food products to be heated, a magnetron for heating food within said chamber by radiating alternating electromagnetic energy into said chamber, a control circuit for controlling the application of electrical energy to said magnetron, said circuit including a pre-settable timer for controlling the operation of the magnetron for pre-selected intervals, a blower positioned to circulate air over said magnetron and into and out of said chamber through ports in the walls of the chamber, blower circuitry for controlling said blower including a first blower circuit energized by a series connected timer controlled switch and door controlled switch, and said blower circuitry including a second blower circuit energized by closing a switch when the door is opened.

3. An oven in accordance with claim **2** wherein the door controlled switch in said first and second blower circuit is a single pole double throw switch controlled by opening and closing said door.

4. An oven in accordance with claim **2** wherein said magnetron has a filament, filament circuitry for interconnecting said filament with a source of electrical power, said filament control circuitry including means for controlling the voltage level applied to said filament, said voltage level controlling means including switch means responsive to said timer for supplying voltage a level below the operating voltage of the filament when the timer is inoperative and for supplying voltage at the operating level of the filament when the timer is operative.

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RICHARD M. WOOD, *Primary Examiner.*

L. H. BENDER, *Assistant Examiner.*