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(54) **Microwave oven, its management of the starting current**

(57) In a microwave oven, initial surge current protection is provided by the winding of a motor (12) rather

than the more conventional current-limiting resistor. Consequently, energy, that would otherwise be wasted producing unwanted heat, is used for useful work.

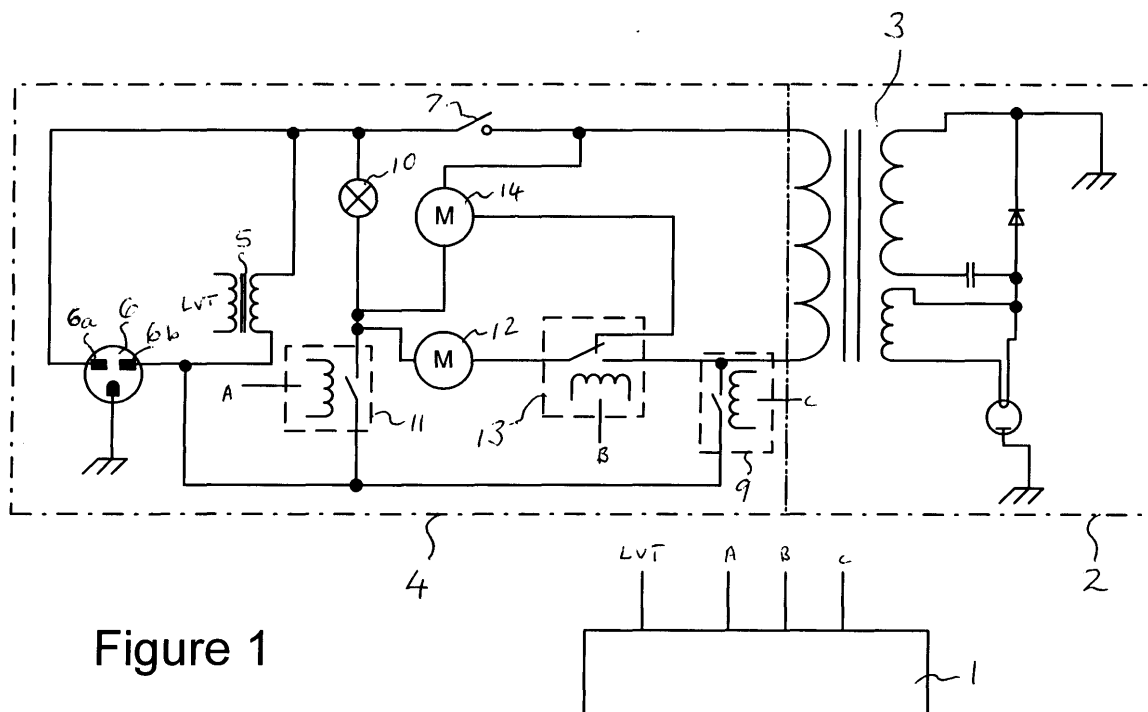


Figure 1

Description

[0001] The present invention relates to a microwave oven comprising a high-voltage transformer for driving a microwave generator, current-limiting means and switching means for introducing the current limiting means in series with the primary winding of the transformer for preventing a current surge therethrough when cooking is started.

[0002] Microwave ovens are typically provided with surge current protection devices. In the absence of such devices, an initial surge of current at switch-on would produce a damaging output from the high-voltage transformer of the oven's high-voltage power supply.

[0003] One form of surge protection device routes current to the high-voltage transformer through a current-limiting resistor for a short period after switch-on.

[0004] A microwave oven according to the present invention is characterised in that the current-limiting means comprises a winding of a motor. Consequently, useful work is done by the current limiting device rather than it merely producing unwanted heat. Also, there is a reduction in the number of components because the motor winding fulfills two functions.

[0005] Preferably, the motor drives a turntable in the cooking chamber of the oven.

[0006] Preferably, the switching means comprises switches and a control means for controlling the operation of the switches. More preferably, the switches include a open/close relay between the primary winding of the high-voltage transformer and a power input terminal and a change-over relay having a first, common terminal coupled to said winding, a second terminal coupled to the one side of said open/close relay and a third terminal coupled to a reduced-voltage current source, and the control means is operable to control the relays such that, during an initial period of current supply to the primary winding of the high-voltage transformer, the open/close relay is open and the first and second terminals of the change-over relay are connected and thereafter the open/close relay is closed and the first and third terminals of the change-over relay are connected. Still more preferably, the reduced voltage current source is a tap on a winding of a further motor. The reduced voltage is a voltage less than the mains voltage required for operation of the oven. Conveniently, the further motor is a ventilation fan driving motor.

[0007] According to the present invention, there is also provided a method of operating a microwave oven according to the present invention, the method comprising making a circuit through the primary winding of the high-voltage transformer and the winding of the motor to initiate current flow through the primary winding of the high-voltage transformer and thereafter introducing a short bypassing the winding of the motor.

[0008] Preferably, a method according to the present invention includes subsequently connecting the winding of the motor to a current source, other than the primary

winding of the high-voltage transformer, for running the motor. The current source is preferably at a voltage less than the mains voltage required for operation of the oven and may be provided by a tap on a winding of another motor.

[0009] An embodiment of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a circuit diagram of a microwave oven according to the present invention; and
Figure 2 is a flow chart illustrating the operation of the controller of the microwave oven of Figure 1.

[0010] Referring to Figure 1, the circuit of a microwave oven comprises a controller 1, a magnetron power supply 2, including a high-voltage transformer 3, and a power routing circuit 4.

[0011] The power routing circuit 4 will now be described. A low-voltage transformer 5 is connected between the live and neutral terminals of a mains plug 6. The controller 1 is powered from the output of the low-voltage transformer 5. The live terminal 6a of the mains plug 6 is also connected to one terminal of a door switch 7 which opens and closes with the door of the oven's cooking chamber. The other terminal of the door switch 7 is connected to one end of the primary winding of the high-voltage transformer 3. The other end of the primary winding of the high-voltage transformer 3 is coupled to one terminal of a first relay 9 which is opened and closed by the controller 1. The other terminal of the first relay 9 is coupled to the neutral terminal 6b of the mains plug 6.

[0012] A cooking chamber lamp 10 is connected between one terminal of a second relay 11, which is operated by the controller 1, and the first terminal of the door switch 7. The other terminal of the second relay 11 is connected to the second terminal of the first relay 9.

[0013] The winding of a turntable motor 12, for driving a turntable in the oven's cooking chamber, is connected between the first terminal of the second relay 11 and a first terminal of a third relay 13 which is also controlled by the controller 1. The third relay 13 is a change-over relay and the first terminal is its common terminal. The second terminal of the third relay 13 is connected to the first terminal of the first relay 9.

[0014] The winding of a ventilation fan motor 14 is connected between the second terminal of the door switch 7 and the first terminal of the second relay 11. The winding of the ventilation fan motor 14 has a tap which is connected to the third terminal of the third relay 13.

[0015] The operation of the circuit in Figure 1 will now be described with reference to Figure 2. It will be assumed in the following that the cooking chamber door, and hence the door switch 7, is closed.

[0016] When a user wishes to cook some food, he places the food in the cooking chamber and sets the

cooking time using the controller 1. At this time, the first and second relays 9, 11 are open and the first and third terminals of the third relay 13 are connected by its moving contact.

[0017] When the user presses a start button, the controller 1 closes the second relay 11 (step s1). This causes the lamp 10 to light up and the turntable and fan motors 12, 14 to start. At this point, the winding of turntable motor 12 is powered from the tap on the winding of the fan motor 14 and no circuit exists between the live and neutral terminals 6a, 6b of the mains plug 6 through the primary winding of the high-voltage transformer 3.

[0018] After closing the second relay 11, the controller 1 enters a loop (step s2) to determine when 50ms has elapsed. When 50ms has elapsed, the controller 1 switches the third relay 13 (step s3) so that its moving contact connects its first and third terminals. This places the winding of the turntable motor 12 between the primary winding of the high-voltage transformer 3 and the neutral terminal 6b of the mains plug 6 thereby creating a circuit between the live and neutral terminals 6a, 6b of the mains plug 6 through the high-voltage transformer 3. Current now begins to flow through the primary winding of the high-voltage transformer 3. However, it is limited to a safe level by the winding of the turntable motor 12.

[0019] After switching the third relay 13, the controller 1 enters a loop (step s4) to determine when 50ms has elapsed. When 50ms has elapsed, the controller 1 closes the first relay 9 (step s5) so that the current through the primary winding of the high-voltage transformer 3 is no longer limited by the winding of the turntable motor 12.

[0020] After switching the first relay 9, the controller 1 enters a loop (step s6) to determine when 50ms has elapsed. When 50ms has elapsed, the controller 1 switches back the third relay 13 (step s7). The delay in switching back the third relay 13 is to ensure that the first relay 9 is closed before the third relay 13 is switched back thereby avoiding momentary isolation of primary winding of the high-voltage transformer 3 from the neutral terminal of the mains plug 6 and the voltage spikes across the high-voltage transformer's secondaries that would result.

[0021] When the cooking time has elapsed, the controller 1 returns the relays 9, 11, 13 to their original conditions.

Claims

1. A microwave oven comprising a high-voltage transformer (3) for driving a microwave generator, current-limiting means (12) and switching means (1, 9, 13) for introducing the current limiting means in series with the primary winding of the transformer (3) for preventing a current surge therethrough when the cooking is started, **characterised in that** the

current-limiting means comprises a winding of a motor (12).

2. A microwave oven according to claim 1, wherein the motor drives (12) a turntable in the cooking chamber of the oven.
3. A microwave oven according to claim 1 or 2, wherein the switching means (1, 9, 13) comprises switches (9, 13) and a control means (1) for controlling the operation of the switches (9, 13).
4. A microwave oven according to claim 3, wherein the switches (9, 13) include a open/close relay (9) between the primary winding of the high-voltage transformer (3) and a power input terminal (6) and a change-over relay (13) having a first, common terminal coupled to said winding, a second terminal coupled to the one side of said open/close relay (9) and a third terminal coupled to a reduced-voltage current source, and the control means (1) is operable to control the relays (9, 11) such that, during an initial period of current supply to primary winding of the high-voltage transformer (3), the open/close relay (9) is open and the first and second terminals of the change-over relay (13) are connected and thereafter the open/close relay (9) is closed and the first and third terminals of the change-over relay (13) are connected.
5. A microwave oven according to claim 4, wherein the reduced voltage current source is a tap on a winding of a further motor (14).
6. A microwave oven according to claim 5, wherein the further motor (14) is a ventilation fan driving motor.
7. A method of operating a microwave oven according to any preceding claim, the method comprising making a circuit through the primary winding of the high-voltage transformer (3) and the winding of the motor (12) to initiate current flow through the primary winding of the high-voltage transformer (3) and thereafter introducing a short (9) bypassing the winding of the motor (12).
8. A method according to claim 7, including subsequently connecting the winding of the motor (12) to a current source (14), other than the primary winding of the high-voltage transformer (3), for running the motor (12).

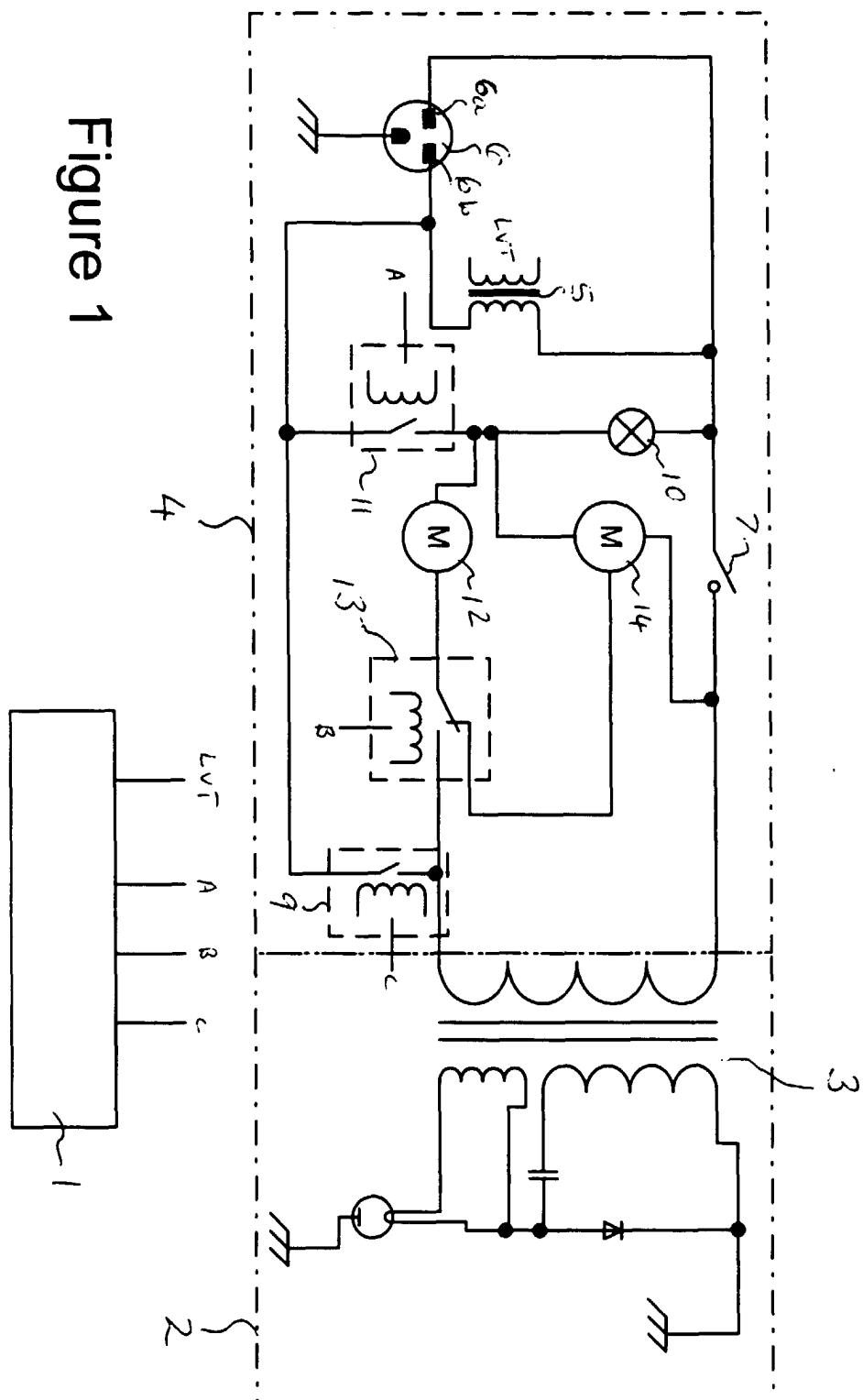


Figure 1

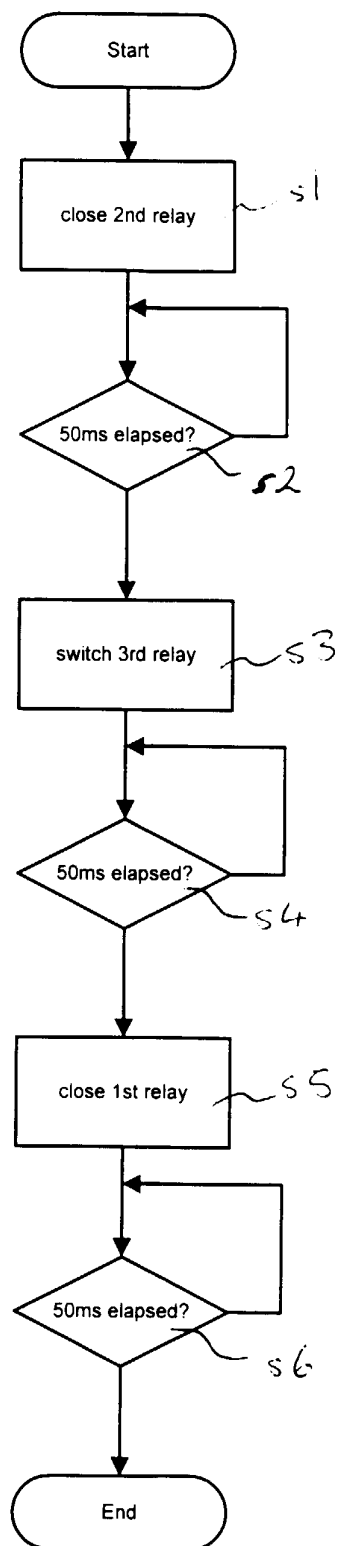


Figure 2