

[54] **MAGNETRON POWER SUPPLY
HAVING IN-RUSH CURRENT LIMITER**

[75] Inventor: **Paul Wythe Crapuchettes**, Wood-
side, Calif.

[73] Assignee: **Litton Systems, Inc.**, San Carlos,
Calif.

[22] Filed: **Dec. 6, 1971**

[21] Appl. No.: **204,851**

[52] U.S. Cl.**219/10.55, 315/104, 328/270**

[51] Int. Cl.**H05b 9/06**

[58] Field of Search 219/10.55; 315/8, 101, 102,
315/104, 105, 106, 107; 325/492, 493, 494,
495; 328/259, 267, 270

[56] **References Cited**

UNITED STATES PATENTS

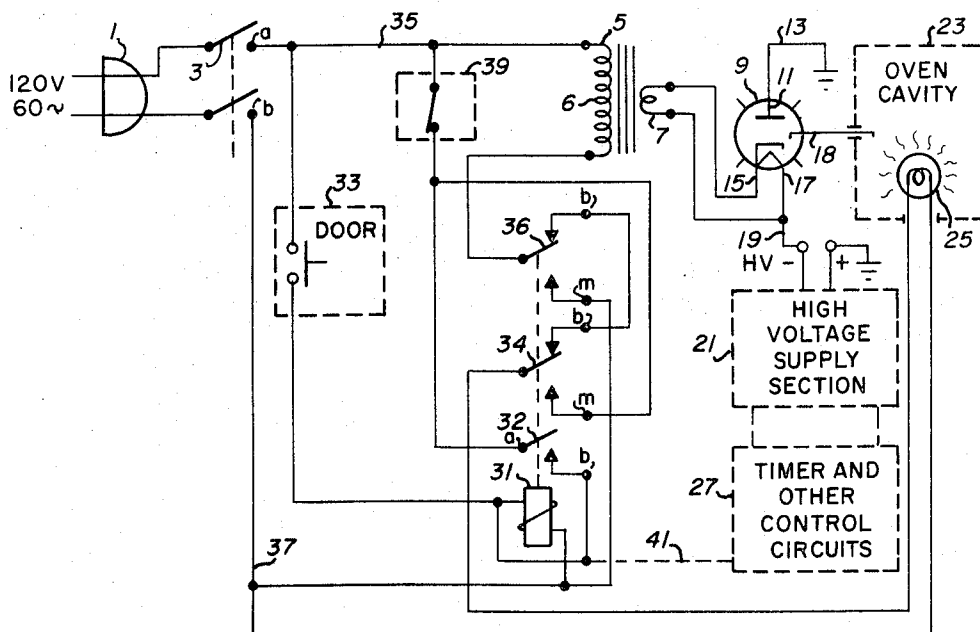
3,624,334	11/1971	Chapell	219/10.55
3,591,826	7/1971	Valles.....	219/10.55 X
3,225,302	12/1965	Öjelid	315/104
3,373,364	3/1968	Tumarkin et al.	328/270
3,611,012	10/1971	Lemmon	328/270

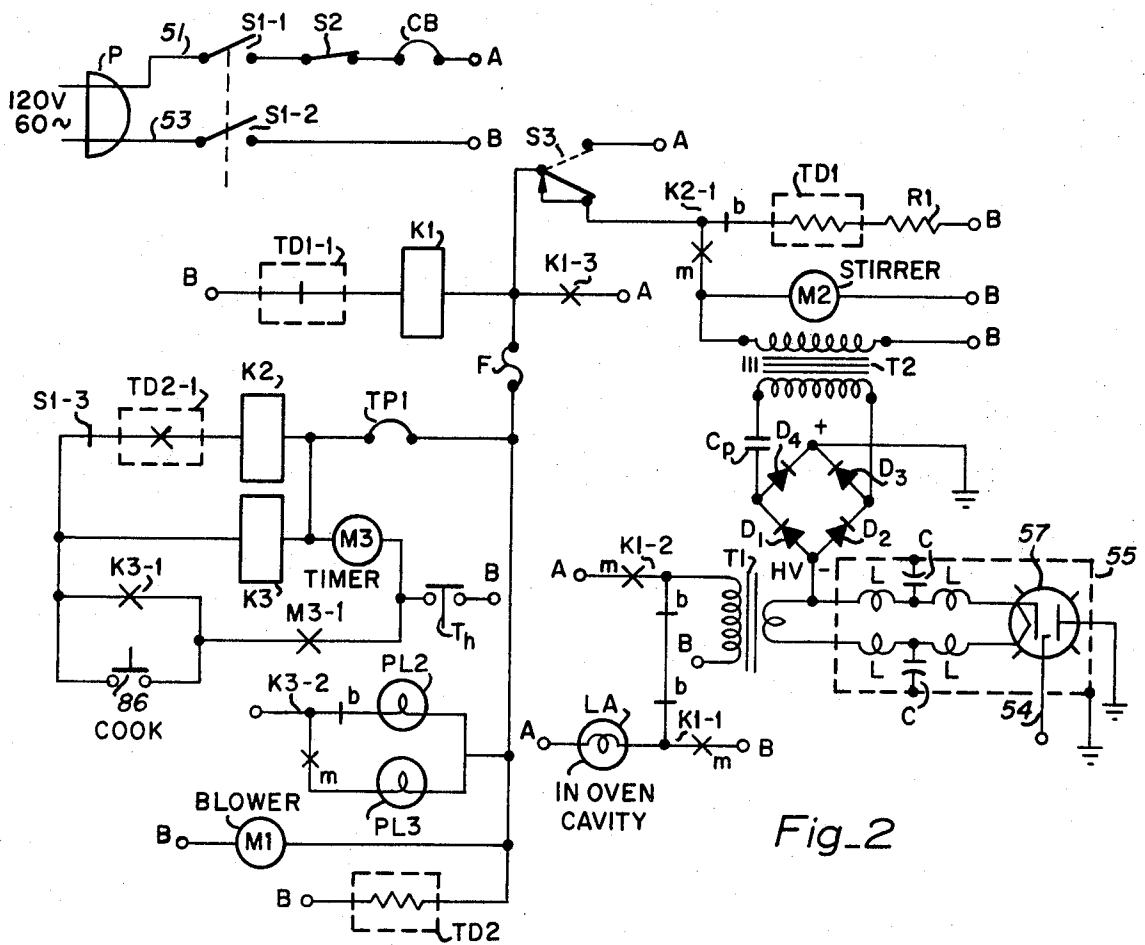
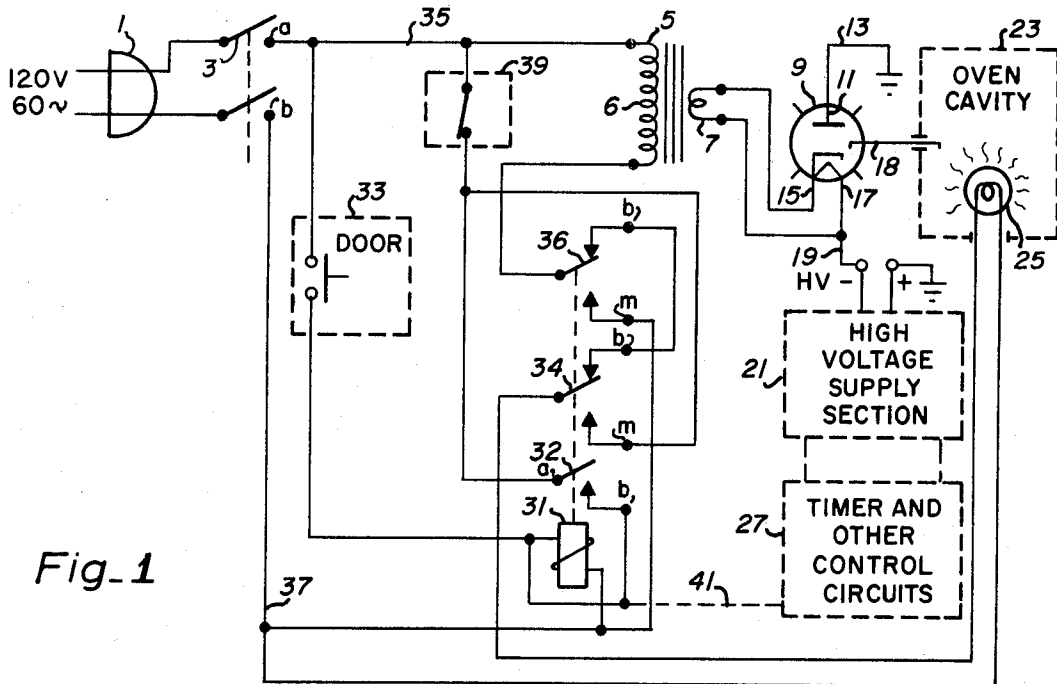
Primary Examiner—J. V. Truhe
Assistant Examiner—Hugh D. Jaeger
Attorney—Ronald M. Goldman et al.

[57] **ABSTRACT**

In a microwave oven which includes a cooking cavity, a magnetron for supplying microwave energy into the cooking cavity, a power supply of the type which supplies power to a magnetron and containing a filament transformer for stepping down line AC voltage to the lower voltage level for the magnetron heater, and an oven lamp for illuminating the oven cavity. The lamp normally is electrically in series with the primary winding of the filament transformer and current through the filament transformer is thereby limited resulting in minimal heater current to the magnetron heater. A relay or other controlling switch is energized by operation of an oven cavity door switch upon the first opening of the oven cavity door. The relay operates, interrupts the described series circuit, and places both the primary winding of the filament transformer and the lamp in parallel each across the AC supply lines so that full voltage is thereafter applied to both the lamp and filament transformer.

8 Claims, 2 Drawing Figures





MAGNETRON POWER SUPPLY HAVING IN-RUSH CURRENT LIMITER

FIELD OF THE INVENTION

This invention relates to microwave ovens and, more particularly, to microwave oven power supplies containing oven lamps and filament transformers.

BACKGROUND OF THE INVENTION

Microwave ovens include a cooking cavity into which food is introduced and heated by microwave energy fed into the cavity. In substantially all such ovens, a microwave tube of the type known as a "magnetron" is employed as the microwave energy source. The magnetron in operation requires a source of high DC voltage and a source of filament or heater current, requirements which the magnetron has in common with other types of electronic vacuum tubes. In practice other conventional circuitry necessary for proper operation is provided in the power supply such as circuit breakers, On-Off switch, door switch, interlock switches, timers and switches, various time delay devices and oven and indicator lamps.

There are several types of magnetrons available for these purposes and these differ in detail from one another. For example, all magnetrons have an anode, a cathode, a filament and magnetic pole pieces and flux source. As is known, the filament and cathode are functionally related in that it is the purpose of the filament to heat the cathode so that the latter efficiently emits electrons. In one magnetron type construction the filament is physically spaced from the cathode and thus indirectly heats the cathode. In another type of magnetron the filament and cathode are physically joined as a single unit and the heating is applied directly to the electron emitting substance of the cathode.

Obviously for a given current applied to the heater the warm-up time for a magnetron of the former construction is longer than the corresponding warm-up time for the magnetron of the last named construction. In either case, however, the heater itself is a thermally dependent resistance—being low in resistance when cold and being high in resistance when hot. Thus given a particular filament voltage, the initial current passing through the filament is higher than when the filament is heated.

In those prior art microwave ovens which incorporate a magnetron having indirect heating of the cathode, the warm-up time of the magnetron was unnecessarily long as a result of this indirectness of cathode heating. Hence circuit structure was incorporated in the power supply to increase initially the filament voltage above normal voltage levels. The purpose of this was to heat the cathode at a faster rate to reduce the magnetrons warm-up time. After the preheating period, the filament voltage was reduced to its normal level. In that type of magnetron construction, the heater operating temperature is on the order of 1,400° C. and maximum initial filament current or "in-rush" current, as may be variously termed, is on the order of four times greater than the normal current level. Increasing the filament voltage and currents during the preheat period was permissible and did not appear to have any harmful effects. In those microwave ovens which incorporate a magnetron of the type containing a directly heated cathode such as the Litton L-

5001, however, the heater operating temperature is substantially higher, approximately 1,760° C. Because the magnetron has a directly heated cathode and operates at a higher temperature, the warm-up time of the magnetron is short and the preheat circuit previously discussed used in connection with the indirectly heated cathodes in which the filament voltage is initially increased is neither necessary nor desirable. Quite to the opposite, the higher operating temperatures of 1,760° C. results in a heater in-rush current which is on the order of six times greater than the normal heater current level of 20 amps, reaching 150 amps in a type L-5001. As a result of such extremely large currents in tubes of this construction, a noticeable problem sometimes occurs in the destruction of the heater and cathode.

Obviously there are many obvious ways by which this initial current can be reduced. Thus conventional high leakage reactance transformers could be used to limit the in-rush current. Unfortunately, such types of transformers for operation at low heater voltages are very expensive. Another obvious solution is to add a resistor in circuit with the filament transformer in order to limit such current in-rush. Such a resistor, however, must be capable of dissipating at least 30 watts of energy and as such is expensive.

OBJECTS OF THE INVENTION

Accordingly, it is an object of my invention to limit in-rush current to the filament of the magnetron in a microwave oven.

It is a further object of my invention to provide in-rush current limiting means in a microwave oven power supply which is inexpensive and which does not require the addition of resistor components to the power supply circuit.

And it is an additional object of my invention to provide means to limit the in-rush current to the filament of a magnetron of the type containing a directly heated cathode in the circuit of a microwave oven.

BRIEF SUMMARY OF THE INVENTION

In accordance with the foregoing objects of my invention, a microwave oven includes an oven cavity, a magnetron for supplying microwave energy within the oven cavity, a power supply of the type which includes a filament transformer for supplying filament current to the magnetron, a tungsten filament lamp for illuminating the oven cavity. Control circuit means normally maintain the primary winding of the filament transformer electrically in series with the lamp across the 120-volt AC line resulting in a lower voltage to each. In response to the initial opening of the oven cavity door the control circuit means connects each of the transformer primary winding and the lamp in parallel across the 120-volt line so as to place each at full operating level.

The foregoing and other objects and advantages of the invention, together with the elements and cooperation of the elements characteristic of my invention, together with substitute and equivalent elements therefor, becomes more apparent upon consideration of the following detailed description of a preferred embodiment of the invention taken together with the figures of the drawings.

DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 illustrates schematically the in-rush current limiting circuit of the invention in simplified form, and

FIG. 2 illustrates schematically a complete oven power supply circuit including the in-rush current limiting circuit of the invention.

DETAILED DESCRIPTION OF THE INVENTION

The circuit of FIG. 1 includes: a plug 1 for connection to the 120-volt 60-cycle AC line conventionally supplied by the electrical power company; a double pole single throw On-Off switch 3; a filament transformer 5 containing primary winding 6 and secondary winding 7, suitably for transforming 120 volts down to 5 volts across secondary winding 7; a magnetron 9 which can suitably be a Litton type L-5001; an oven cavity 23; a tungsten filament lamp 25; a high voltage supply represented by the dashed lines 21; miscellaneous conventional timer and control circuits are symbolically represented by dashed lines 27; a normally closed shut-down switch 39; a door pulse switch 33; and an electromagnetic relay 31. Relay 31 operates on 120-volt AC. The relay includes a set of normally open contacts, 32a and 32b, a set of transfer contacts 34 which includes a break contact 34b and a make contact 34m, and an additional set of transfer contacts 36 which includes a break contact 36b and a make contact 36m. The line 35 is connected to terminal 3a of On-Off switch 3 and extends to one side of primary winding 6. Lead 37 connects to the make contact 3b of the On-Off switch and extends to one terminal of relay coil 31 to one terminal of lamp 25 and to make contact 36m. The door pulse switch 33, normally open, is connected in circuit between line 35 and the other terminal of relay coil 31. An additional connection is made between that terminal of the relay and its make contact 32b as well as to the control circuits 27 via lead 41. The normally closed shut-down switch 39 is connected in a series circuit between line 35 and the movable contact 32a of relay 31 as well as to contact 34m of the transfer contacts 34. Another electrical circuit is completed between the remaining end of the transformer primary winding 6 to transfer contact 36 and an electrical circuit is completed between contacts 36b and 34b of the transfer contacts 36 and 34, respectively.

As indicated in the drawing, magnetron 9 includes heater terminals 15 and 17 which are connected across the secondary 7 of the filament transformer as well as to the negative (-HV) high voltage terminal of high voltage supply 21 via lead 19. An anode 11 of the magnetron is connected via lead 13 to chassis ground potential. The positive polarity high voltage lead of supply 21 is likewise connected to chassis ground potential. A suitable transmission line 18 completes a microwave transmission circuit between magnetron 9 and oven cavity 23, and lamp 25 as indicated is installed within or in proximity to the oven cavity so as to provide illumination within that cavity. Numerous fuses, circuit breakers and interlock circuits, normally found as a practical matter in microwave ovens, are not included in this schematic inasmuch as they are conventional and not necessary to the understanding of the structure of my invention.

In normal operation plug 1, as illustrated in FIG. 1, is connected across the 120-volt 60-cycle AC line, and On-Off switch 3 is operated to its closed position. This applies the 120 volts across lines 35 and 37 and completes a series circuit via line 35 to one side of primary winding 6 through transfer contact 36, break contact 36b, break contact 34b, transfer contact 34, lamp 25, to line 37.

Accordingly, current flows through primary winding 6 and lamp 25. Lamp 25 provides illumination in oven cavity 23 at a slightly reduced level. Likewise the voltages induced in secondary winding 7 of the transformer 5 are on the order of 1 volt which is considerably less than the normal level of 5 volts. The filament voltage is applied to the heater terminals 15 and 17 of magnetron 9 and heats the magnetron filament.

The oven remains in this condition until such time as the operator desires to cook food. At that time, the oven cavity door is opened momentarily as the food to be cooked is inserted into the oven cavity and the door is reclosed. This action momentarily operates door switch 33 which momentarily closes a circuit between lines 35 and 37 to the coil of relay 31.

Relay 31 operates and closes its contacts 32. This completes a holding circuit from line 35 through the normally closed switch 39, relay contact 32, to the relay coil 31, which bypasses the circuit from line 35 containing door switch 33, and relay coil 31 remains energized and in the operated condition. Concurrently, relay transfer contacts 36 and 34 switch from contact with the break contacts 36b and 34b, respectively, to the make contacts 36m and 34m, respectively. A circuit is completed from line 37 through lamp 25, transfer contact 34, make contact 34m, through normally closed switch 39 to line 35, and thus places the full 120 volts across lines 35 and 37 across lamp 25. Accordingly, lamp 25 provides full illumination to the oven cavity.

Another circuit is completed from the one side of primary winding 6 through contact 36-make to line 37. The other side of primary winding 6 is connected to line 35 as previously described. Thus primary winding 6 is placed directly across the 120 volts appearing between line 35 and 37. With the full 120 volts applied to primary winding 6, the filament voltage is then raised from the previous low level of 3 volts to the normal level of 5 volts. Accordingly, a larger current flows to the magnetron filaments and the cathode of magnetron 9 is placed at its normal operating temperature.

It is noted that an additional circuit is completed at contacts 32 to the miscellaneous circuits represented by the dashed lines 27 via line 41. These include the timer circuits shutdown and miscellaneous control circuits which control the high voltage supply represented by the dash lines 21 which supplies high negative voltage via line 19 to the magnetron cathode which are necessary to the operation of a practical microwave oven. These circuits are conventional and inasmuch as they are not necessary or helpful to a clear illustration of the invention are omitted or simplified in this FIG. 1. In normal oven operation the miscellaneous circuits include a cook switch and timer circuit which closes the high voltage circuit and operates supply 21 which in turn causes magnetron 9 to generate microwave energy. This microwave energy is withdrawn from the mag-

netron by a transmission line 18 and passed into the oven cavity.

Upon completion of the cooking operation the shutdown circuits, after an appropriate time delay, operates shutdown switch 39. Switch 39 opens and interrupts the holding circuit to relay coil 31. Upon de-energization of relay coil 31, relay contacts 32 are returned to the normally opened position, and relay contacts 34 and 36 are restored to their contact with contacts 34b and 36b. Primary winding 6 and lamp 25 are thus placed again in a series circuit across lines 35 and 37.

Numerous modifications are apparent to the foregoing sequence of operation and to the elements of the invention. For example, by use of a conventional relay structure having make-before-break contacts, transfer contact 36 can be made of the make-before-break variety. In this way the circuit to the primary of transformer 5 is completed or placed at the higher voltage level prior to the time that the existing circuit is broken. In so doing, a possible current surge through the primary winding is eliminated and the effect of such a connection is to momentarily darken lamp 25 which will flicker.

Additionally, the contacts can include the use of conventional arc suppressing means across the contacts, typically capacitors or resistor-capacitor combinations. These are conventional and are used to prolong the life of relay contacts by preventing the damaging effects of electrical arcs that occur when a closed circuit is interrupted. And while the switch used to connect the primary winding and lamp in series and in parallel across the 120-volt line is shown to be an electromechanical relay, it is apparent that available electronic switches can be substituted for the relay if desired.

In one typical example, a 50-watt tungsten lamp was inserted in series with a primary winding supplying a L-5001 magnetron. Due to the cold filament of the lamp the first cycle (one-sixtieth second) in-rush was 100 amps peak and dropped to 30 amps peak for the second cycle and finally stabilized at 13 amps peak. When the filament transformer primary was placed directly across the line, the filament current rose to 60 amps peak initially and quickly settled to the equilibrium value of 27 amps peak. In this combination, therefore, the destructive consequences of in-rush currents of one-half second or so duration and 70 to 150 amps peak have been avoided. Obviously, the initial current can be varied somewhat by varying the lamp wattage size and hence vary the proportion of voltage across the transformer primary winding.

Although the foregoing description presented in connection with the embodiment of FIG. 1 is adequate and concisely and clearly illustrates the invention, it is perhaps even more informative to illustrate and describe the invention in connection with the complete and detailed circuit of a commercial microwave oven as I present in FIG. 2.

For convenience and simplicity of illustration, the schematic of FIG. 2 is drafted using the principles of "detached contact" form of drawings. Briefly, in the detached contact form of schematic drawing the relay coil is located at any convenient location and the relay contacts in the schematic are separated physically and placed where convenient in contrast to the conventional form of drawing in which a relay coil and all of its

associated contacts are located together. Additionally in this form of electrical drafting, relay contacts are represented by X's and dashes. More particularly when a pair of relay contacts are normally open and are to "make," that is close those contacts, upon energization of the relay coil, such pair of contacts are presented as an X in the drawings. Likewise, if a pair of relay contacts are normally closed and instead are opened upon energization of the relay coil to "break" or interrupt a circuit path, this form of contact is represented in the schematic as a dash drawn through a circuit line. Combining these two features, a set of relay transfer contacts which conventionally includes a transfer contact which normally abuts a "break" contact, and which, upon energization of the relay coil, moves from contact with the break contact into contact with the third or make contact, is represented by both an X and by a dash adjacent one another, and the juncture between the X and dash symbols represents the location of the movable transfer contact of the relay.

Given a relay such as K1 in FIG. 2 by this convention the electromagnetic coil of the relay is represented by K1 and the terms "relay" and "relay coil" are synonymous. The first set of relay contacts on the relay is a transfer contact and this is denoted in the drawing as K1-1 which identifies the transfer contacts as the first set of contacts on relay K1. The make contact of this set can be referred to as contact K1-1m and the break as K1-1b. Likewise additional sets of contacts are illustrated such K1-2, another set of transfer contacts, and K1-3, a set of make contacts. For regular switches, the conventional symbols may be used.

With the foregoing drafting conventions in mind, the description of the complete power supply arrangement detailed and illustrated in FIG. 2 may be clearly understood. The power supply is connected to a source of 120-volt 60-cycle AC line current by means of a suitable plug, P, to apply the line voltage across lines 51 and 53. Line 51 is connected to one contact of On-Off switch S1, a double pole single throw switch, contact S1-1 in series with a second timer interlock switch, S2, and a circuit breaker, CB, to a point or terminal designated A. Line 53 is connected in series with contacts S1-2 of switch S1 to a point or terminal B. Switch S1 is the On-Off switch for the oven power supply and for safety includes contacts which interrupt or open both sides of the household AC line in the Off position. The terminals A and B are used in the drawings as a reference point and, hence, where other elements are connected to A or B, it is understood that they are in fact wired electrically in common with those reference points.

The transfer contact, S3, the oven door switch is connected to one side of relay coil K1 to the make contact of relay hold contact K1-3 and to fuse F. The make contact of switch S3 is wired to terminal A. The other terminal of relay coil K1 is connected in series through break contact TD1-1 to terminal B. The other contact of relay make contact K1-3 is connected to terminal A. Fuse F is connected to one side of circuit breaker TP1, lamps PL2 and PL3, blower motor M1, and time delay heater coil TD2. The other side of heater coil TD2 and blower motor M1 are connected to terminal B. Lamp PL2 is connected to the break contact and lamp PL3 is connected to the make contact, respectively, of relay

transfer contacts K3-2 and the transfer contact of K3-2 is connected to terminal B.

The other terminal of circuit breaker TP1 is connected to one terminal of relay coil K2, relay coil K3 and timer motor M3. The other terminal of relay coil K2 is connected through a make contact TD2 of delay relay TD2 through break contacts S1-3 to the other terminal of relay coil K3. A parallel circuit is wired from that terminal of relay coil K3 through its make contacts K3-1 and through the normally open cook switch contacts S6 and from there through normally open make contacts M3 of the timer mechanism to the other terminal of the timer motor.

The remaining terminal of timer motor M3 is wired in parallel with the remaining break contact of contacts M3-1 in series with normally closed timer home switch Th to point B of the power line. The timer is of a conventional structure and provides the means to select the cooking time. At the end of the selected timed interval the timer operates its contacts Th to open the circuit.

An additional circuit is provided between an interlock contact on door switch S3 to the transfer contact of contacts K2-1 of relay K2. The break contact of K2-1 is connected to one side of the heater coil of time delay relay TD1. The other side of the heater coil of TD1 is connected through resistor R1 to terminal B of the power lines. The make contact of K2-1 is connected in parallel to one side of stirrer motor M2 and to one terminal of the primary winding of a transformer T2, the high voltage transformer. The other terminal of both stirrer motor ML and primary winding of transformer T2 is connected to terminal B. The secondary winding of the transformer T2 is connected in series with capacitor CP to a diode bridge rectifier consisting of diodes D1, D2, D3 and D4. The positive output terminal of the bridge rectifier is connected to chassis ground and the negative output terminal is connected to the secondary low voltage filament winding of filament transformer T1. The make contact of transfer contacts K1-2 is connected to terminal A; the break contact of K1-2 is connected to the break contact K1-1; and the transfer contact of K1-2 is connected to one side of the primary winding of stepdown filament transformer T1.

A second circuit from terminal A is made through lamp LA to the transfer contact of relay contact K1-1. The make contact of contact K1-1 is connected to terminal B. The remaining terminal of transformer T1 primary winding is also wired to terminal B.

The secondary winding of transformer T1 is connected through an L-C filter located in a shielded enclosure 55 to the heater terminals of a magnetron 57. The magnetron anode is connected to chassis ground and the output terminal of the magnetron is connected through suitable transmission lines 59 to the oven cavity, not illustrated.

In operation with plug P installed in the electrical path outlet the On-Off switch S1 is operated to its On position which closes contacts S1-1 and S1-2. Assuming normal operation, switch S2 and circuit breaker CB are also closed and hence this circuit provides 120-volts AC across the terminals A and B. Reference to the circuit containing lamp LA is made. A current path exists from terminal A through lamp LA, break contact

K1-1, break contact K1-2, the primary winding of transformer T1 to terminal B. In this way, a reduced voltage is applied across the primary winding of transformer T1 and this is reflected in a lower output voltage being applied to the heaters of magnetron 7. Lamp LA operates at reduced intensity. Any current surge through this circuit are obviously minimized by the resistance of lamp LA.

By means of the foregoing circuit path, a reduced voltage is applied to the primary winding of filament transformer T1 which appears as a lower-than-normal filament voltage a the secondary of the filament transformer. Accordingly, the magnetron heater to which the filament transformer secondary is coupled is preheated.

At any time subsequent to operation of the On-Off switch S1-1, the operator will desire to commence cooking or heating of food. This can be either seconds, minutes, or even hours later and, as becomes apparent from the following description, the magnetron heater is preheated as described for essentially the same period of time.

At the time the operator desires to cook food, the oven door is open, the food inserted, and the door is reclosed. This results in momentary operation of door switch S3. Accordingly, a momentary path exists between terminal A, make contact of door switch S3, relay coil K1, through closed contacts TD1-1 to terminal B, and relay coil K1 is energized. Relay K1 closes its make contacts K1-3 which completes an alternative current path from terminal A to relay coil K1, and hence relay K1 is held in its operated condition regardless of the subsequent opening of door switch S3. Relay contacts K1-2 and K1-1 are also operated. Transfer contact of contacts K1-2 interrupts the break circuit and completes a circuit via the make contact between terminal B, lamp LA, and terminal A, which results in full energization of the lamp and full intensity illumination of the oven cavity. The transfer contact of K1-2 interrupts the break circuit and completes a circuit via the make contact to terminal A, resulting in a current path between terminal A, transformer T1 primary winding and terminal B, and thus results in the application of full line voltage to the filament transformer primary winding. In so doing, the voltage at the secondary winding of T1 is raised to normal heater voltage.

At this time, additional current paths are completed from point A, contact K1-3, fuse F to pilot lamp PL2, to blower motor M1, and to thermal time delay relay TD2, as well as to one side of relays K2 and K3 and timer motor M3. At this time, lamp PL3 is operated to indicate that the oven is in a ready condition and blower motor M1 commences operation of the conventional blower which channels cooling air to the magnetron. Timer motor M3 is energized and closes contacts M3. The timer illustrated is set to the desired time and upon depression of cooker switch S6 a circuit is completed through relay coil K3, switch S6, contacts M3 to terminal B. Relay K3 closes a make circuit at contact K3-1 to provide an alternative holding current path to terminal B in order to maintain relay K3 in the operated condition. Upon operation, contacts K3-2 transfers from the break to the make condition, thus closing a current circuit to lamp PL3 and extinguishing lamp PL2 which thus indicates other food inserted into

the cavity is cooking. Concurrently with this operation, TD2, after a time delay of approximately 10 seconds, closes contacts TD2-1 in the circuit of relay K2. Relay K2 operates and through contacts of K3-1 is held energized. Contacts K2-1 close a make circuit from terminal A, contacts K1-3, switch S3, to stirrer motor M2 and primary winding of transformer T2 to terminal B.

The oven stirrer, not illustrated, operates and the 120-volt line voltage is transformed by transformer T2 to the high voltages, typically 2,500 volts, which appear across the secondary winding. This voltage is rectified by the bridge rectifier consisting of diodes D1 through D4 and applied to the heater lead of magnetron 7. Since the cathode is connected to the heater within the tube the negative voltage is applied to the cathode. Both the anode of magnetron 57 and the other end of bridge rectifier are connected electrically to chassis ground and thus complete a high voltage circuit.

In normal operation the magnetron delivers its microwave energy via transmission line 59 to the oven cavity and results in cooking of the food.

As thus described it is evident how the invention illustrated in FIG. 1 and as appears in detail in FIG. 2 cooperates with the other conventional elements of a microwave oven power supply circuit to preheat the magnetron filament and limit in-rush current. However for convenience, the further sequence of events is also helpful. Upon completion of the cooking cycle as determined by the timer, contact T4 is opened and results in the de-energization of relay K3. In de-energizing, relay K3 opens the circuit to relay K2 which also de-energizes, closing a circuit via contacts K2-1, break to time delay TD1 and opening the high voltage circuit to transformer T2. Should further cooking operation follow, relays K2 and K3, cooking switch S6 and timer motor M3 will be operated again in the same manner as previously described, without further change in the energized state of relays K1, time delay TD2 and blower motor M1, which remain on for a predetermined time. If no further cooking cycle occurs after perhaps 90 seconds, time delay TD1 operates and opens contacts TD1-1 to break the circuit to relay K1. Relay K1 is then de-energized and restores to normal contacts K1-3, contacts K1-2, and contacts K1-1, restoring the series circuit of lamp LA and transformer primary winding T1. Blower motor M1 is also de-energized and the entire circuit remains in that condition until door switch S3 is subsequently closed at the commencement of another cooking cycle.

The lamp preferably should have a voltage rating equal to that of the line voltage to be supplied to the oven at the plug and a power rating in watts within a range of 30 to 65 percent, for example 50 percent, of that power normally consumed by the magnetron heater. In a specific example, the line voltage in the embodiments of FIGS. 1 and 2 is 120 volts and the magnetron heater in normal operation outside any in-rush period is supplied approximately 5 volts at 20 amperes or, in terms of power, 100 watts. In this specific example therefore the lamp is rated at 120 volts and 40 watts.

It is apparent to those skilled in the art that numerous modifications can be made to the disclosed preferred embodiments of my invention either to change the details of the elements thereof or to substitute obvious

equivalents therefor as well as to change slightly the sequence of operations as a result of differences in power supply circuits and thus vary the functional relationship of the invention with that of the other elements comprising the power supply. It is thus expressly understood that such details have been presented in this specification only as illustrative of my invention so as to teach one skilled in the art how to make and use my invention and not by way of limitation, and that all such changes, modifications, and substitutions or improvements fall within the scope of my invention. Accordingly, it is requested that my invention be broadly construed, limited only by the breadth and scope of the appended claims.

What is claimed is:

1. In a microwave oven which includes:

an oven cavity for receiving food to be cooked;

a door for providing access to said oven cavity;

a magnetron for supplying microwave energy into said oven cavity;

lamp means for illuminating said oven cavity with light;

power supply means for said magnetron, said power supply means including a filament transformer having a primary winding and a low voltage secondary winding and circuit means connecting said secondary winding to said magnetron filaments; and

power lines for providing power to said power supply means;

the invention comprising in combination therewith; first circuit means for placing said primary winding and said lamp means electrically in a series circuit across said power lines, and switch means responsive to operation of said cavity door for interrupting said series circuit and placing each of said primary winding and said lamp means individually in parallel across said power lines.

2. The invention as defined in claim 1 wherein said lamp means comprises a light bulb having a tungsten filament.

3. The invention as defined in claim 1 wherein said switch means comprises an electromechanical relay, said relay including contact means for interrupting said series circuit of primary winding and lamp means and having additional contact means for connecting each of said primary winding and lamp means individually across said power lines.

4. The invention as defined in claim 3 further comprising an On-Off switch for completing a circuit between said oven power supply means and external power lines for initially preparing said series current path through said lamp means and said primary winding.

5. In a microwave oven which includes:

an oven cavity for receiving food to be cooked;

lamp means for illuminating said oven cavity, said lamp means having an electrically resistive filament;

a magnetron for supplying microwave energy into said oven cavity, said magnetron having a directly heated cathode construction and a filament;

magnetron power supply means, said magnetron power supply means including a filament transformer having a primary winding and a secondary

winding and circuit means connecting said secondary winding to said magnetron filaments;
 power line means for supplying power at a predetermined voltage to said magnetron power supply means;
 the invention comprising in combination therewith:
 first circuit means for placing said primary winding and said lamp means electrically in a series circuit across said power lines and switch means responsive to operation of said cavity door for interrupting said series circuit and placing each of said primary winding and said lamp means in parallel across said power lines.
 6. A microwave oven including:
 an oven cavity;
 a movable door for permitting access to said cavity;
 lamp means for illuminating said cavity;
 said lamp means having a tungsten filament;
 a magnetron for generating microwave energy for transmission into said oven cavity, said magnetron containing a directly heated cathode structure and heater terminals;
 power supply means for said magnetron, said power supply means including a filament transformer, said filament transformer having a primary winding containing first and second terminals and a low voltage secondary winding;
 means connecting said secondary winding of said transformer to said heater terminals of said magnetron;
 power circuit means for supplying line voltage to said power supply means, said circuit means applying said line voltage across first and second terminals;
 first On-Off switch means in series circuit with said power circuit means for completing a circuit to said first and second terminals;
 electromagnetic relay means, said relay means including a first set of normally open contacts, a second set of transfer contacts, and a third set of transfer contacts, each of said sets of transfer contacts including a break contact, a make contact and a transfer contact, said transfer contact normally maintains closed a circuit to said break contact and which upon energization of said relay interrupts said closed circuit and closes a normally open circuit to said make contact;
 door switch means connected in a series circuit, said relay means between said first and second ter-

minals for energizing said relay means upon operation of said oven door;
 means connecting together in circuit, said break contacts of each of said first and second sets of relay contacts;
 means connecting said primary winding in circuit between said transfer contact of said first set and said first terminal of said power circuit means;
 means connecting said lamp means in circuit between said transfer contact of said second set and said second terminal of said power circuit means to form a series circuit with said primary winding and said lamp means;
 and means connecting said make contact of each of said second and first sets of relay contacts in circuit with said first terminal and said second terminal, respectively, of said power circuit means;
 and means connecting said first normally open contacts in circuit with said relay means and said power circuit means for maintaining said relay means energized independent of said door switch, subsequent to initial operation of said door switch;
 whereby upon closure of said On-Off switch current flows through said primary windings and said lamp means to provide reduced low voltage to said magnetron filaments and illuminate said oven cavity and whereby upon initial operation of said oven door said relay means operates and is maintained energized and places each of said lamp means and said primary winding individually across said power lines to fully illuminate said oven cavity and provide full heater voltage to said magnetron.
 7. The invention as defined in claim 6 wherein said magnetron heater is rated to consume normally a predetermined X watts of energy and wherein said line voltage from said power circuit means is a predetermined Y volts, and wherein said lamp means has a voltage rating of Y volts and a nominal power consumption rating within the range of 30 percent to 65 percent of said X watts.
 8. The invention as defined in claim 5 wherein said magnetron filament is rated at a nominal predetermined power consumption of X watts and wherein said power line means supplies a voltage of Y volts and wherein said lamp means has a voltage rating of Y volts and a power consumption rating in the range of 30 percent to 65 percent of said X watts.

* * * * *

50

55

60

65