

[54] **PROGRAMMING CIRCUIT FOR
MICROWAVE OVENS**

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[22] Filed: **Apr. 3, 1972**

[21] Appl. No.: **333,351**

[52] U.S. Cl. **219/10.55, 307/301, 317/141 S**

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

[58] Field of Search .. 219/10.55; 317/141 R, 141 S;
307/301

[56]

References Cited

UNITED STATES PATENTS

3,480,792	11/1969	Matheis	317/141 S
3,569,656	3/1971	White et al.	219/10.55
3,624,334	4/1972	Chapell	219/10.55
3,694,608	9/1972	Loubert et al.	219/10.55

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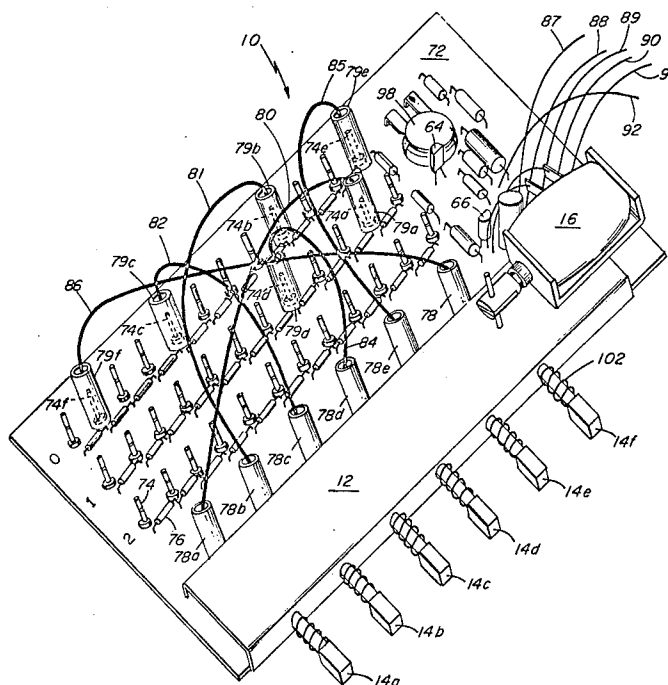
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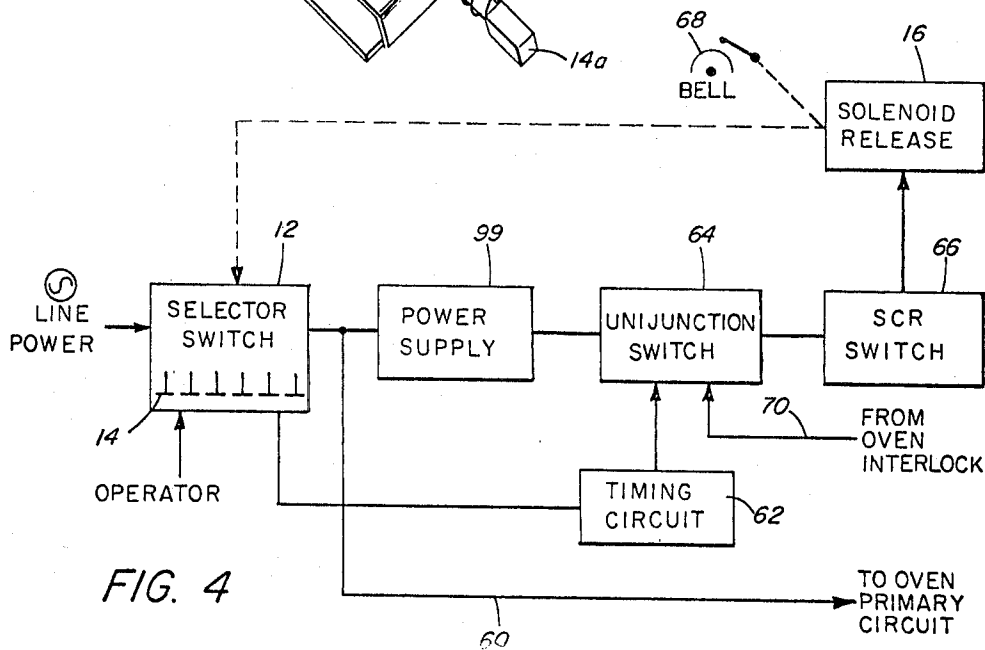
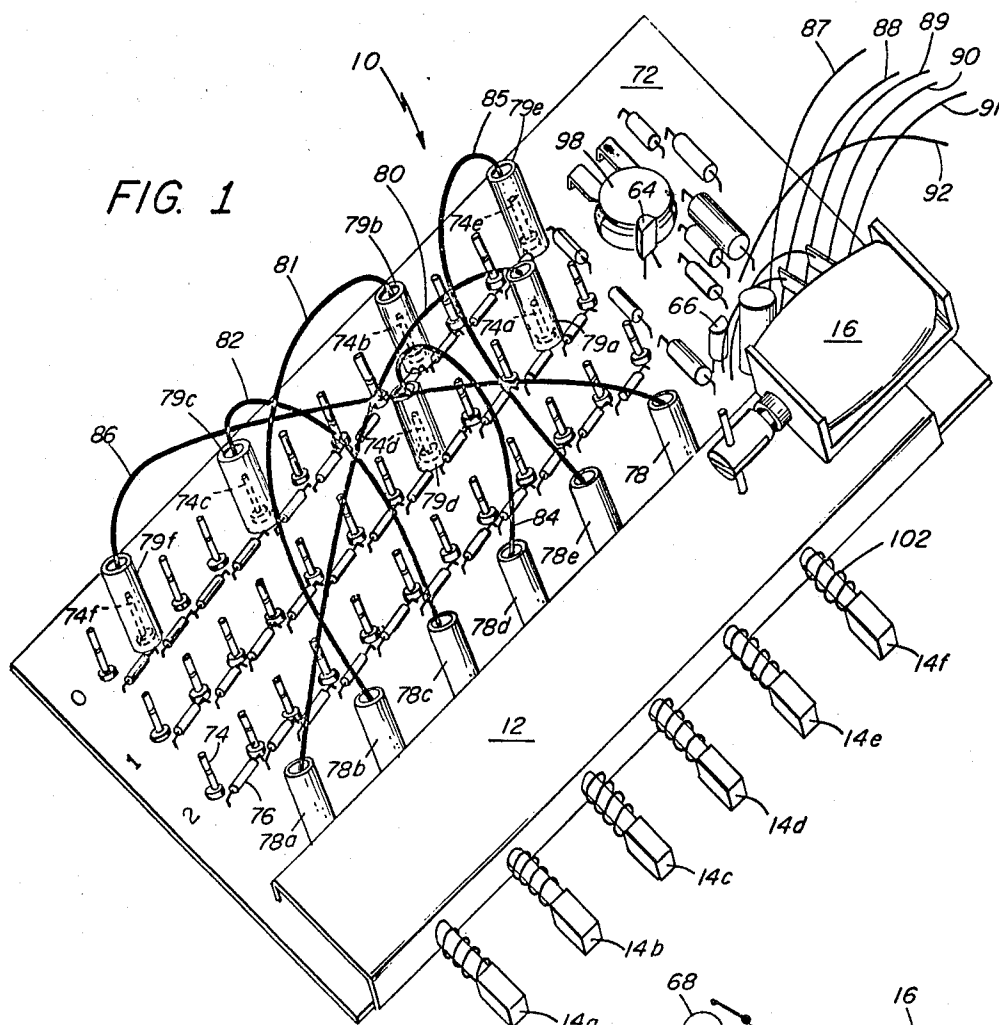
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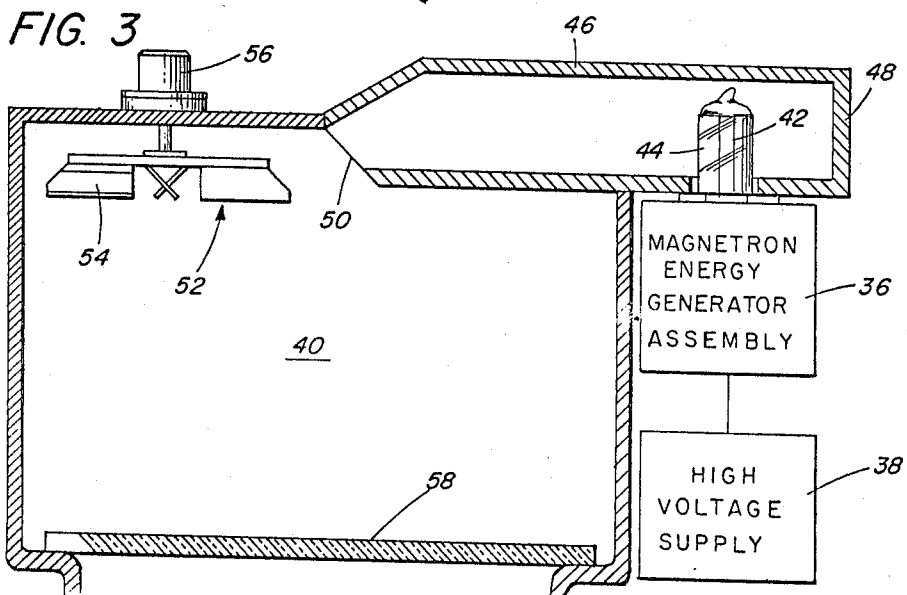
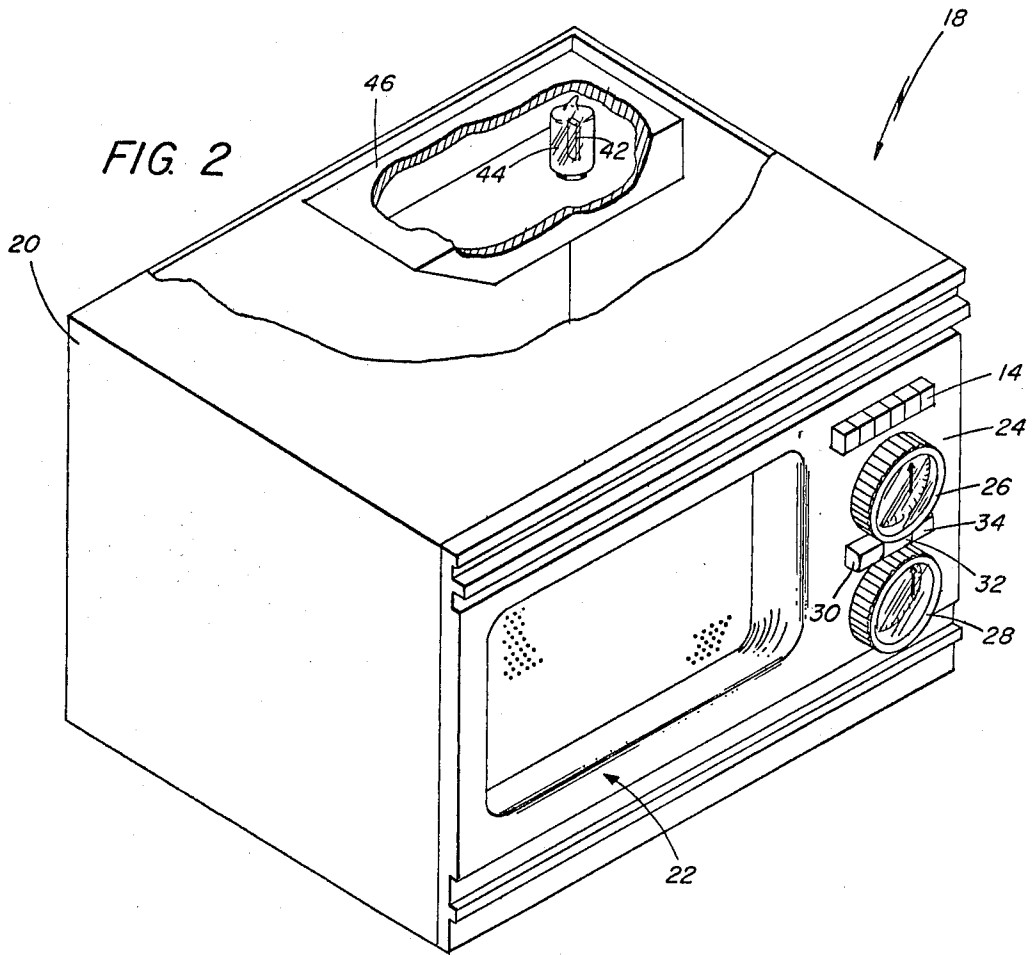
ABSTRACT

An electrical circuit is disclosed for microwave heating apparatus including means for varying cooking cycles programmed on the basis of food or product-type. Automatic control means are provided by timing circuits and selector means and constant or intermittent operation is permitted with programmed "on-off" cycling of the microwave energy source. Multiple tap RC circuit means as well as logic circuit means are illustrative programming circuit embodiments. Solid state components and printed circuit techniques provide compactness as well as dependability in operation.

6 Claims, 6 Drawing Figures







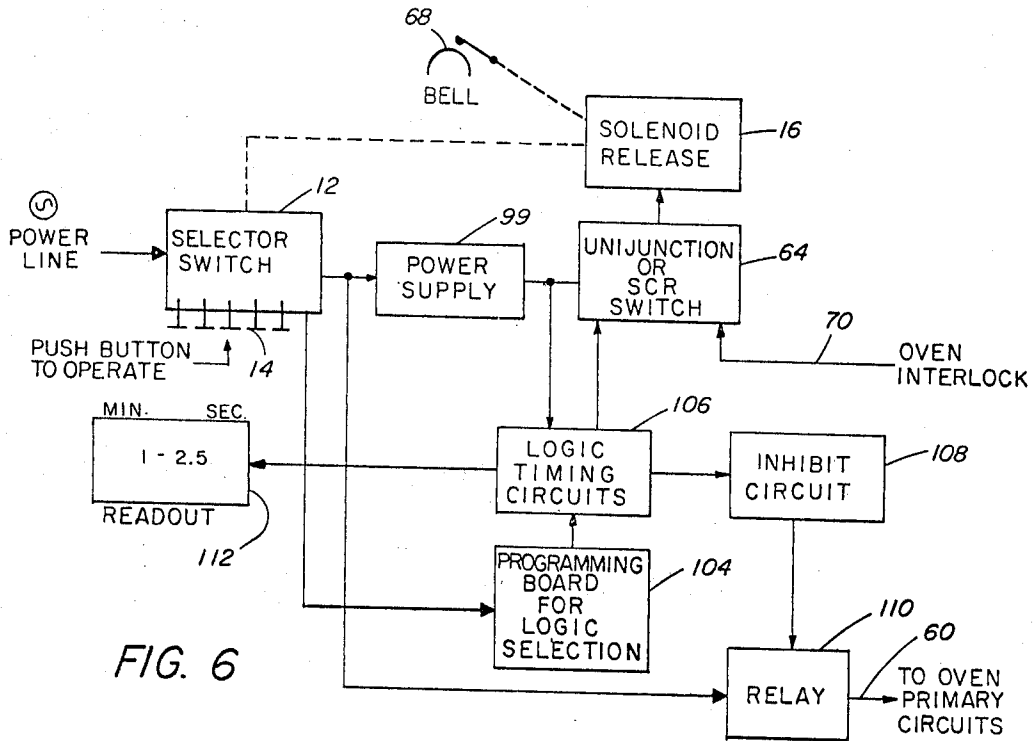


FIG. 6

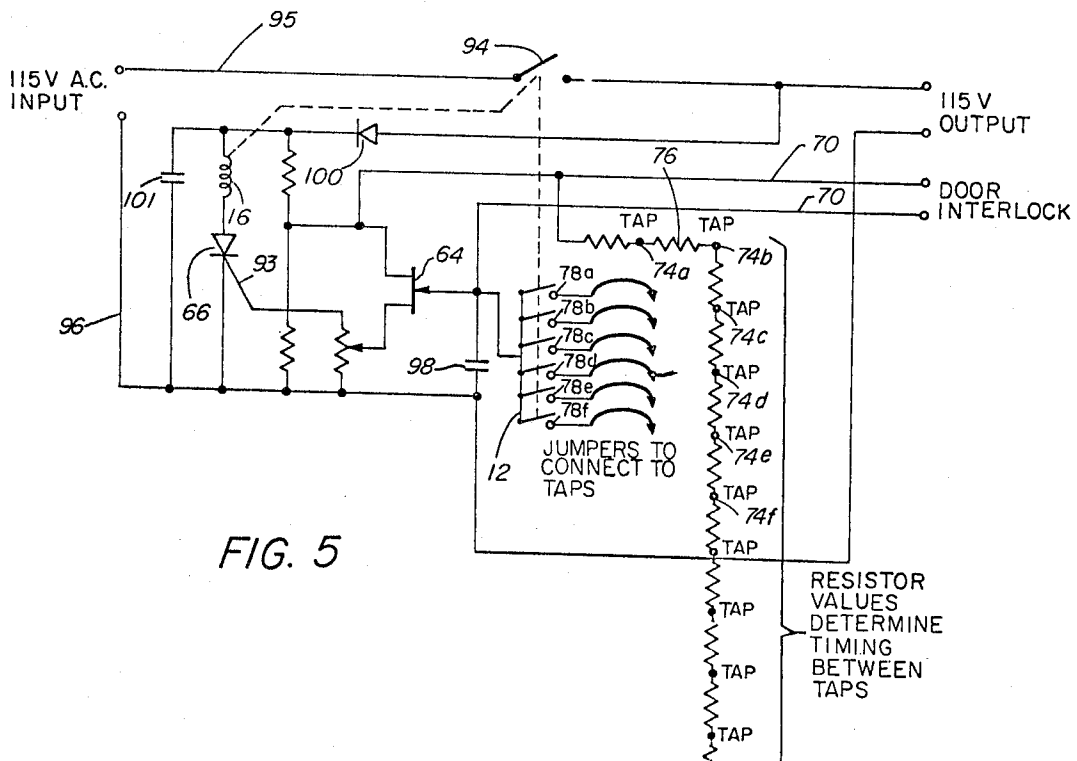


FIG. 5

PROGRAMMING CIRCUIT FOR MICROWAVE OVENS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to automatic operation of microwave heating apparatus.

2. Description of the Prior Art

Microwave heating of domestic and industrial products includes the generation of electromagnetic energy by such sources as the magnetron which is now well known in the art. Such generators provide a constant output of energy which is radiated within an enclosure or apparatus housing an article to be cooked or heated. Time, therefore, is the only variable which is required to be manipulated by the operator. In addition to varying of cooking cycles for edible products, industrial processing requires varied cycles. Included in such industrial applications are the heating of rubber, plastic, leather, ceramics, ink, textiles and paper, all inherently poor thermal conductors. For the purposes of the specification, the term "microwave" is defined as electromagnetic energy having wavelengths in the order of approximately 30 centimeters to 1 millimeter and frequencies in excess of 300 MHz.

In the processing of applicable products, prior art microwave ovens utilize conventional dial-type timers with the duration of the heating cycle determined manually by the operator. In the preparation of certain foodstuffs, such as frozen foods, thawing is required before cooking with microwave energy because ice has a different dielectric loss tangent from water which can lead to nonuniform heating. It has been the practice, therefore, to permit such frozen foods to thaw at room temperature prior to cooking with microwave energy which is both time consuming and requires continual attention by the operator in order to assure proper preparation.

In commercial vending-type food preparation, as well as cafeterias, error-free automatic cooking is desirable by eliminating reference to cooking charts and manual timer settings to prevent waste and conserve operator time.

SUMMARY OF THE INVENTION

In accordance with the invention, a circuit is disclosed for single-button product-oriented selection of cooking cycles in the operation of microwave heating apparatus for foods or industrial products. One embodiment of the invention incorporates multiple tap RC circuit means providing predetermined incremental values between taps. Resistance values are selected between taps of, for example, 5 seconds and jumper cables interconnect selector buttons to the taps. The programming is set up at the time of the installation or at any subsequent time by rearrangement of the jumper cables. Taps further down the resistance line establish a longer time constant for charging a capacitor to permit longer "on" time. The selector buttons are marked in accordance with the appropriate product designation. After automatic cycling by the timing circuit, a signalling device, either visible or audible, is energized to notify the operator.

Another embodiment of the invention involves the incorporation of logic programming circuits which incorporate any combination of "on-off" cycles. This cy-

cling is particularly applicable in the preparation of frozen foods by microwave energy with the oven being cycled "on" for a short period of time to commence the thawing and then a rest or "off" cycle to permit the product to reach the equilibrium temperature prior to the main cooking cycle. A selection of the appropriate programming circuit boards for each product is made by the operator by any means such as a selector switch with push buttons. Inhibit circuits incorporated in the logic circuits prevent the release of the selector switch until the cycling periods have been completed and prevent operator override. Safety means such as door interlocks are incorporated in the circuits to deenergize the heating apparatus upon any malfunction. Solid state means, such as silicon controlled rectifiers, control an electromagnetic solenoid releasing the selector switch. Printed circuit techniques for the RC and/or logic program boards assist in reducing costs and are compact. Such solid state circuits and components also have a low failure record and provide very accurate timing. Another feature incorporated in the present invention is the ease of adjustment in the programming simply by variation of the multiple tap connections or separate logic circuit boards.

BRIEF DESCRIPTION OF THE DRAWINGS

Details of the illustrative embodiments of the invention will be readily understood after consideration of the following description and reference to the accompanying drawings, wherein:

FIG. 1 is an isometric view of an RC-type timing circuit board and selector switch;

FIG. 2 is an isometric view of a microwave oven apparatus embodying the invention;

FIG. 3 is a vertical cross-sectional view of the microwave oven apparatus illustrated in FIG. 2;

FIG. 4 is a block diagram of the timing circuit embodying the invention;

FIG. 5 is a schematic diagram of the timing circuit illustrated in FIG. 1; and

FIG. 6 is a block diagram of a logic timing circuit.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings, FIG. 1 illustrates a timing circuit 10 of the RC type together with an accompanying selector switch 12 having a plurality of push buttons 14 and solenoid release 16. Before proceeding to the detailed description of the illustrative embodiment, reference is directed to an exemplary microwave oven 18 shown in FIGS. 2 and 3 incorporating the disclosed programming circuits.

Microwave oven 18 comprises parallel conductive walls 20 defining an enclosure 40 having an access opening which is closed by means of door assembly 22 of the drop-down bottom-hinged or side-hinged type. Control panel 24 is disposed adjacent to the door and the microwave energy generator and high voltage power supply circuits as well as the illustrative timing and selector circuits of the invention are disposed behind. A 5-minute timer switch 26 and a 30-minute timer switch 28 are supported by the panel. Start button 30, stop button 32 and a light button 36 are also mounted on panel 24. The selector switch push buttons 14 are disposed and extend beyond the outer face of the panel 24 and any number of such buttons may be provided. For the sake of simplicity six push buttons 14

have been illustrated, each of which will carry a food or product-type designation by some indicia means above or on the buttons.

A microwave energy generator such as a magnetron 36 is coupled to high voltage power supply including the transformer and DC rectifying circuits indicated by block 38. The microwave energy is fed into the enclosure 40 by means of probe antenna 42 mounted within a dielectric dome 44 through a hollow launching waveguide section 46. Waveguide section 46 is short-circuited at one end by a wall member 48 and is open at the inner end 50. The energy is distributed by any of the well-known means in the art such as, for example, a mode stirrer 52 having a plurality of paddle members 54 driven by a motor 56. The articles to be heated are supported on a dielectric plate 58 disposed near the bottom of the oven enclosure.

The illustrative magnetron generator conventionally radiates microwave energy at an allotted frequency of 2,450 MHz, however, other energy generators may be employed to radiate at the other assigned frequency of 915 MHz. Such generators provide a constant output cooking power of approximately 700 watts while other such generators may provide 1,000 watts. The operator may cook manually by setting of the appropriate timer switches 26 or 24 as well as the control buttons, 30, 32 and 34 or automatically by selection of the push button 14 for the article being cooked. In industrial and commercial vending microwave apparatus, the manually operated controls can be removed to avoid undue tampering and damage to the equipment. The heating cycles are then controlled solely by the automatic cycling timing circuits actuated by the appropriate selector push button.

Referring again to FIG. 1, as well as FIGS. 4 and 5, the exemplary automatic programming timing means is shown. FIG. 4 illustrates in a block diagram the interconnection of all of the principal components of the automatic control timing and selector circuits. Selector switch 12 is coupled to conventional domestic or industrial line voltage sources supplying a low voltage, low frequency AC electrical energy. Power supply 99 provides a rectified voltage to operate the timing circuit, such as diode 100 and filter capacitor 101. The line power to selector switch 12 is also coupled to the other oven electrical circuits by line 60. The selector switch 12 is connected to a timing circuit 62 which may be of any type which will provide the requisite cycling. A unijunction switch 64, which may be of a solid state type, after a predetermined time has elapsed, triggers a solid state device such as a silicon controlled rectifier 66 which in turn actuates solenoid release 16 to release the selector switch push buttons 14. The completion of the cooking cycle is signalled by any suitable alarm means 68 such as a bell or buzzer. The unijunction switch 64 is also coupled to the oven interlock circuits by line 70 in order that any malfunction or hazardous condition will automatically terminate the cycle and prevent damage to the apparatus or remove the safety hazard.

In FIG. 5 a schematic circuit diagram of the illustrative RC timing and selector circuit in FIG. 1 is shown. A printed circuit board 72 has all of the components of the overall electrical timing circuits mounted on one side with the conductive connections provided on the reverse side in the normal printed circuit techniques. A plurality of pin taps 74 are provided and are evenly

spaced along the board. A resistor 76 interconnects each of the taps 74 and has a predetermined incremental value. In an exemplary embodiment each of the resistors 76 were selected to provide a 5-second time interval. The taps are arranged in three rows, 0, 1 and 2, of 12 taps each to provide 36 total resistors or a total elapsed time of 180 seconds. While three rows have been illustrated, any number of rows may be provided to yield the desired overall cycling times. Each of the push buttons 14 is electrically connected by a jumper cable and jack to the desired resistance values.

Push button 14a is connected by jack 78a and jumper cable 80 to tap 74a by another jack 79a. If the total resistance value is calculated, an overall cooking time of 115 seconds would be provided for the product being cooked upon the actuation of the push button 14a. The next button 14b is interconnected by jack 78b and cable 81 to another jack 79b and tap 74b. In the particular example, the total overall cooking time would be 45 seconds.

Push button 14c is connected by cable 82 and jacks 78c and 79c to tap 74c to yield an overall cooking time of 25 seconds.

In a similar fashion push buttons 14d, e and f are connected by cables 84, 85 and 86 to jacks 78d, e and f, jacks 79d, e and f and pins 74d, e and f to yield, respectively, cooking times of 100 seconds, 60 seconds and 10 seconds. The cables 80-86 inclusive may be color coded and any combination can be arranged by authorized service personnel at the time of installation or any subsequent time simply by rearranging the jacks to yield the desired cooking times for the designated products. Such programming removes any reference to cooking charts or manual setting of timers to thereby yield substantially error-free performance.

Electrical lines 87-92 inclusive provide for the coupling of all the circuit components on the board 72 to the mainline source as well as oven interlocks and primary circuits and are all at the low voltage levels. The circuit is completed by silicon-controlled rectifier 66 which is gated by lead 93 from the unijunction switch 64 controlled by the timing circuit. Lines 70 connect to the oven interlocks; and the selector switch, together with the solenoid release 16, is interconnected through the start-stop switch 94. The mainline voltage lines 95 and 96 are provided as well as the capacitor 98. A semiconductor diode 100 is also provided to suitably bias the overall circuit. The remaining components illustrated comprise resistors and capacitors for balancing the overall RC programming timing circuits. In addition, the push buttons 14 are provided with springs 102 and latching means which are released upon movement of the solenoid release 16.

Another programming timing circuit is disclosed in FIG. 6. In this circuit the mainline voltage is again coupled to selector switch 12, power supply 99, unijunction switch 64, silicon controlled rectifier 66, solenoid release 16 and alarm signalling means 68 together with the oven interlocks and oven primary circuits including the magnetron energy generator in a manner similar to that shown in FIG. 4. A logic circuit using, for example, a binary-coded decimal (BCD) system for programming of the oven to include "on-off" timing cycles is provided by programming circuit boards 104 connected to a timing circuit 106. Each of the boards is selected by the actuation of the appropriate push button 14 by the operator and incorporate periods of nonoper-

ation or rest for thawing and reenergizing of the magnetron to continue the cooking cycle. In this circuit configuration an inhibit circuit 108 and relay 110 prevent the release of the selector switch 12 by solenoid release 16 until all the cycling periods have been completed. Time indicating means are provided by, for example, visible counter means to indicate the lapsed cooking time. At the time of installation or thereafter, appropriate changes in the cycles may be made by plugging in different logic circuit programming boards.

While the RC and logic programming circuit automatic control timing and selector means have been described herein, numerous other programming arrangements may be performed by an oscillator or power line frequency counting circuits. In addition, numerous substitutions in the circuit components may be practiced by those skilled in the art without departing from the spirit and scope of the invention. It is intended, therefore, that the foregoing detailed description of the illustrative embodiments be considered broadly and not in a limiting sense.

I claim:

1. In combination;
 - a voltage source;
 - an electromagnetic energy generator; and
 - an electrical circuit to operate said energy generator connected to said voltage source;
 - said circuit including means for automatically controlling the operation cycles;
 - said means comprising;
 - timing circuit means including serially connected resistances each having substantially the same value and a fixed capacitance for programming predetermined total time cycles of operation by electrically interconnecting a predetermined number of said resistances to said capacitance to collectively add to the required total resistance values to achieve the desired operation time;
 - selector switch means operatively associated with said timing circuit means to select each desired operation cycle; and
 - solid state means coupled to said timing circuit means for releasing said selector means upon completion of a desired programmed cycle.

2. The combination according to claim 1 wherein said serially connected resistances have a plurality of taps disposed between each resistance and said capacitance.

3. The combination according to claim 2 and jumper cables for electrically connecting said selector switch means to a desired tap to provide the total resistance values to achieve the total desired operation time.

4. The combination according to claim 2 wherein each of said resistances has a substantially similar value.

5. Microwave heating apparatus comprising:

an oven enclosure;

an electromagnetic energy generator;

means for radiating said energy within said enclosure to heat articles disposed therein;

electrical circuit means for operating said energy generator including a line voltage source and a high voltage power supply;

means for automatically controlling the application of line voltages to said power supply;

said control means comprising;

electrical timing circuit means including serially connected resistances each having a substantially similar value and a fixed capacitance for programming predetermined total time cycles of operation by electrically interconnecting a predetermined number of said resistances to said capacitance to collectively add to the total time required for the article to be heated;

selector switch means having a plurality of push buttons each identified with varied articles operatively associated with said timing means; and solid state means coupled to said timing circuit means for releasing said push buttons upon completion of a desired programmed cycle.

6. The heating apparatus according to claim 5 wherein said serially connected resistances have a plurality of taps disposed between each resistance and said capacitance and jumper cables electrically connect each selector switch push button to a desired tap to provide the total resistance values to achieve the total desired operation time.

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