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(54) Microwave oven with induction heating function

(57) An improved microwave oven with an induction heating function capable of selectively using a microwave oven or an induction heat function without any interruptions from a microwave oven heating circuit and an induction heating circuit when cooking food, which includes a microcomputer for generating a cooking mode selection control signal and a pulse width modulation signal in accordance with a cooking mode selection key input and for controlling a selection operation of the microwave heating circuit and the induction heating circuit; a relay drive circuit for generating a first drive signal and a second drive signal in accordance with a cooking mode selection control signal outputted from the microcomputer and for outputting a certain drive signal; and first and second relays, selectively switched by the first drive signal or the second drive signal outputted from the relay drive circuit, for supplying an electric voltage of a power supply circuit to the microwave heating circuit and the induction heating circuit.

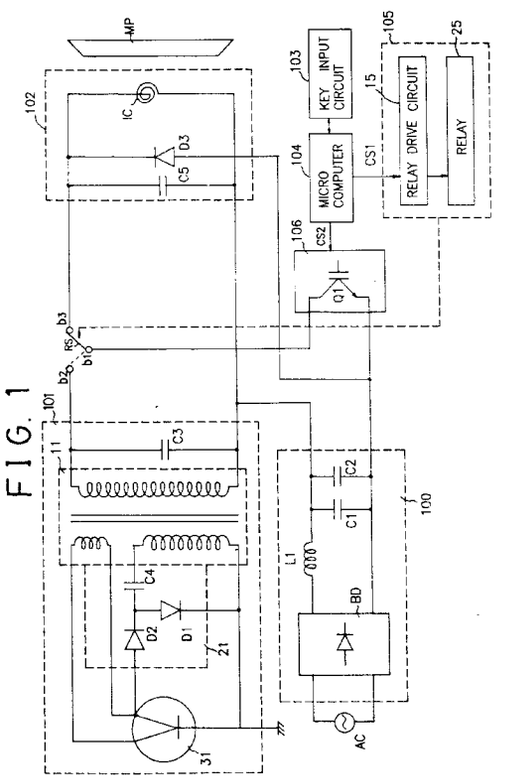

FIG. 1

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a microwave oven with an induction heating function, and in particular to an improved microwave oven with an induction heating function capable of selectively using a microwave oven or an induction heat function without interruptions from a microwave oven heating circuit and an induction heating circuit when cooking food.

2. Description of the Conventional Art

Referring to Fig. 1, a conventional microwave oven with an induction heating function includes a power supply circuit 100 for converting an input alternating current AC into a ripple direct current using a bridge diode BD, for smoothing the thusly converted direct voltage using a coil L1 and capacitances Cl and C2, and for supplying the thusly smoothed direct current to a microwave oven with an induction heating function, a microwave heating circuit 101 for generating a microwave oven after increasing the voltage supplied thereto up to a predetermined level, an induction heating circuit 102 having an induction coil IC, a capacitance C5, and a damper diode D3, a key input circuit 103 having a cooking mode selection key and various kinds of function keys, a microwave oven 104 for generating a pulse width modulation signal CS2 so as to drive the cooking mode selection control signal CS1, the microwave heating circuit 101, and the induction heating circuit 102 in accordance with a predetermined mode selected by the key input circuit 103 and for controlling a heating circuit selection operation of a microwave oven with an induction heating function, a cooking mode selection circuit 105 for selecting the microwave heating circuit 101 or the induction heating circuit 102 in accordance with a switching operation of a relay switch RS connected between the microwave heating circuit 101 and the induction heating circuit 102, and a heat driving circuit 107, having a switching device Q1 and switched by the pulse width modulation signal CS2 outputted from the microcomputer, for driving the microwave heating circuit 101 and the induction circuit 102 in accordance with a selection of the cooking mode selection circuit 105.

The microwave heating circuit 101 includes a high voltage transformer 11 for increasing the voltage level outputted from the power supply circuit 100 up to a predetermined level, a high voltage generating circuit 21 having high voltage diodes D1 and D2 and a high voltage capacitance C4 for converting the high voltage increased by the high transformer 11 into a current high voltage, and a magnetron 31 for generating a microwave in accordance with the thusly converted direct high voltage.

The cooking mode selection circuit 105 includes a relay drive circuit 15 for generating a relay drive signal and for driving a relay 25 in accordance with a cooking mode selection drive circuit CS1 outputted from the microcomputer 104, and a relay 25 for switching the microwave heating circuit 101 or the relay switch RS connected to the induction heating circuit 102 in accordance with a relay driving signal outputted from the relay drive circuit 15.

The operation of the conventional microwave oven with an induction heating function will now be explained with reference to Fig. 2.

To begin with, when an alternating power AC is supplied to the power supply circuit 100, the alternating current AC is rectified to a current voltage by the bridge diode BD and is smoothed by the coil L1 and the capacitances C1 and C2.

At this time, the relay switch RS is connected to a terminal b2 of the microwave heating circuit 101 or a terminal b3 of the induction heating circuit 102. In state that the relay switch RS is connected to the terminal b3 of the induction heating circuit 102, when a user selects a microwave cooking mode key of the key input circuit 103, the microcomputer 104 recognizes a key input signal applied thereto, and generates a cooking mode selection control signal CS1 and a pulse width modulation signal CS2.

Thereafter, the relay drive circuit 15 of the cooking mode selection circuit 105 receives the cooking mode selection control signal CS 1 outputted from the microcomputer 104 and outputs a relay drive signal in accordance with a cooking mode selection control signal CS1 applied thereto.

Therefore, the relay 25 switches the relay switch RS connected to the terminal b3 of the invertor 102 to the terminal b2 of the microwave heating circuit 101.

Meanwhile, the switching device Q1 of the heating drive circuit 106 is turned on or turned off in accordance with a pulse width modulatien signal CS2 outputted from the microcomputer 104.

Therefore, when the switching device Q1 is turn on, the direct current voltage outputted from the power supply circuit 100 is supplied to the capacitance C3 and the high voltage transformer 11. The capacitance C3 and a primary coil of the high voltage transformer 11 become a resonant state by a direct current outputted from the power supply circuit 100 in accordance with a turn-on/turn-off operation of the switching device Q1 of the heating drive circuit 106 and are applied to both ends of the capacitance C3, and the resonant voltage is inducted to a secondary coil of the high voltage transformer 11.

Thereafter, the resonant voltage inducted to the secondary coil of the high voltage transformer 11 is converted into a direct current through the high voltage diodes D1 and D2 and the high voltage capacitance C4 of the high voltage generating circuit 21 and drives the magnetron 31.

Therefore, the magnetron 31 generates a magnet-

ron so as to cook food.

Meanwhile, when the relay switch Rs at an initial state is connected to the terminal b2 of the microwave heating circuit 101, and when a user inputs an induction heating mode key of the key input circuit 103 so as to cook food using the induction heating circuit 102, the microcomputer 104 recognizes the induction heating mode key and outputs a cooking mode selection control signal CS1 and a pulse width modulation signal CS2 in accordance with the recognition.

Thereafter, the relay drive circuit 15 of the cooking mode selection circuit 105 receives the cooking mode selection control signal CS1 outputted from the microcomputer 104 and outputs a relay drive signal so as to drive the relay 25. The relay switch RS is connected to the terminal b3 of the induction heating circuit 102.

Therefore, the direct current voltage outputted from the power supply circuit 100 is applied to the induction coil IC and the resonant capacitance C5 of the induction heating circuit 102 because the power supply circuit 100, the induction heating circuit 102, and the heating drive circuit 106 are closed.

At this time, the switching device Q1 of the heating drive circuit 106 is turned on and turned off in order in accordance with a pulse width modulation signal SC2 outputted from the microcomputer 104, and the resonant voltage outputted from the capacitance C5 and the induction coil IC and applied to both ends of the capacitance C5, and a relatively big resonant voltage level is applied to the induction coil IC.

Therefore, a metal pan is heated by the induction heating of the induction coil IC, and the food in the cavity of the microwave oven is heated.

However, the conventional microwave oven with an induction heating function has disadvantages in that when a user selects a predetermined cooking mode between a microwave cooking mode and an induction cooking mode, since the food in the cavity of the microwave oven is heated by a cooking mode selected by a relay switch for a predetermined time, it is impossible to achieve a desired cooking state because the cooking operation is performed in state that a predetermined unstable component is contained in the electric power because the power is supplied through the relay switch.

In addition, when an electric power of 220V is supplied thereto, since the resonant voltage level is higher than that of the relay switch during a cooking operation, it is nearly impossible to execute a stable microwave heating operation.

Moreover, in state that a relatively high resonant voltage, as shown in Fig. 2A, is applied between the collector terminal and the emitter terminal of the switching device, a pulse width modulation signal of a high level, as shown in Fig. 2C, is applied to the gate terminal of the transistor, the transistor is turned on, and the collector terminal, as shown in Fig. 2B, may receive a short voltage therefrom, so that the transistor can be damaged by the short voltage.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide a microwave oven with an induction heating function, which overcome the problems encountered in a conventional microwave oven.

It is another object of the present invention to provide an improved microwave oven with an induction heating function capable of selectively using a microwave oven or an induction heat function without any interruptions from a microwave oven heating circuit and an induction heating circuit when cooking food.

To achieve the above objects, in accordance with a first embodiment, there is provided a microwave oven with an induction heating function, which includes a microcomputer for generating a cooking mode selection control signal and a pulse width modulation signal in accordance with a cooking mode selection key input and for controlling a selection operation of the microwave heating circuit and the induction heating circuit; a relay drive circuit for generating a first drive signal and a second drive signal in accordance with a cooking mode selection control signal outputted from the microcomputer and for outputting a certain drive signal; and first and second relays, selectively switched by the first drive signal or the second drive signal outputted from the relay drive circuit, for supplying an electric voltage of a power supply circuit to the microwave heating circuit and the induction heating circuit.

To achieve the above objects, in accordance with a second embodiment, there is provided a microwave oven with an induction heating function, which includes a microcomputer for generating a cooking mode selection control signal and a pulse width modulation signal in accordance with a cooking mode selection key input and for controlling a selection operation of the microwave heating circuit and the induction heating circuit; a cooking mode selection circuit for selecting one of the microwave heating circuit and the induction heating circuit corresponding to a cooking mode selection control signal outputted from the microcomputer and for supplying a voltage of a power supple circuit to a heating drive circuit; and a switching device protection circuit for cutting off a pulse width modulation signal of the microcomputer, which determines an ON/OFF interval of the switching device of the heating drive circuit when a resonant voltage exceeds a predetermined level by detecting the resonant voltage outputted from one of the microwave heating circuit and the induction heating circuit and for protecting the switching device.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram of a conventional microwave oven with an induction heating function.

Fig. 2A is a wave form of a collector-emitter voltage of a switching device of a heat driving circuit of Fig. 1.

Fig. 2B is a wave form of a collector current of a

switching device of a heat driving circuit of Fig. 1.

Fig. 2C is a wave form of a gate voltage of a switching device of a heat driving circuit of Fig. 1.

Fig. 3 is a block diagram of a microwave oven with an induction heating function of a first embodiment according to the present invention.

Fig. 4 is a block diagram of a microwave oven with an induction heating function of a second embodiment according to the present invention.

Fig. 5A is a wave form of a collector-emitter voltage of a transistor of a heat driving circuit of Fig. 4.

Fig. 5B is a wave form of a collector current of a transistor of a heat driving circuit of Fig. 4.

Fig. 5C is a wave form of a gate voltage of a transistor of a heat driving circuit of Fig. 4.

Fig. 5D is a wave form of a base-emitter voltage of a transistor of a switching device protector of Fig. 4.

DETAILED DESCRIPTION OF THE INVENTION

Referring to Fig. 3, a microwave oven with an induction heating function of a first embodiment according to the present invention includes a power supply circuit 1 for converting an externally supplied alternating current voltage AC into a direct voltage using a bridge diode BD, for smoothing the thusly converted direct current voltage using a coil L11, capacitances C11 and C12, and for supplying the thusly smoothed voltage to a microwave oven with an induction heating function, a microwave heating circuit 2 for generating a microwave and for executing a microwave heating operation after increasing an electric power supplied thereto through relay switches RS1 and RS2, an induction heating circuit 3, having an induction coil IDC, a resonant capacitance C15, and a damper diode D13, for generating a high frequency magnetic field in accordance with a power supplied from the power supply circuit 1 and for heating a metal plate MTP, a microcomputer 5 for generating a pulse width modulation signal PWM so as to enable a cooking mode selection control signal and so as to drive the microwave heating circuit 2 and the induction heating circuit 3 in accordance with a cooking mode selection signal outputted from the key input circuit 4 and for controlling a heating selection operation, a cooking mode selection circuit 6 for switching one of the relay switches RS1 and RS2 connected to the microwave heating circuit 2 and the induction heating circuit 3 at an initial stage and for selecting one of the microwave heating circuit 2 and the induction heating circuit 3, and a heating drive circuit 7, switched by a pulse width modulation signal PWM outputted from the microcomputer 5 and having a switching device Q11, for supplying an electric power outputted from the power supply circuit 1 to the microwave heating circuit 2 or the induction heating circuit 3 in accordance with a selection of the cooking mode selection circuit 6 and for driving one of the microwave heating circuit 2 and the induction heating circuit 3.

The microwave heating circuit 2 includes a high voltage transformer 21 for increasing the power supplied from the power supply circuit 1 through the relay switches RS1 and RS2 up to a predetermined level, a high voltage generating circuit 22, having high voltage diodes D11 and D12 and a high voltage capacitance C14, for converting the thusly increased high voltage into a direct current voltage, and a magnetron 23 for generating a microwave in accordance with a supply of the high direct current voltage converted by the high voltage generating circuit 22.

The cooking mode selection circuit 6 includes a relay drive circuit 61 for outputting drive signals DSI and DS2 so as to drive first and second relays 62 and 63 in accordance with a cooking mode selection control signal CSC outputted from the microcomputer 5, and first and second relays 62 and 63 for selectively switching the relay switches RSI and RS2 in accordance with drive signals DS1 and DS2 outputted from the relay drive circuit 61.

The operation of the microwave oven with an induction heating function of a first embodiment according to the present invention will now be explained with reference to the accompanying drawings.

To begin with, when an alternating current voltage AC is supplied to the power supply circuit 1,. the alternating current voltage AC is rectified to a direct current voltage by a bridge diode BD and smoothed by the coil L11 and the capacitances C11 and C12.

At this time, the relay switch RS1 is connected to the terminal b13 of the invertor RS 1, and the relay switch RS2 is connected to the terminal C12 of the microwave heating circuit 2, and there is thusly a disconnection between the microwave heating circuit 2 and the induction heating circuit 3.

Thereafter, in order to select a microwave heating mode, when a user selects a microwave cooking mode of the key input circuit 4, the microcomputer 5 recognizes a key input signal in accordance with a microwave cooking key selected by the user and generates a cooking mode selection control signal CSS and a pulse width modulation signal PWM.

Thereafter, the relay drive circuit 61 of the cooking mode selection circuit 6 receives a cooking mode selection control signal CSS outputted from the microcomputer 5 and outputs a relay drive signal DS1 in accordance with the thusly received cooking mode selection control signal CSS.

Therefore, the relay switch RS1 is connected to the terminal b12 of the microwave heating circuit 2 by the first relay 62 in accordance with a relay drive signal DS1 outputted from the relay drive circuit 61.

Meanwhile, the switching device Q11 of the heating drive circuit 6 is turned on and turned off in order in accordance with a pulse width modulation signal PWA outputted from the microcomputer 5.

Thereafter, when the switching device Q11 is turned on, the direct current voltage outputted from the power supply circuit 1 is supplied to the capacitance C13 and

the high voltage transformer 21 through the relay switches RS1 and RS2.

In addition, as the switching device Q11 of the heating drive circuit 7 is turned on and turned off in order, a certain resonant voltage is generated at the capacitance C13 and a primary coil of the high voltage transformer 21 by a direct current voltage supplied thereto from the power supply circuit 1 and is applied to both ends of the capacitance C13 and is inducted to a secondary coil of the high voltage transformer 21.

Thereafter, the resonant voltage inducted to the secondary coil of the high voltage transformer 21 is converted into a direct current voltage through the high voltage diodes D11 and D12 and the high capacitance C14 of the high voltage generating circuit 22 and drives the magnetron 23.

Therefore, the magnetron 23 generates a high frequency wave so as to heat food.

Thereafter, when the cooking operation is completed, a cooking completion control signal is outputted from the microcomputer 5, and the delay drive circuit 61 of the cooking mode selection circuit 6 receives the cooking completion control signal outputted from the microcomputer 5, stops the drive of the first relay 62, and sets the relay switch RS1 to the initial stage. That is, the relay drive circuit 61 is connected to the terminal b13 of the induction heating circuit 3.

Therefore, the direct current outputted from the power supply circuit 1 is not supplied to the microwave heating circuit 2 and the induction heating circuit 3.

Meanwhile, when the user selects an induction heating mode from the key input circuit 4, the microcomputer 5 recognizes a key input signal corresponding to the induction heating mode and outputs a selection control signal CSS and a pulse width modulation signal PWM in accordance with the recognition.

Thereafter, the relay drive circuit 61 of the cooking mode selection circuit 6 receives a cooking mode selection control signal CSS outputted from the microcomputer 5 and outputs a relay drive signal DS2 so as to driving the second relay 63.

That is, the first relay 62 is not driven by the relay drive circuit 61. The second relay 63 switches the relay switch RS2 to the terminal c13 by a driving signal DS2 outputted from the relay drive circuit 61.

Meanwhile, the switching device Q11 of the heating drive circuit 7 is turned on and turned off in order in accordance with a pulse width modulation signal PWM outputted from the microcomputer 5.

Therefore, the direct voltage outputted from the power supply circuit 1 is supplied to the induction coil IDC and the resonant capacitance C15 because the power supply circuit 1, the induction heating circuit 3 and the heating drive circuit 7 are disconnected therefrom.

In addition, since the switching device Q11 of the heating drive circuit 7 is turned on and turned off in order, a predetermined resonant voltage occurs at the capacitance C15 and the induction coil IDC and is applied to both ends of the capacitance C15. At this time, a relatively high resonant voltage occurs at the induction coil IDC.

Therefore, since a high frequency magnetic field is formed by the induction coil IDC and applied to the metal plate MPT, the metal pan is heated, the food in the pan is heated.

Thereafter, the cooking operation mode is completed, and the microcomputer 5 outputs a cooking completion control signal, and the relay drive circuit 61 stops the drive of the second relay 63, and the relay switch RS2 is connected to the terminal c12.

Referring to Fig. 4, the microwave oven with an induction heating function of a second embodiment according to the present invention has the same construction as the first embodiment except a switching device protection circuit 8 for protecting the switching device Q11 by cutting off the pulse width modulation signal PWM of the microcomputer 5, which is subject to determining an ON/OFF interval of the switching device Q11 of the heating drive circuit 7 when a resonant level is higher than a predetermined level by detecting the resonant voltage level outputted from the induction heating circuit 6.

The switching protection circuit 8 includes a zenor diode ZD1 for passing through the resonant voltage outputted from the microwave heating circuit 2 or the induction heating circuit 6 when it exceeds a predetermined level, and a transistor Q12 for receiving the voltage outputted from the zenor diode ZD1 through the capacitances RI and R2 and for cutting off the pulse width modulation signal PWM outputted from the microcomputer and applied to the heating drive circuit 7.

The operation of the microwave oven with an induction heating function of the second embodiment according to the present invention will now be explained with reference to Fig. 5.

To begin with, as described in the first embodiment, when a user inputs a corresponding key of the key input circuit 4 so as to select a microwave cooking mode, the relay switch RS1 is connected to the terminal b12 by the first relay 62 and the second relay 63 for selecting the microwave heating circuit 2.

Thereafter, the power outputted from the power supply circuit 1 is applied to the capacitance C13 and a primary coil of the high voltage transformer 21 and applied to both ends of the capacitance C13 in accordance with a switching operation of the switching device Q11 of the heating drive circuit 7.

Here, when a relatively high resonant voltage is applied to both ends of the capacitance C13 as shown in Fig. 5A, that is, a voltage VCE is applied between the collector terminal and the emitter terminal of the switching device Q11, since the voltage VCE between the collector terminal and the emitter terminal of the switching device Q11 is high than that of the zenor voltage VZ of the zenor diode ZD1 of the switching device protection circuit 8, the voltage VCE is divided by the capacitances

R1 and R2. Therefore, a high voltage as shown in Fig. 5D is applied to the base terminal of the transistor Q12.

Therefore, the transistor Q12 is turned on in accordance with a high voltage applied to the base terminal thereof and by-passes the pulse width modulation signal PWM outputted from the microcomputer 5 to the ground terminal.

A low level voltage, as shown in Fig. 5C, is applied to the gate terminal of the switching device Q11 of the heating drive circuit 7, and a certain level of voltage lower than that of the zenor voltage VZ is not applied to the collector terminal of the switching device Q11, the switching device Q11 is safely protected.

Meanwhile, when the user inputs a corresponding key from the key input so as to select the induction heating circuit 3, the relay switch RS2 of the first and second relays 62 and 63 are turned on, and since the relay switch RSI maintains a turned-on state, a certain resonant voltage is applied to both ends of the capacitance C15 of the induction heating terminal 3.

As shown in Fig. 5A, when a relatively high resonant voltage VCE is applied to both ends of the capacitance C15, the zenor diode ZD and the transistor Q12 become activated, and since a certain voltage higher than that of the zenor voltage VZ is not applied to the collector terminal of the switching device Q11, the switching device Q11 is safely protected.

As described above, the microwave oven with an induction heating function is capable of selectively using a microwave oven and an induction heat function without any interruptions from a microwave oven heating circuit and an induction heating circuit when cooking food by providing first and second relays which is selectively used for a certain mode. In addition, the microwave heating circuit and the induction heating circuit can be safely used irrespective of the internal pressures of the high voltage resonant and relays due to use of the electric power of 220V.

Moreover, the present invention is directed to expanding the life span of the product by preventing damages of the switching device due to a relatively high resonant voltage by stopping the drive of the switching device for a predetermined time when the resonant voltage exceeds a predetermined level by detecting the resonant voltage which occurs due to the noise components contained in the input voltage and electric power between turn on/off intervals of the switching device of the heating drive circuit.

Claims

1. A microwave oven with an induction heating function having a microwave heating circuit and an induction heating circuit which are selectively used by a user, comprising:

   a microcomputer for generating a cooking mode selection control signal and a pulse width modulation signal in accordance with a cooking mode selection key input and for controlling a selection operation of said microwave heating circuit and said induction heating circuit;
   relay drive means for generating a first drive signal and a second drive signal in accordance with a cooking mode selection control signal outputted from said microcomputer and for outputting a certain drive signal; and
   first and second relays, selectively switched by said first drive signal or said second drive signal outputted from said relay drive means, for supplying an electric voltage of power supply means to the microwave heating circuit and the induction heating circuit.

2. The microwave oven of claim 1, wherein of said first or second relays, one is at an initial stage, and the other is switched to one of the microwave heating circuit and the induction heating circuit corresponding to its cooking mode.

3. The microwave oven of claim 1, wherein said first and second relays switch the microwave heating circuit or the induction heating circuit to either the power supply means or the cooking drive means.

4. The microwave oven of claim 1, wherein said relay drive means drives one of the first and second relays in accordance with a mode selection control signal of said microcomputer.

5. A microwave oven with an induction heating function having a microwave heating circuit and an induction heating circuit which are selectively used by a user, comprising:

   a microcomputer for generating a cooking mode selection control signal and a pulse width modulation signal in accordance with a cooking mode selection key input and for controlling a selection operation of said microwave heating circuit and said induction heating circuit;
   cooking mode selection means for selecting one of said microwave heating circuit and said induction heating circuit corresponding to a cooking mode selection control signal outputted from said microcomputer and for supplying a voltage of power supple means to a heating drive means; and
   a switching device protection means for cutting off a pulse width modulation signal of said microcomputer, which determines an ON/OFF interval of the switching device of said heating drive means when a resonant voltage exceeds a predetermined level by detecting the resonant voltage outputted from one of the micro-

wave heating circuit and the induction heating circuit and for protecting the switching device.

6. The microwave oven of claim 5, wherein said switching device protection means includes a zenor diode which becomes activated when a resonant voltage at the switching device of the heating drive means exceeds a predetermined level, and a transistor for receiving a voltage outputted from said zenor diode through first and second capacitances and for cutting off a pulse width modulation signal applied to the gate terminal of the switching device.

FIG. 1

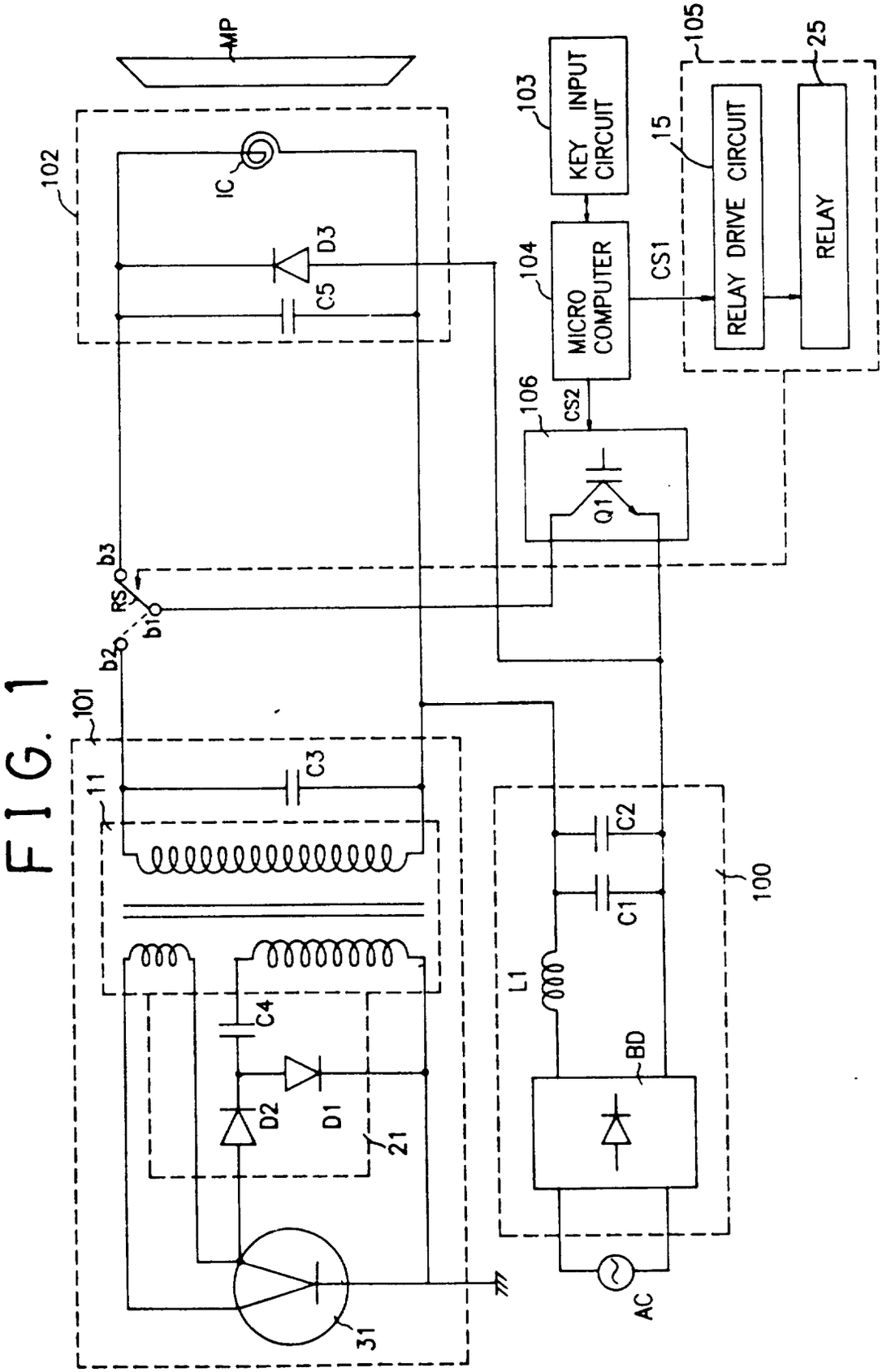

MP
102
IC
D3
C5
103
KEY INPUT CIRCUIT
104
MICRO COMPUTER
CS1
105
15
RELAY DRIVE CIRCUIT
25
RELAY
106
CS2
Q1
b3
RS
b1
b2
101
11
C3
C4
D2
D1
21
31
C2
C1
L1
BD
100
AC

FIG. 2A

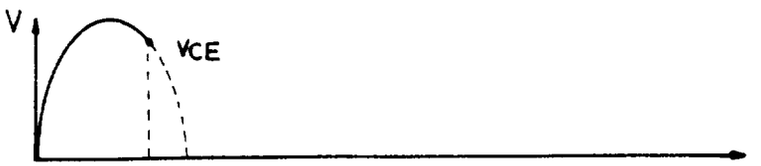


FIG. 2B

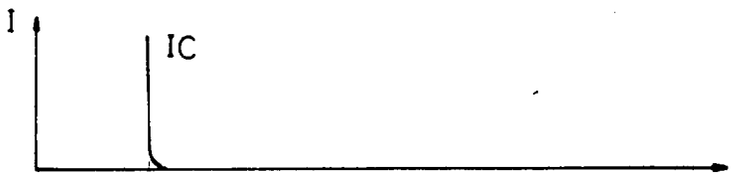
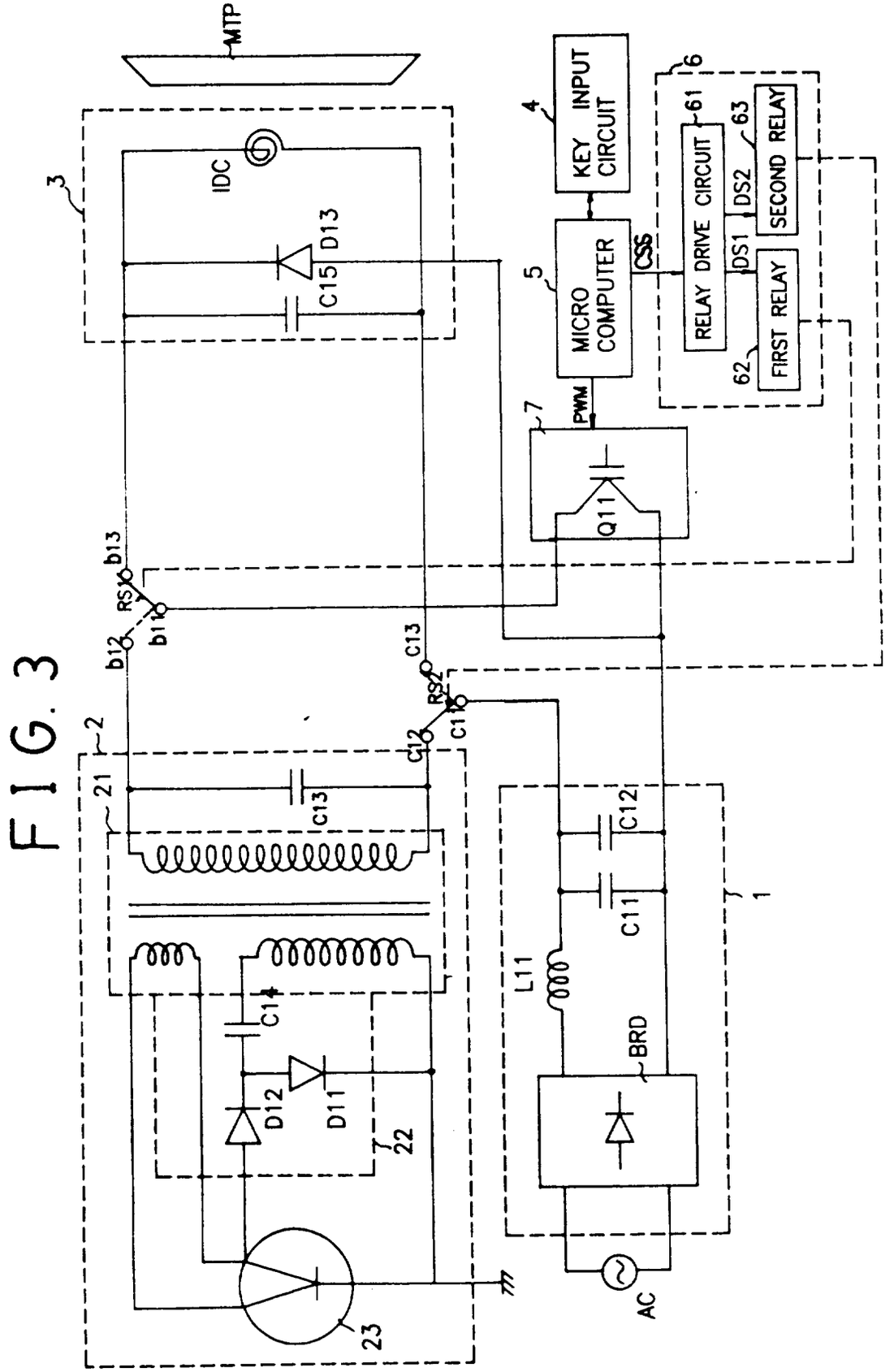


FIG. 2C

FIG. 3


MTP
IDC
D13
C15
3
KEY INPUT CIRCUIT
4
MICRO COMPUTER
5
CSS
RELAY DRIVE CIRCUIT
61
DS1
DS2
SECOND RELAY
63
FIRST RELAY
62
6
PWM
7
Q11
b13
RS1
b11
b12
C13
RS2
C12
C11
2
21
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C12
C11
L11
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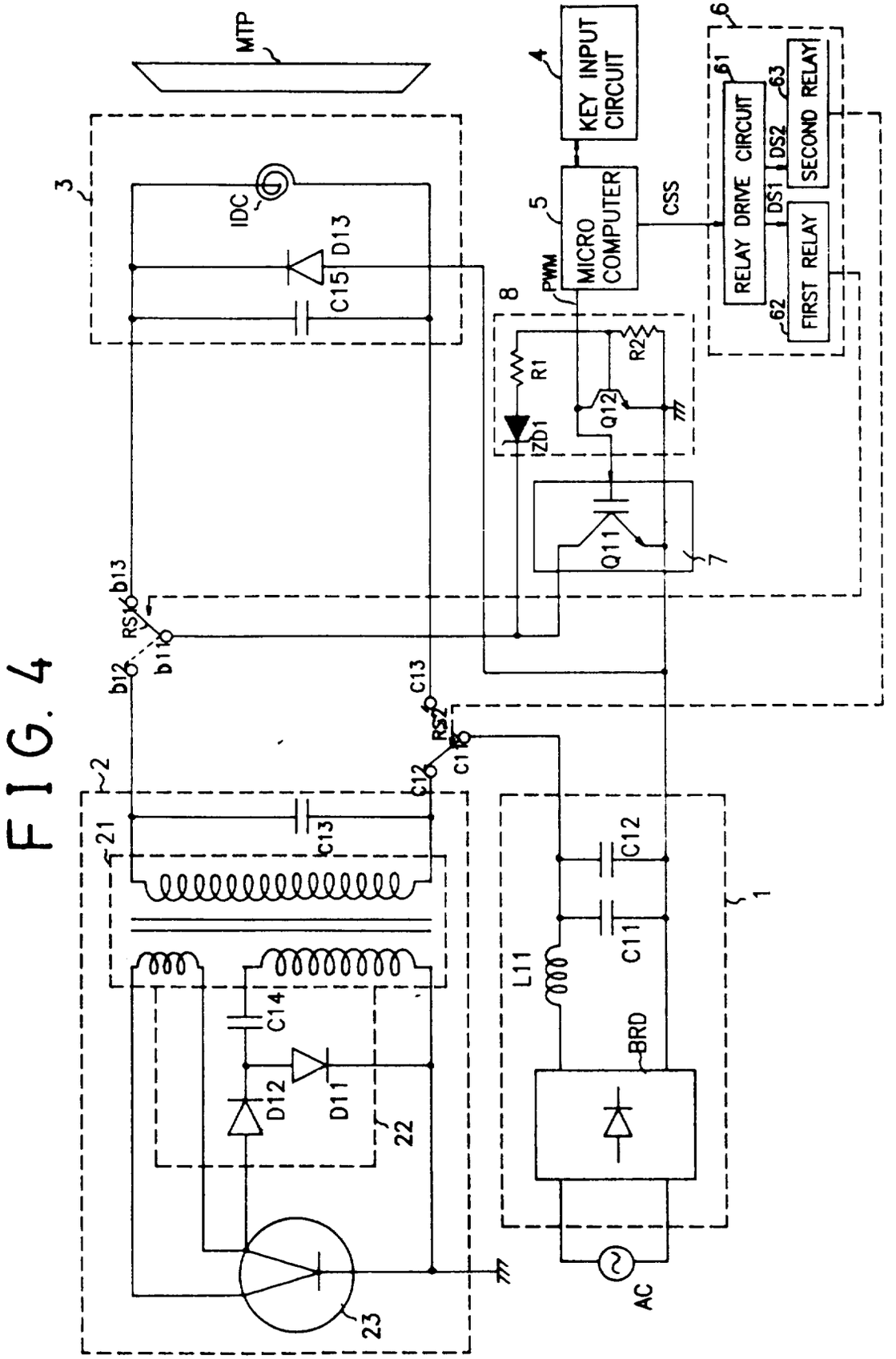
1
C14
D12
D11
22
23
AC

FIG. 4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61
RELAY DRIVE CIRCUIT
DS1
DS2
63
SECOND RELAY
62
FIRST RELAY
8
R1
R2
ZD1
Q12
Q11
7
b13
RS1
b11
b12
C13
RS2
C11
C12
2
21
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FIG. 5A

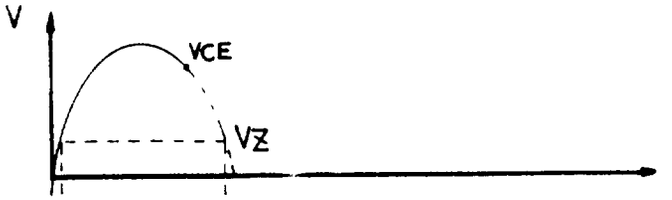

FIG. 5B

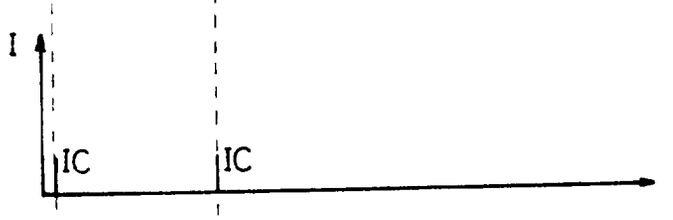

FIG. 5C

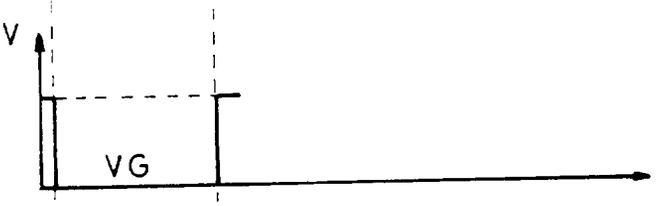

FIG. 5D