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3,471,939

ELECTRONIC CONTROL CIRCUIT FOR A DRYER
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Filed Oct. 4, 1967, Ser. No. 672,832

Int. Cl. F26b 25/22; G05b 11/28

U.S. Cl. 34—45

6 Claims

ABSTRACT OF THE DISCLOSURE

An electronic control circuit for a clothes dryer. The control circuit utilizes an accumulator or integrator type of timer device which is rendered operative when positive and negative half wave (full wave) cycles are applied to the timer and is rendered inoperative during periods when either the positive and/or negative half cycles are not applied to the timer. The electronic control circuit includes first circuit means connected in series with the timer device to provide a current path through the timer device during one polarity of the alternating current, and a second circuit connected to the timer device to prevent the other polarity of half cycles of the alternating current from passing through the timer device until a predetermined condition of the dryer is sensed or during the existence of a predetermined condition. The accumulator or integrator type of timer device can be, for example; a timer motor, a heater actuated bimetallic switch or a simple integrating switching circuit.

BACKGROUND OF THE INVENTION

Field of the invention

This invention relates generally to a control system for an appliance and more particularly to a control system which has particular utility when used with a clothes dryer of the type having a treatment zone wherein is provided sensing means for sensing the relative wetness of the clothes being tumbled within the treatment zone.

Description of the prior art

Heretofore, clothes dryers and other appliances have been provided with means for sensing the relative dryness of material placed within the appliance, and upon sensing a preselected degree of dryness to actuate a relay circuit which, in turn, will function to terminate the sequence or operation of the appliance. Such a control circuit would utilize a large value capacitance in electrical parallel with a dryness sensing element which is positioned within the treatment zone of a dryer. The capacitance charges to a value proportional to the electrical resistance exhibited by the clothes bridging the sensing element. Since the dryer will be terminated when the capacitor attains a voltage of approximately 70 volts, it must be insured that the capacitor will effectively integrate the random signals generated by the moisture sensor. Thus, it is necessary to utilize a large value capacitor, as for example, four microfarads or more. Also, due to the long time constants involved, the insulation resistance of the capacitor must be very high, on the order of 25×10^{-10} ohms/mfd. By so utilizing such a large and high quality capacitor, the cost and size of the control circuit is increased.

Furthermore, the control function is initiated only after

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the large value capacitor has charged to the predetermined voltage. Accordingly, the timer motor, which is actuated after the charging capacitor has reached its predetermined value, is required to have a relatively long timing cycle or running time. Therefore, appliance control circuits of the prior art are generally larger and relatively expensive in view of the large size and high quality of components required for proper operation of the control circuit.

SUMMARY OF THE INVENTION

In accordance with this invention, an improved control circuit utilizes a unique circuit arrangement which allows a relatively small capacitor to be used as a charging capacitor for sensing the relative moisture retention of material being dried by the appliance. More specifically, the present invention utilizes an integrating device, such as a timer or bimetal switching device, in conjunction with an electronic switching circuit to integrate the more or less random signals generated by a sensing device within the appliance. The novel circuit arrangement, although relatively simple, is unique in that it requires no large or expensive components in the RC of timing circuit heretofore required in electronic control circuits of the prior art.

It is, therefore, an object of the present invention to provide a simplified control circuit arrangement which requires a small value charging capacitor for proper operation of the control circuit.

Another object of the present invention is to provide a simple and inexpensive control circuit for an appliance which control circuit provides consistent results time after time.

Still another object of the present invention is to provide an electronic control circuit which utilizes solid state components to operate a simple and inexpensive accumulator for integrating timing device which, in turn, controls the termination of a sequence or operation of the appliance.

The control circuit of the present invention can be used to control the sequence of operation of any appliance wherein a predetermined condition is sensed and a sequential operation of one or more controls is required upon termination of the existence of the predetermined condition. However, the control circuit of the present invention has a particular utility when used in conjunction with a clothes dryer and will be described in conjunction therewith.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a schematic diagram of the timer control circuit of the present invention;

FIGURE 2 is a graph showing the current wave form of the current passing through the timer device of FIGURE 1 when the timer device is disabled;

FIGURE 3 is a graph showing the current wave form of the current passing through the timer device of FIGURE 1 when the timer is energized;

FIGURE 4 is a front elevational view of a control dial which is used to select the sequence of operation of the dryer;

FIGURE 5 is a simplified schematic diagram of the complete control circuitry of a dryer and incorporating the timing circuit of the present invention; and

FIGURE 6 illustrates an electrically operated bimetal switching device which can be incorporated in the timing circuit of FIGURES 1 and 5 to provide the necessary integrating function of the timing circuit.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Although the control circuit of the present invention is of utility in any dryer construction, a particularly useful application is made to dryers for fabrics and the like, an illustrative embodiment of which is described in U.S. Patent No. 3,409,997, issued Nov. 12, 1968, and assigned to Whirlpool Corporation, assignee of the present invention.

Seen in FIGURE 1 is a timing control circuit 60 constructed in accordance with the principles of this invention. The timing control circuit 60 includes a pair of terminals 61 and 62 for connection to a source of alternating current.

A diode 63 is connected in parallel with a resistor 64 to form a circuit network 66. The circuit network 66 functions to allow current to flow through a low resistance path through a timer motor 67 during one polarity of the applied positive and negative cycles and to provide a high resistance path through the timer motor 67 during the other polarity of the positive and negative cycles. The timer motor 67 is of the type which operates or advances only when energized by both positive and negative cycles of the applied voltage. Therefore, during periods of energization from one or the other of the positive and negative cycles, the timer motor will not be sufficiently energized to advance its position.

Connected in parallel with the timer motor 67 is a silicon controlled rectifier 68 which is connected in opposite conductive polarity with respect to the diode 63. A stabilizing resistor 69 is connected between the gate electrode and cathode electrode of the silicon controlled rectifier 68 to main the gate current and voltage through the silicon controlled rectifier within the specified rating of the device and prevent false triggering thereof. Also connected to the gate electrode of the silicon controlled rectifier 68 is one end of a neon lamp 70 which has the other end thereof connected to a current limiting resistor 71.

The other end of the current limiting resistor 71 is connected to a resistor 72 and to one electrode of a sensor assembly 54. Sensor assembly 54 comprises two electrically isolated electrodes positioned within the treatment chamber of a clothes dryer as described in U.S. application Ser. No. 548,678, filed May 9, 1966, now Patent No. 3,391,468 and assigned to Whirlpool Corporation, assignee of the present invention. The electrodes function to monitor the moisture present in the clothing as it falls against them thereby bridging the gap from one electrode to the other. If clothing is relatively damp, a low resistance will be sensed between the electrodes whereas dry clothing will effect a high resistance electrical bridge. The resistor 72 functions to reduce the effective sensitivity of the sensor assembly. It is noted that resistor 72 may be of a variable type, thereby enabling the machine operator to control end moisture retention of the clothing by varying the value of resistor 72.

In accordance with the present invention, a low value capacitor 73 has one end thereof connected to a line 74 and the other end thereof connected to the junction between the sensor assembly 54 and the current limiting resistor 71. By utilizing the novel circuit arrangement of the present invention, the capacitor 73 is connected in series with the sensor assembly 54 rather than in parallel therewith. By way of example, and not by way of limitation, the value of capacitor 73 is less than 1 microfarad and preferably .00047 microfarad.

Seen in FIGURE 2 is a graphic representation of positive half cycles 76 of the alternating current passing through the timer motor 67. A negative going portion 78a represents a small amount of current flow passing through the motor due to the inability to switch silicon controlled rectifier 68 into conduction until capacitor 73 has acquired sufficient charge to ionize neon lamp 70

and gate it on. Therefore, when the silicon controlled rectifier 68 is rendered conductive, negative cycles of the applied alternating current voltage will bypass the timer motor 67 thereby causing the timer motor to be partially energized and remain inoperative.

Seen in FIGURE 3 is a graphical representation of a full wave 77 of the alternating current voltage applied to the timer motor 67. When the silicon controlled rectifier 68 is no longer rendered conductive, the current passing through the diode 63, during positive half cycles, will pass through the motor 67 and the current of the negative half cycles will pass through the motor 67 and through the resistor 64 to completely energize the timer motor and render the timer motor operative.

In operation, if wet clothing bridges the electrodes of sensor assembly 54, current will flow through the bridged sensor assembly 54 and charge capacitor 73 to a voltage level of approximately 60 volts in one millisecond or less, which is indicated as the time between t2 and t3 in FIGURE 2. This voltage across the capacitor 73 will now ionize the neon lamp 70 which, in turn, renders the silicon controlled rectifier 68 conductive. This action shunts the negative cycle of the applied alternating current around timer motor 67 and thereby maintains the timer motor 67 in a stalled condition. As the clothes within the dryer drum become less wet, capacitor 73 will no longer charge to a level sufficient to ionize neon lamp 70 thereby maintaining the silicon controlled rectifier 68 in a non-conductive state. This action allows both negative and positive half wave cycles of the applied alternating current voltage to pass through the timer motor and advance timer cams, not shown, to actuate corresponding switches. Therefore, the timer motor 67 in conjunction with the control circuit 60 of the present invention functions as an accumulative or integrator type timing circuit.

Accordingly, a clothes dryer equipped with the timing control circuit of the present invention is provided with a simple and easy to operate control dial 80, as seen in FIGURE 4, to select the desired amount of run-out time of the timer motor 67. The control dial 80 includes indicia near the outer periphery thereof to provide quick visual indication of the desired setting. In utilizing the timer control circuit of the present invention, the control dial 80 need not be calculated in minutes, as is the common practice in the prior art. The timer control circuit of the present invention operates as a function of the dryness of the clothes within the drum of the dryer. Therefore, should the control dial 80 be set, as for example, to the regular dry position 80a, each load of clothes dried by the dryer will be dried to the same extent regardless of the type of clothes or the amount of water in the clothes when they are placed in the dryer.

For a better understanding of the timer control circuit of the present invention when used in conjunction with a clothes dryer, reference is now made to FIGURE 5. The terminal 61 of the control circuit 60 is connected to a normally closed stationary contact 81 of a door switch 82. The door switch functions as a safety device to insure that the dryer access door, not shown, is closed before the dryer operation is initiated and to terminate the dryer operation should the door be opened during the drying operation. A normally open stationary contact 83 is connected to the line L1 and functions to energize the lights 84 when the door is open.

The terminal 62 of the control circuit 60 is connected in circuit with a movable contactor 86 of a centrifugal switch operated by the dryer drive motor 33. The drive motor 33 includes a run winding 88 and a start winding 89 which are connected together at one end thereof and to a lead 90 which, in turn, is connected to the stationary contact 81 of the door switch 82. Therefore, the drive motor 33 will not be energized until the door switch 82 is in the closed position, as shown in FIGURE 5.

To initiate the operation of the control circuit of FIG-

FIGURE 5, a push-to-start switch 91, which is connected between the motor 33 and the neutral line N, is actuated. This causes the motor 33 to be energized and actuate the centrifugal switch 86 as run speed is approached, thereby opening the current path through the start winding 89 and completing a current path for the run winding 88 through the centrifugal switch 86 and a line 85 connected to the neutral line N.

A timer switch T_1 is connected between the line L_1 and a circuit point 92, the timer switch T_1 must be in the closed position, indicating that a predetermined degree of dryness has been selected by the control dial 80, before the push-to-start switch 91 will be effective in initiating the operation of the control circuit.

A second timer switch T_2 is connected to the line L_1 and in series with a heater element 93 which, in turn, is connected in series with a centrifugal switch 94. It is understood that element 93 could be replaced by a burner control system in the event the dryer was of the gas fuel type. The centrifugal switch 94 is also operated by the drive motor 33 to insure that the drying drum is rotating and tumbling the clothes within the drum before heat is applied thereto. The stationary contact 95 of the centrifugal switch 94 is connected to a line L_2 . Therefore, the control circuit, connected between lines L_1 and N is energized by a 115 volt alternating current voltage while the heater element 93 connected between lines L_1 and L_2 is energized by a 230 volt alternating current voltage.

In operation, the user of the dryer may set the timer dial 80 to the very dry position 80b. This action will close the timer contacts T_1 and T_2 . Next, the user will depress the push-to-start switch 91 which action will energize the dryer motor 33. As the motor reaches a predetermined speed the centrifugal switches 86 and 94 will be actuated thereby connecting the electronic control timer circuit 60 to the neutral line N, and connect the heater element 93 to the line L_2 .

As the clothing within the drum begins to dry, the timer motor 67 will be advanced in accordance with the charge developed across the capacitor 73. As the control dial 80 was initially set to the very dry position 80b, approximately thirty minutes of total run-out time will have to be accumulated before the control circuit of FIGURE 5 reaches the cool down cycle. At the end of the drying cycle, timer contact T_2 will open to deenergize the heater element 93. After approximately five minutes of additional run-out time of the timer motor 67 the timer contact T_1 will open to terminate the complete drying cycle. Therefore, the five minutes additional run-out time of the timer motor 67 provides sufficient cool down of the interior of the drying drum before the clothes therein stop tumbling.

Seen in FIGURE 6 is an alternate integrating device which can be used in place of the timer motor 67. A pair of contactors 96 and 97 are provided to energize a conventional timing device during periods when the contacts 96 and 97 are closed. The contactor 97 is a bimetal element which is wrapped by a heater core 98. Therefore, full wave alternating current voltage applied to the heater core is sufficient to cause the heat generated thereby to close the contacts 96 and 97. On the other hand, half wave pulses of alternating current voltage are not sufficient to heat the bimetal element of the contact 97 and the contacts 96 and 97 will remain open. Therefore, it can be seen that any integrating device can be operated from the novel timer control circuit of the present invention.

Although minor modifications may be suggested by those versed in the art, it should be understood that I wish to embody within the scope of the patent warranted hereon all such modifications as reasonably come within the scope of my contribution to the art.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A control circuit for an appliance comprising: first and second terminals for connection to a source of alternating current, a diode, a resistor connected in parallel with said diode to form a circuit network, energizable means connected in series with said network and their junction comprising a circuit point, said network and said energizable means being connected across said first and second terminals, switch means connected in shunt relation with said energizable means and in series with said network, said switch means includes, a silicon controlled rectifier having anode, cathode and gate electrodes, said anode being connected to one side of said energizable means, said cathode being connected to the other side of said energizable means at said circuit point, sensor means connected to said switch means and responsive to a predetermined condition of the appliance, whereby one polarity of half cycles from said source of alternating current voltage pass through said diode to partially energize said energizable means and the other polarity of half cycles from said source of alternating current voltage passes through said switch means and said resistor of said network thereby shunting the current path of said energizable means when said predetermined condition is present, a discharge device connected between said sensor means and the gate electrode of said silicon controlled rectifier, and a capacitor having one end thereof connected to said sensor means and said discharge device and the other end thereof connected to said circuit point, said capacitor being charged in response to said sensor means to render said silicon controlled rectifier conductive during periods of said other polarity when said predetermined condition is present.

2. In a clothes dryer including a rotatable drum for receiving clothes to be dried, a motor coupled to said drum for rotating said drum, said motor adapted for connection to a source of positive and negative half cycles of alternating current, means for heating the interior of said drum, sensing means positioned within said interior of said drum for sensing the relative dryness of the clothes within the drum, the improvement therein comprising, timer means for operation from the source of positive and negative half cycles of alternating current voltage, said timer means including contactor means for controlling the operation of said motor and said heating means, first circuit means in series with said timer means to provide a current path through said first means and said timer means during one polarity of said positive and negative half cycles, said first circuit means including a diode and a resistor connected in parallel to provide a low resistance current path through said timer means during one polarity of said positive and negative half cycles and to provide a higher resistance current path through said timer means during the other polarity of said positive and negative half cycles, and said second circuit means connected in circuit with said timer means and said first circuit means to provide a shunt current path bypassing said timer means during the other polarity of said positive and negative half cycles during one time interval and allowing current to flow through said timer means during said other polarity of said positive and negative half cycles during another time interval, said second circuit means including switch means having anode, cathode and gate electrodes, said anode being connected to one side of said timer means, said cathode being connected to the other side of said timer means, a discharge device having one end thereof connected to said gate electrode, a capacitor having one end thereof connected to said discharge device and the other end thereof connected to said cathode, whereby, said capacitor is charged in response to said sensing means within said drum to render said switch means conductive during periods of said other polarity of said positive and negative half cycles until the clothes within said drum reach a predetermined dryness.

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3. A control circuit for an appliance according to claim 1 wherein said energizable means is a timer motor.

4. A control circuit for an appliance according to claim 1 wherein the value of said capacitor is less than 1 microfarad.

5. A control circuit for an appliance according to claim 1 wherein said energizable means is an operator of a bimetallic switch.

6. A clothes dryer according to claim 2 wherein the value of capacitance of said capacitor is less than 1 microfarad.

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U.S. Cl. X.R.

318—227, 230, 483