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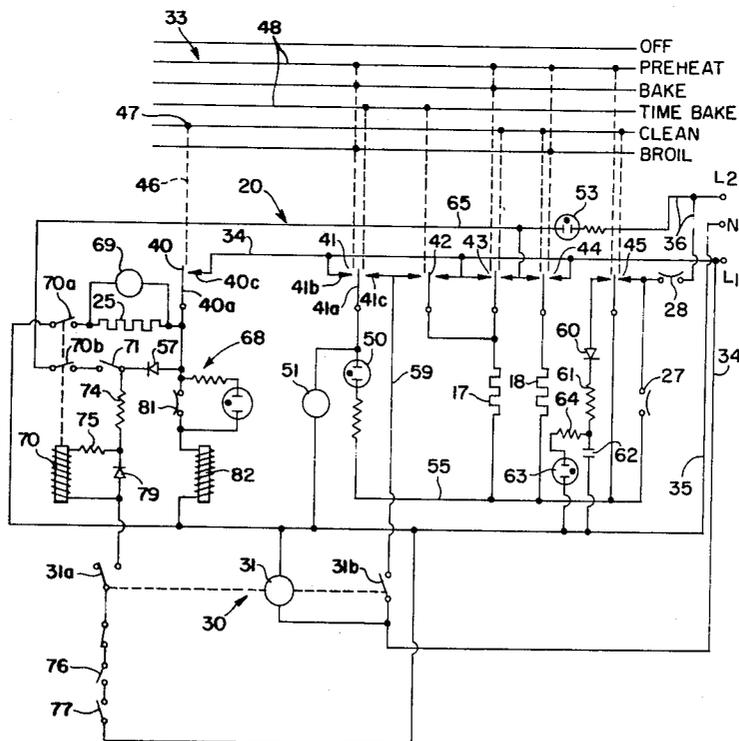
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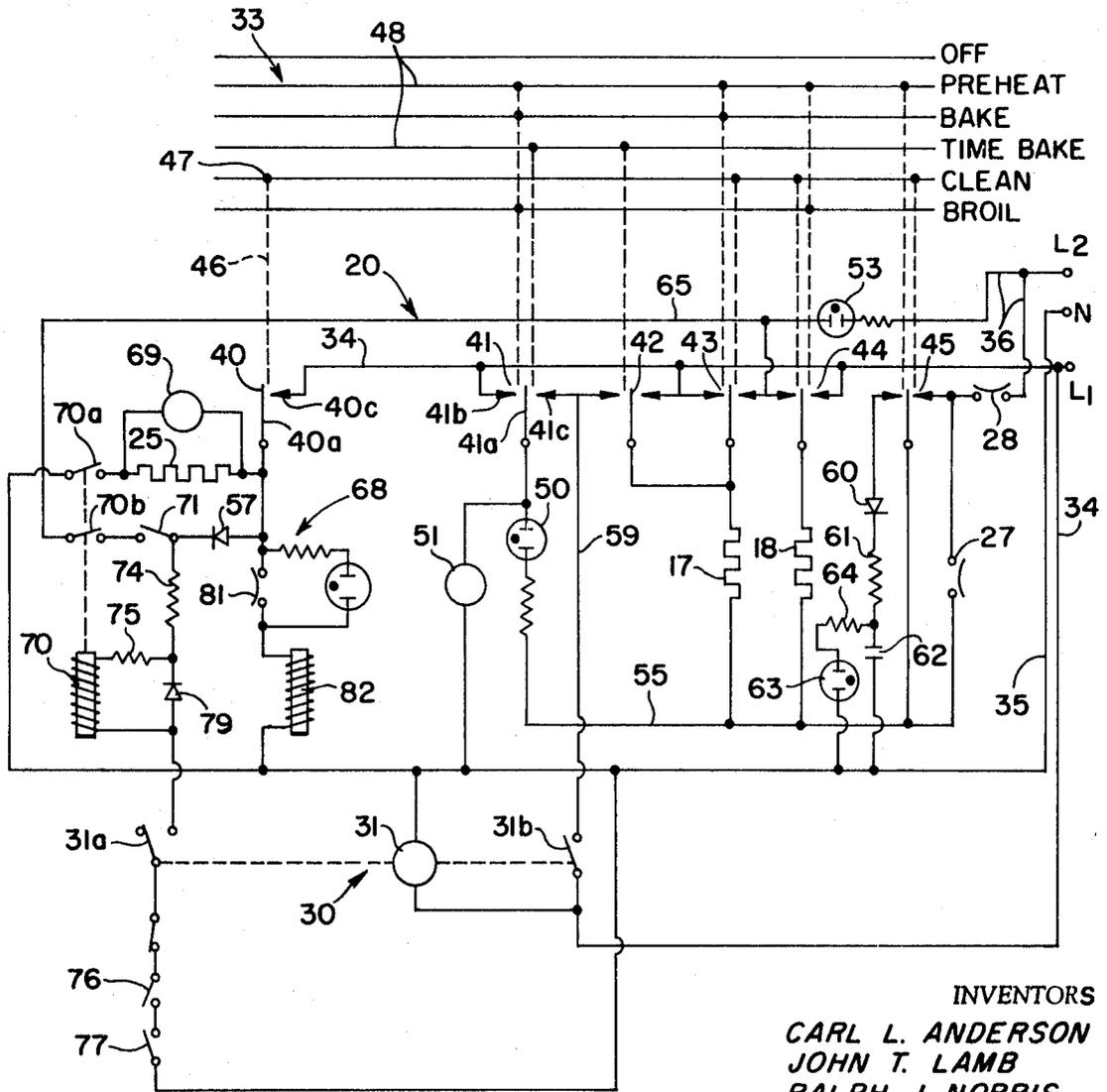
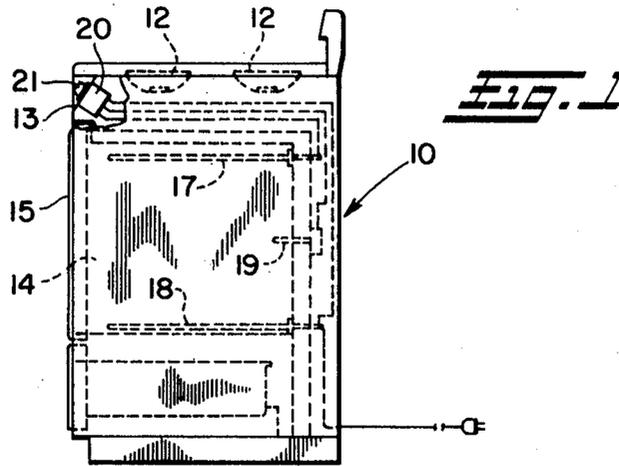
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- [54] **ELECTRIC SELF-CLEANING OVEN CIRCUIT**  
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- [51] Int. Cl. .... A21b 1/40
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**ABSTRACT:** A control circuit for a self-cleaning oven consisting of a switching system for alternatively connecting the bake and broil elements across the 236-volt powerline to generate heat for normal cooking operations, and for connecting the elements in parallel across the 236-volt line during the self-cleaning cycle. A semiconductor rectifier in series with the parallel-connected elements is utilized to control the rate of heat rise during the cleaning cycle to a predetermined cleaning temperature level, and to further limit power application thereafter. The switching system also controls temperature-regulating components and a safety circuit responsive to abnormal operation of the semiconductor rectifier to interrupt the cleaning cycle.





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**Fig. 2**

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## ELECTRIC SELF-CLEANING OVEN CIRCUIT

This invention relates to oven electrical circuits and more particularly to a self-cleaning oven circuit wherein only the normal bake-and-broil-heating elements are utilized to achieve the requisite temperature conditions for self-cleaning. Thus, the typical electric oven has a usual 236-volt source of power and the bake element, being a moderate heating element, may be connected directly to the 236-volt source to provide sufficient heat energy.

Similarly, the broil element is designed for a particular operating level and the heating capacity of such an element is usually on the order of 1½ to 2 times that of the bake element. It is preferable here also to receive power from the full 236-volt powerlines.

During a self-cleaning cycle a different heating capacity is required than either of these units could provide independently. It has been determined that the simultaneous energization of both of these elements at their normal operating voltages will provide too great a rate of heat rise within the oven and excessive vaporization of combustible residues. Prior art systems have utilized additional heating elements and provide switching whereby some of the elements are operated at a 236-volt potential and others at the lower line-to-neutral potential and some systems operate both elements commonly at the lower potential. All these designs are dependent upon the actual voltage received on the powerlines and due to the variances in such voltages across the country, the prior art systems required great tolerance to accommodate such situations to achieve a reliable mode of operation.

It would be preferable to utilize the high voltage available from the power source for the generation of heat from both heating elements and it is most expedient to control the application of power to both these elements to achieve the most desirable rate of heat rise and total power dissipation required for the self-cleaning cycle.

Thus, it is one object of this invention to provide an improved circuit or electric self-cleaning ovens which utilizes only the normal bake and broil elements required in any oven and which includes means for controlling the application of full line-to-line power to at least one of these elements during the cleaning cycle.

It is another object of this invention to provide an improved electric control circuit for self-cleaning ovens of a more refined design than previously known circuits and which is more economical in construction and operation.

It is yet another object of this invention to provide an improved electric circuit for self-cleaning ovens which utilizes solid-state components for controlling the application of power and which is therefore more reliable and dependable than the mechanically interrupted type of control circuit.

It is still another object of this invention to provide an improved oven control circuit which includes suitable safeguards for domestic operation including a semiconductor rectifier failure disconnect circuit.

Other objects and advantages of the present invention will become apparent as the following description proceeds.

To the accomplishment of the foregoing and related ends, the invention, then, comprises the features hereinafter fully described and particularly pointed out in the claims, the following description and the annexed drawing setting forth in detail a certain illustrative embodiment of the invention, this being indicative, however, of but one of the various ways in which the principle of the invention may be employed.

In said annexed drawing:

FIG. 1 is a side view of a typical oven installation showing the relative location of some of the components of the oven control circuit and;

FIG. 2 is an electrical circuit schematic of the preferred form of the circuit of this invention together with a chart of control switch operation.

Referring now to FIG. 1, there is shown a typical range 10 embodying the principles of this invention. Located on the top surface of the range are the usual elements 12 for surface

cooling and at the forward portion is a control panel 13 housing switches and timers for control of the surface elements and of the oven. An enclosure 14 forms the oven portion of the range and a door 15 is provided for access to the oven. Located within the oven 14 are upper and lower resistance heating elements 17, 18 schematically representing the usual bake and broil elements respectively for providing the heat both for normal oven operation and for the self-cleaning cycle. A probe 19 is shown extending into the interior of the enclosure 14, such probe being the sensing element for a conventional thermostatic regulator. Various other components forming a portion of the control system of this invention are located in a conventional manner in the control panel or in other available areas within the range.

The oven further includes an exhaust system having a catalytic burner for treating the exhaust fumes, during the cleaning cycle, for removal of odors, ash particles and the like. The heating element 25 (schematically shown in FIG. 2) associated with the catalyst exhaust unit is provided for achieving an effective treating temperature but the element does not significantly contribute to the overall temperature levels achieved within the oven and is not essential to this self-cleaning circuit.

The manner of operation of the range is well understood, the surface elements 12 being selectively actuatable by power switches located on the control panel 13 and the various oven cycles being provided by a multiposition control switch 20 manually settable by knob 21. Under control of switch 20 the bake, broil, and self-clean cycles may be selected as well as several other special oven-heating cycles, including, for example, a preheat cycle.

Also included in the control panel 13 of the oven is a thermostatic regulator which is settable to various positions according to the various cycles of operation of the oven. The regulator is operatively connected with the probe 19 located within the oven enclosure 14 and comprises electrical contacts 27, (shown in FIG. 2) which are in the normally closed state and which are opened when the temperature within the oven enclosure reaches a level corresponding to that preset at the regulator dial. A presettable high-level thermostat having contacts 28, is also responsive to oven temperatures in a similar manner. These thermostats may be of the conventional fluid-actuated type, the contacts 27 having a capacity for controlling the normal oven operations which usually vary from a minimum to approximately a 500°-600° F. range, and contacts 28 being preset for the self-cleaning cycle which is on the order of 1,000° F. Further, a timer 30 is located in the control panel of the range and comprises a conventional clock mechanism 31 with associated contacts 31a, 31b actuatable by a preset selection of the timer interval. Both the timer and the regulator are interconnected with the control circuitry for the oven by means of the selector control switch 20 and are adapted in various manners to control the normal cooking operations and the self-cleaning operation. Various other safety and interlocking circuitry is included within the control system to insure safe operation particularly during the self-clean cycle when elevated temperatures are realized.

Referring now to FIG. 2 there is shown a schematic circuit diagram of the oven control system including a chart 33 of operating positions for the selector control switch 20. Input power is supplied in the conventional manner on three input lines 34, 35, 36 designated respectively L1, N and L2 which comprise the usual single-phase 60-cycle, 236-volt source of power from line to line with a center neutral or ground connection. The selector switch 20 is shown in schematic form as are the bake-and-broil heating elements, in the form of resistors 17, 18. It will be understood that the heating elements are essentially of the resistance type and have been especially designed to provide the requisite power for the bake-and-broil heating cycles.

The selector switch is shown in FIG. 2 as a plurality of single-pole switches 40-45 having a movable contact designated where appropriate by the appended letter *a*, and one or two

fixed contacts designed by letters *b*, *c* for the left- and right-hand contacts as indicated at switch 41. Not all designations are shown in the interest of clarity, but the same convention will be understood. The switches are adapted to be closed by rotation of the control knob 21 at various settings of the selector switch 20 to interconnect portions of the circuitry. Each of the switches 40-45 is of the normally open type and the respective closing of same is indicated by a dashed line as at 46 and a dot as at 47 placed in the selector switch chart 33 at the various settings indicated by the captioned horizontal lines 48. The switches 40-45 are normally grouped as a single rotary selector switch 20, however, for ease of understanding the operation of this control circuit, such switch 20 has been shown in this modified form. Each of the switches 40-45 is allocated to control of various portions of the circuitry. Thus, switch 40 is effective to control energization of the catalyst heater 25 and other control and safety elements only during the clean cycle. Switch 41 is provided primarily for auxiliary functions, these including an indicator 50 energizable during several cycles and a rotisserie motor 51. Switches 42, 43 control the energization of the bake-heating element 17 and switch 44 similarly, the broil-heating element 18. Switch 45 is provided for control during the preheat cycle and the oven-cleaning cycle.

Input power on line L1 is connected via line 34 to the contacts 40c, 41b, 42c, 43b, 44c of the switches. Similarly, line L1 is connected by way of line 34 to one side of the normally open timer switch 31b and to the clock timer motor 31. The neutral potential N is transmitted by way of line 35 to various portions of the circuitry and will usually be adapted for utilization with the line L1 potential to supply a reduced voltage for control portions of the circuit. Line L2 is directed by way of line 36 to a neon lamp 53 to provide an indication of operation in the clean cycle. Line L2 potential is further directed through the high-limit thermostat 28 and the bake thermostat 27 to a line of common potential 55. The high-limit thermostat 28 provides a dual function, one being that of a safety switch during normal cooking operations, the normal temperature level being controlled by the interrupting action of the bake thermostat 27 which is settable to various temperature levels. In the self-cleaning cycle, however, the high-limit thermostat 28 is the sole temperature-responsive device and prevents excessive temperatures being reached within the oven enclosure 14.

The bake element 17 is connected at one end directly to the common line 55 carrying 236-volt potential and at the other end to the movable contacts 42a, 43a. The broil-heating element 18 is connected at one end to the same line of potential 55 and at the other to the movable contact 44a of switch 44. It will be noted then that the bake and broil elements 17, 18 receive energization directly from the lines L1, L2 in normal cooking operations, thereby receiving energization of 236 volts. In the cleaning cycle the heating elements 17, 18 will be connected across the same lines of potential; however, a semiconductor rectifier 57 will be in series connection with both elements to limit the application of power to one-half the cycle of the applied voltage.

To facilitate understanding of this circuit the various heating cycles will be described in greater detail. Therefore, in the bake cycle movable contacts 41a, 43a will abut fixed contacts 41b, 43b respectively as indicated by the dots in the selector switch chart 33, thereby connecting the bake-heating element 17 directly to lines 34, 55 placing the element 17 directly across 236 volts. In the broil cycle movable contacts 41a, 44a will abut fixed contacts 41b, 44c respectively thereby connecting the broil element 18 in the same manner to 236 volts. As noted previously, switch 41 controls energization of oven indicator lamp 50 indicating an operating condition and applies power to the rotisserie outlet 51. In both of these cycles line 55 is connected to input line L2 by way of the serially connected thermostats 27, 28 such that the setting of the bake thermostat 27 controls the eventual temperature attained within the oven. Setting of the bake thermostat 27 to a par-

ticular level causes closure of the contacts so long as the temperature within the oven is lower than such setting. It will be appreciated that even though the bake-and-broil heating elements 17, 18 are connected identically in each of these cycles, each has been designed to have different heating characteristics such that the rate of heat temperature rise within the oven and the total power dissipation of the elements is different, as stated, the broil element 18 having approximately 1½ to 2 times the power rating of the bake element 17.

In the special cycles, a similar energization of the heating elements 17, 18 occurs. Thus, in the time back cycle movable contacts 41a, 42a abut fixed contacts 41c, 42b so that energization power for the bake-heating element 17 is received from line 59. Line 59 is serially connected through the normally open contact 31b of the timer 30 to power line L1, via line 34, to again connect the element 17 across the 236-volt lines. Setting of the timer 30 to a desired interval causes closure of the associated contact 31b, which will open upon completion of the interval to interrupt the application of power to the heating element 17. Normal operation of the bake element 17 in conjunction with the bake thermostat 27 is maintained such that intermittent interruption of the thermostat 27 at a preselected temperature level maintains the temperature within the oven enclosure 14 at such desired level.

Similarly in the preheat cycle movable contacts 41a, 43a, 44a and 45a are connected to fixed contacts 41b, 43b, 44c and 45b respectively, the latter switch 45 providing energization of a series circuit consisting of diode 60, resistor 61 and condenser 62 to the neutral line 35. A neon bulb 63 having series-limiting resistor 64, as do other mentioned neon bulbs 50, 53 etc., is connected in parallel across the condenser 62 such that as the condenser is charged in potential by way of the diode 60 and limiting resistor 61, ignition of the neon bulb 63 occurs to discharge the condenser as a form of oscillator circuit. The repetitive ignition of neon lamp 63 provides a flashing indication of the selection of the preheat cycle and serves as a reminder to the operator. In this cycle as in the cycles previously described, the bake-and-broil heating elements 17, 18 are connected directly between lines L1, L2, in this case directly in parallel to provide maximum utilization of the heating elements. Such parallel connection provides a more rapid heat rise within the oven enclosure, the final temperature being controlled by the setting of the bake thermostat 27. Such connection of the heating elements 17, 18 as in this cycle does require maximum current drain upon the powerlines but this condition is only of a temporary nature and is advantageous in elevating the temperature of the oven enclosure in a rapid manner.

In the cleaning cycle movable contacts 40a, 43a, 44a, and 45a are moved to abut fixed contacts 40c, 43c, 44b and 45c, respectively. Closure of the latter contact serves to short circuit the bake thermostat 27 so that control of the voltage appearing on line 55 is dependent only on actuation of the high-limit thermostat 28. The bake-and-broil heating elements 17, 18 are connected in parallel to receive energization from line 65 which also supplies voltage to indicator bulb 53 for the clean cycle. Closure of switch 40 applies voltage from line 34 or input L1 to the interlocking and power dissipation control circuitry indicated generally at 68. Similarly, the catalyst-heating element 25 and the associated fan motor 69 receive energization through switch 40, the fan providing an exhaust flow for the oven. The fan motor 69 and catalyst-heating element 25 are further connected serially with a normally open contact 70a of the clean relay 70 to the neutral line 35. Following the connection through switch 40, line A is further connected in series with a semiconductor diode 57, a normally open lock switch 71 and a second contact 70b of the clean relay 70 to line 65 and thus, to the bake-and-broil heating elements 17, 18 in parallel. The anode of diode 57 is connected to the movable contact 40a of switch 40 and the cathode to the lock contacts 71 in this configuration of the circuit to provide a burnout protection feature which will be described in greater detail hereinafter. The contacts 70a, b of the clean relay are of the

heavy-duty type to provide interruption of the high-current level supplied to the heating elements.

Energization of the clean relay 70 is provided by the serial connection of resistors 74, 75, to one side of the coil of the relay 70, the second side of the coil being connected to the neutral line 35 by way of the series connection of a normally open contact 31a of the timer 30, an interlock switch 76, and a door switch 77. A further diode 79 is connected from the second side of the coil of the clean relay 70 to the junction of resistors 74, 75 in an opposite polarity with respect to the power diode 57 as shown in FIG. 2.

A further safety circuit consists of the connection from the anode side of the power diode 57, through a thermostat contact 81, to the coil of a lock solenoid 82 and then to the neutral line 35. The lock solenoid 82 cooperates with a manual latching device for the oven door 15 to prevent accidental opening of the door while high-temperature levels are present in the enclosure.

Thus, during the cleaning cycle the following circuit operation takes place: the oven door 15 will be closed thereby closing contact 77 and a lock mechanism will be actuated to close contact 76. The timer 30 will be set to the predetermined cleaning interval thereby closing its associated contacts 31a, b and the selector switch 20 will be set to the clean setting. The clean relay 70 will be energized to close its associated contacts 70a, b to apply power to the bake and broil elements 17, 18 as noted, the semiconductor diode 57 limiting the application of power to these elements. Cleaning temperatures will be achieved within the oven enclosure 14 by the heat dissipated by the elements, such heat being limited at a preset level by the high-limit thermostat 28. It is significant to note that the reduction in power supplied to the heating elements 17, 18 due to the rectifying action of the diode 57 provides a reduced rate of temperature rise within the oven enclosure during this cycle. The power dissipation of the heating elements 17, 18 is designed to provide sufficient power to compensate for the heat lost from the oven enclosure 14 due to the exhaust system and the insulation material of the enclosure.

Even under varying voltage conditions normally encountered in the country sufficient heat will be generated, and if excess power is provided by the heating elements 17, 18, maximum temperature will be limited by the high-limit thermostat 28 causing an interruption of power and a consequent cooling of the enclosure 14 until the thermostat 28 again closes to reapply power to the elements.

During the cleaning cycle the elevated temperature will cause the lock switch thermostat 81 to open to deenergize the lock solenoid 82 which interlocks with the door opening lever to prevent such opening during the cleaning cycle. Termination of the cycle is provided by completion of the timer 30 interval whereupon contacts 31a, b will open to deenergize the clean relay 70 thereby opening its associated contacts 70a, b to remove power from the heating elements 17, 18. Continued cooling of the oven enclosure 14 causes the lock switch thermostat 81 to eventually close thereby causing energization of the lock solenoid 82 and a withdrawal of the mechanical latch (not shown), permitting the oven door to be opened.

While the nonadjustable semiconductor rectifier 57 is described in the preferred embodiment as providing the most economical form of apparatus for limiting power application to the heating elements 17, 18, various other forms may be utilized as well within the teachings of this invention. Thus, a controlled rectifier (i.e., a conventional SCR) having a triggering circuit of some variability may be employed to achieve voltage limitation to the elements 17, 18 at near a half-power level. Similarly, nonelectronic components such as a thermostat interrupter or mechanically driven switch could be utilized. All such components will allow some variation in periodicity of conduction, although the half-cycle inherent period of the preferred embodiment has been determined to be highly satisfactory in limiting the rate of heat rise within the oven enclosure 14 below an undesirable maximum level.

The clean relay circuitry includes a protection scheme for failure of the main semiconductor rectifier 57 which may be caused by a defective component, a temporary overload condition or natural occurrences such as nearby lightning strokes and the like. In normal operation power is applied through the diode 57 and through resistors 74, 75 to the coil of the clean relay 70, a minimal current flow being provided by the resistance values of resistors 74, 75 which typically are 75 and 750 ohms, respectively. In the event of burnout or open circuitry of the diode 57, no current will flow to the clean relay 70 and the clean cycle will be interlocked against operation. In the event of shorting of the diode 57, reverse current flow will occur through diode 79, resistor 74, and now shorted diode 57, diode 79 having shunted resistor 75 and the coil of the clean relay 70. Resistor 74 is selected to have a power rating only slightly greater than that required to accommodate the normal forward current flow through the clean relay circuitry. Under short circuit conditions a much higher reverse current flow, on the order of several times that of the normal forward current flow will occur and cause an overloading of resistor 74 and its consequent burnout.

Such circuitry provides an additional safety factor in the oven control circuit, utilizing readily available and inexpensive components. It is clear that the polarity of the diodes 57, 79 may be reversed, maintaining only the relative cathode-to-cathode or anode-to-anode configuration. It is clear also that the location of the components can be varied to some extent, for example, resistor 74 could be located elsewhere in the series circuit, and similarly, a different device such as a fuse, a coil of a relay, or amplifier arrangement could be serially connected to sense this over current condition and to interrupt the circuit. The use of the resistor 74, however provides the most economical and simple approach to such protective circuit, the resistor 74 combining the functions of a current limiter and a fuse in a single component.

Other modes of applying the principles of the invention may be employed, change being made as regards the details described, provided the features stated in any of the following claims or the equivalent of such be employed.

We, therefore, particularly point out and distinctly claim as our invention:

1. In an electric oven having a self-clean cycle, a circuit for controlling the generation of heat within the oven from a source of electrical AC power, comprising a bake-heating element for generating heat for normal baking applications, a broil-heating element, having greater heat dissipation than said bake element, for generating heat for normal broiling applications, a semiconductor diode for limiting the power applied to said heating elements, a switching device connected to said heating elements and said diode, said switching device being operative in normal heating applications to alternatively connect said bake-and-broil heating elements directly to the source of power and in the self-clean cycle to connect said heating elements in parallel with each other and in series with said diode to the source of power, and means responsive to failure of said diode for disconnecting said heating elements from the source of power in the self-clean cycle.

2. A circuit as set forth in claim 1, wherein said disconnecting means comprises a second rectifier connected from between the junction of said semiconductor diode and said heating elements to the source of power, in a polarity to oppose current flow from said diode, an element in series connection with said second rectifier, said element being responsive to excessive current flow to prevent further current flow therethrough, and a relay in parallel connection with said second rectifier, said relay having contacts in series connection with said heating elements and energizable in response to current flow through said diode to close said contacts, said second rectifier operative in response to a shorted condition of said diode for conducting excessive current flow through said element, thereby causing deenergization of said relay, opening of said contacts and disconnection of said heating elements from the power source.

3. A circuit as set forth in claim 2 wherein said element is a resistor for limiting current flow to said relay, said resistor having only sufficient wattage rating to accommodate current flow to said relay and being overloaded to destruction by excessive current flow from said second rectifier.

4. In an electronic oven, a circuit for controlling the application of power from a source to heating elements for normal and self-cleaning oven cycles, comprising a bake-heating element, a broil-heating element, a semiconductor diode, a high-temperature thermostat responsive to heat within the oven, a variable thermostat responsive to normal cooking heat within the oven, said thermostats being in series connection with the source of power and said heating elements, and means, in the first instance, for alternatively connecting said heating elements to the source of power and, in the second instance, for connecting said heating elements in parallel to the source of power in series with said semiconductor diode and for shunting said variable thermostat, thereby to generate heat for the self-cleaning cycle, said high-temperature thermostat being operative in the second instance to limit the heat in the oven.

5. A circuit as set forth in claim 4 further including means responsive to abnormal conduction of said semiconductor diode for interrupting the application of power to said heating elements.

6. An electric self-cleaning oven circuit for generating heat within an oven enclosure from a source of electrical power comprising first and second electrical heaters of different wattage ratings corresponding respectively to bake-and-broil heating elements of a conventional oven, said heaters adapted for alternative connection to the line-to-line voltage of the source of power in the bake-and-broil heating cycles respectively, means for connecting said heaters in parallel to the same voltage in the self-clean cycle and a single semiconductor diode in series connection with said parallel-connected

heaters in the self-clean cycle for periodically limiting the voltage applied thereto, thereby to control the rate of heat rise within the oven.

7. The circuit as set forth in claim 6 wherein said limiting means is responsive to the line-to-line voltage to apply approximately one-half the power to said elements.

8. An electric self-cleaning oven circuit for generating heat within an oven enclosure from a source of electrical power, comprising first and second electrical heaters of different wattage ratings corresponding respectively to bake-and-broil heating elements of a conventional oven, said heaters adapted for alternative connection to the line-to-line voltage of the source of power in the bake-and-broil heating cycles, respectively, means for connecting said heaters in parallel to the same voltage in the self-clean cycle, a semiconductor rectifier in series connection with said parallel-connected heaters in the self-clean cycle for periodically limiting the voltage applied thereto to control the rate of heat rise within the oven, first and second thermostatic switches in series connection with said parallel-connected heaters and said rectifier, said first thermostatic switch being adjustable and operative to control heat within the oven, said second thermostatic switch being operative to control maximum oven temperature, and means for shunting said first thermostatic switch in the self-clean cycle.

9. The circuit as set forth in claim 8 wherein said shunting means and said means for connecting said heaters comprise a manually operable switch having a plurality of normally open contacts selectively connected to said heaters, said rectifier and said first thermostatic switch, said manual switch being adapted to selectively close said contacts in bake, broil and self-clean cycles.

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