ABSTRACT OF THE DISCLOSURE

An electronic fabric dryer control circuit including a pair of spaced-apart electrodes positioned to contact the fabric being dried for sensing the presence of moist spots therein. A gas tube is connected in a series circuit with these electrodes across a voltage source such that this gas tube is ignited whenever wet fabric bridges the electrodes. The ignited gas tube maintains a timing capacitor in a substantially fully discharged condition. As the fabric dries and the resistance across the electrodes increases, ignition of the gas tube is terminated and the timing capacitor charges at a substantially constant rate toward a voltage level capable of terminating dryer operation. During the timing cycle, subsequent contact with any wet spot causes the gas tube to again ignite and again fully discharge the timing capacitor to its initial condition.

This invention relates generally to dryer control systems and more particularly to a new and improved electronic dryer control circuit operable to automatically control the termination of a machine drying operation after the fabrics therein have been dried to a predetermined extent.

It is known to regulate the drying period for clothes and other fabrics within a dryer in several different ways. Conventionally, the drying period has been regulated manually by the user through a selectively adjustable timer to terminate the drying operation after the preset drying time has elapsed.

The skilled in the art appreciate that this approach is not fully satisfactory or consistent since the results vary greatly dependent upon the degree of dampness and type of fabrics involved.

Several types of dryer controls have been suggested which sense the moisture in the fabrics, rather than being dependent upon a preset time period for determining the drying interval. Such systems generally have electrodes in contact with the fabrics to sense their electrical resistance, which is a function of moisture. In some prior systems, the drying operation is terminated at the moment a desired degree of resistance, sufficient to interrupt the current flow through a relay or the like, is sensed. Such systems have the disadvantage of frequently causing the dryer to be turned off prematurely since the sensing of any dry area will result in immediate termination of the drying process.

In another type of prior art dryer control system, the electrodes contacting the fabrics partially discharge the capacitor of an R-C network whenever a sufficiently moist fabric area is sensed. When the fabrics have dried sufficiently, the capacitor charges at a faster rate than it can be discharged by the electrodes, and when the capacitor charge reaches a predetermined value, a switch is operated to terminate the drying operation. As such, it is the difference between the charging rate of the capacitor and the discharge rate through the moist fabrics that determines the stopping point for the drying operation. This type of system also raises problems since the point at which the charging rate exceeds the discharge rate is reached after the capacitor voltage is very close to the firing point of the termination initiating switch. Accordingly, the drying operation may be terminated prematurely and before the fabrics have achieved the desired degree of dryness.

Summary of the invention

It is a general object of this invention to provide a new and improved drying control circuit which overcomes the above-described problems of the prior art systems.

It is a more particular object of this invention to provide a novel drying control circuit operative to sense the absolute value of the damp area of the fabrics and reset the timing cycle to its starting point each time a damp spot is sensed by the electrodes, thereby providing the additional drying time required for hard-to-dry loads to obtain a satisfactory dryness upon termination of the drying operation.

It is another object of this invention to provide a new and highly advantageous drying control circuit comprising an electronic timer circuit which includes a charged capacitor that is substantially fully discharged whenever the sensing electrodes contact damp fabrics, thereby causing the dryer operation to continue for the full time delay period following the sensing of a damp spot in the fabric.

It is still another object of this invention to provide a unique drying control circuit, as set forth above, which is characterized by its flexibility of efficient drying operation to a desired degree of dryness with all types of fabric materials and loads.

The novel features which are characteristic of the invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following description taken in conjunction with the accompanying drawing.

Brief description of the drawing

The sole figure of the drawing is an electrical schematic diagram of one illustrative embodiment of drying control circuit incorporating the novel features of the present invention.

Description of the preferred embodiment

Referring now to the drawing, it can be seen that for purposes of illustration and explanation the electronic dryness control circuit has been separated functionally by the dashed lines into four separate circuit portions. The circuit portion A schematically depicts the power circuit of the invention, the circuit portion B schematically depicts the charging circuit of the invention, the circuit portion C schematically depicts the moisture sensing circuit of the invention, and the circuit portion D schematically depicts the electrostatic discharge circuit of the invention. While this illustrative embodiment of the invention advantageously may comprise all of these four circuit portions to provide a representative overall drying control circuit, the invention will be described hereinbelow with respect to each of the separate circuit portions so that an understanding of the invention and its operation will be facilitated.

The power circuit portion A of the invention advantageously comprises a pair of power conductors 10 and 12 which are adapted to be connected to a suitable power source, such as a source of 60-cycle, A.C. voltage. The power conductor 10 is connected to one side of the primary winding 14 of the transformer T while the other power conductor 12 is connected to the switch contact 16 of the push-button switch 22 and the relay contact R2a, adapted to be actuated by the relay coil R2 as described hereinbelow. The stationary relay contact of relay R2a is connected to the other side of the trans-
former primary winding 14. A gaseous lamp, such as the neon lamp 28, and a resistance 30, are connected across the primary winding 14 of the transformer T.

The secondary winding 16 of transformer T is connected to a rectifying filter circuit comprised of the rectifying diode 46, the resistance 48 and the filter capacitor 50. In accordance with well understood principles, the A.C. voltage input to the transformer T is rectified and filtered such that a suitable D.C. voltage is provided to the remainder of the circuit across the filter capacitor 50.

The contact 20 of the push-button 22 is connected to one of a pair of normally closed relay contacts R1a, the other contacts being connected to the coil of relay R2. The other side of relay coil R2 is connected to the power terminal 36 which is adapted to be returned to one side of the A.C. voltage source. In addition, the A.C. voltage source is adapted to be connected to the terminals 38 and 40 which, in turn, are connected across a circuit comprised of the normally open contacts R2b of the relay R2 and a burner or heating element 32. It will be appreciated by those skilled in the art that the novel electrical dryness control of the present invention may be used with advantage in either gas or electric dryers. As such, the element 32 may take the form of a gas burner when the dryness control is utilized with a gas dryer or the form of an electrical heating element when the inventive dryness control is used in an electric dryer.

Further, the A.C. voltage source is adapted to be connected to the power terminals 42 and 44 which, in turn, are connected to a circuit comprised of the relay contact R2c and the blower and drum motor 34 of the dryer.

Advantageously, the power circuit portion of the invention may include suitable means to regulate the D.C. voltage across the leads 96 and 98. In the illustrative embodiment of the invention shown in the drawing, the voltage regulator is shown as being comprised of a pair of series connected neon lamps 92 and 94 connected between the leads 96 and 98.

The charging circuit portion B of the invention now will be described. A voltage divider comprised of the resistance 54 of a potentiometer 52, the resistance 58 and the resistance 60, all in series, is connected across the D.C. power leads 96 and 98 so as to receive the D.C. voltage present across the filter capacitor 50. The wiper contact 56 of the potentiometer 52 is connected to one side of a variable resistance 64. The variable resistance 64 may take the form of either a multi-position switch or a continuously variable resistance. The side of the variable resistance 64, identified as point 66, is connected to a circuit comprised of the charging capacitor 68 connected in parallel with the series connected relay coil R1 and the neon lamp 70, the capacitor 68 and the neon lamp 70 being returned to the point 62 at the junction of the voltage divider resistances 58 and 60.

The moisture sensing circuit of the present invention, portion C, advantageously comprises a diode 76, having its anode connected to point 66 in the charging circuit in its cathode connected to point 82 at the junction of a diode 80 and a resistance 88. The anode of the diode 80 is connected through a resistance 78 to the fabric sensing electrode 74 and as shown, the other fabric sensing electrode 72 is spaced from the electrode 74 and is connected to the D.C. voltage lead 96. Also, the junction point 82 of the diodes 76 and 80 is connected through a resistor 84 to a neon lamp 86 which, in turn, is returned to the D.C. voltage lead 98.

The electrostatic discharge circuit D portion of the invention is shown as comprising a bleed resistance 88 which has one side thereof connected to the junction of the fabric sensing electrode 74 and the resistance 78, and which has the other side connected to the D.C. voltage lead 98. Now that the complete constructional details of this illustrative embodiment of the invention have been explained, this disclosure will now be completed by a description of the novel operation of the present invention.

The electrical drying operation is initiated by depression of the push-button 22 so as to complete a circuit between the A.C. power leads to energize the coil of relay R2. Such energization of the relay coil R2 energizes the relay contact blades R2a, R2b, and R2c to complete their respective electrical circuits. As such, the closing of the relay contact R2a serves to hold the relay coil R2 energized, and also to cause power to be supplied to the transformer T for energizing the dryness control circuit. The closing of the relay contact blade R2b energizes the A.C. voltage to be supplied to the burner or heating element 32 of the dryer, while the closing of the relay contact blade R2c causes A.C. power to be supplied to the blower and drum motor of the dryer.

The rectified D.C. voltage present on the D.C. power leads 96 and 98 is applied across the voltage divider comprised of the potentiometer resistance 54 and the resistances 58 and 60 connected in series therewith. That portion of the D.C. voltage which appears between the potentiometer wiper 56 and 62 at the junction of resistances 58 and 60 serves to cause charging of the series connected capacitor 68 through the variable resistance 64. In accordance with the construction of this illustrative embodiment of the invention, potentiometer 52 may be a factory adjustment while the variable resistance 64 is adjusted to be adjusted by the user so that the time constant of the capacitor charging circuit can be selectively set for the degree of dryness desired for the fabrics within the clothes dryer. Advantageously, the charging circuit resistance 64 may take the form of a multi-position switch or a continuously adjustable rheostat in which the dial associated with the resistance selecting switch can be marked with suitable indicia indicating various degrees of dryness.

If, at any time during the charging cycle, the voltage at point 66 reaches the firing voltage of the neon lamp 70, the lamp will ignite and permit the charging capacitor 68 to discharge in the path including the ignited neon lamp 70 and the coil of relay R1. This serves to energize the relay coil R1 and to open its contacts R1a so as to open the power holding circuit and turn off the dryer so as to terminate the drying operation.

In accordance with a novel feature of the present invention, if the fabrics in the dryer, which are being tumbled and placed into contact with the sensing electrodes 72 and 74, pass in or out of the fabric sensing electrodes 72 and 74, then the circuit will cause the charging capacitors to conduct and to discharge during the charging cycle, the neon lamp 86 in series therewith will ignite and break down. This enables the charging capacitors 68 to discharge through the path including the diode 76, the resistance 84, the ignited neon lamp 86 and the resistance 60. The neon lamp 86 stays ignited to discharge condenser 68 until point 82 of the circuit is reduced to a relatively low voltage sufficient to turn off the conducting neon lamp 86. During this time, substantially the entire charge on condenser 68 will be discharged such that the timing circuit is once again placed in its initial starting condition. Accordingly, the timing circuit is then free to recharge the capacitor 68 until such time as the current voltage of neon lamp 70 is reached or until the presence of damp fabrics again causes the sensing electrodes to conduct and the charging capacitor 68 to be discharged through the neon lamp 86.

Those skilled in the art now will appreciate that the novel circuit of the present invention provides for the sensing of the absolute value of the wet spots in the fabric rather than taking an average value of the load. Any wet spots sensed by the electrodes at any time during the timing cycle causes the charging capacitor 68 to be discharged almost fully to reset the timer to its starting condition. This highly advantageous feature serves to provide the
novel dryness control circuit with an additional time period, such as 10 to 15 minutes, which is highly desirable to permit hard-to-dry loads to obtain a satisfactory dryness upon termination of the drying operation.

The resistance 88 connected in series with the sensing electrodes 72 and 74, and in parallel with the circuit comprising resistance 78, diode 86, resistance 84, and neon lamp 86, serves to permit electrostatic charges which may accumulate on the sensing electrodes to be bleed off or discharged. It will be clear to those skilled in the art that this serves to prevent undesirable conduction between the sensing electrodes in the absence of contact with wet fabrics.

While there has been shown and described a specific embodiment of the present invention, it will, of course, be understood that various modifications and alternative constructions may be made without departing from the true spirit and scope of the invention. Therefore, it is intended by the appended claims to cover all such modifications and alternative constructions as fall within their true spirit and scope.

What is claimed as the invention is:

1. In apparatus for drying fabrics, the improvement of an electrical drying control circuit comprising the combination of a source of electrical power, a pair of spaced-apart electrodes connected in circuit with said source of electrical power and adapted to be placed in contact with the fabrics for sensing the presence of moist spots therein, a timer circuit connected to said electrodes and said source of power for controlling the drying time in response to the moisture condition of the fabrics, said timer circuit comprising a charging capacitor and a resistance, means for presenting the timer circuit for enabling the capacitor to be charged to a desired value corresponding to the degree of dryness desired for said fabrics, means for substantially fully discharging said charging capacitor whenever said electrodes contact a damp spot in said fabrics to place the timer circuit in its starting condition for another complete charging time period, and means for terminating the drying operation if said charging capacitor within a single time period charges up to the preset value corresponding to the degree of dryness desired for said fabrics.

2. The improvement of an electrical drying control circuit in accordance with claim 1 further comprising bleed means connected in circuit with said spaced-apart electrodes for discharging electrostatic charges accumulating thereon.

3. In apparatus for drying fabrics, the improvement of an electrical drying control circuit comprising the combination of a source of electrical power, a pair of spaced-apart electrodes connected in circuit with said source of electrical power and adapted to be placed in contact with the fabrics for sensing the presence of moist spots therein, a timer circuit connected to said electrodes and said source of power for controlling the drying period in response to the moisture condition of the fabrics, said timer circuit comprising a charging capacitor, a first gas tube connected across said charging capacitor and adapted to be closed when the capacitor is charged to a preset value corresponding to a desired drying period, a second gas tube, a first diode circuit connected to said second gas tube across said charging capacitor, a further diode circuit connected to said second gas tube in series with said pair of electrodes, said second gas tube being adapted to be closed and to discharge said charging capacitor whenever said electrodes contact a moist spot in said fabrics.

4. In apparatus for drying fabrics, the improvement of an electrical drying control circuit comprising the combination of a source of electrical power, a pair of spaced-apart electrodes connected in circuit with said source of electrical power and adapted to be placed in contact with the fabrics for sensing the presence of moist spots therein, a timer circuit connected to said electrodes and said source of power for controlling the drying period in response to the moisture condition of the fabrics, said timer circuit comprising a charging capacitor, resistance means connected in series with said charging capacitor, and a second variable resistance member for enabling the timer circuit to be preset to a desired value corresponding to the degree of dryness desired for said fabrics, a first gas tube connected across said charging capacitor and adapted to be closed when the capacitor is charged to a preset value corresponding to a desired drying period, a second gas tube, a first diode circuit connected to said second gas tube across said charging capacitor, a further diode circuit connecting said second gas tube in series with said pair of electrodes, said second gas tube being adapted to be closed and to discharge said charging capacitor whenever said electrodes contact a moist spot in said fabrics.

5. In apparatus for drying fabrics, the improvement of an electrical drying control circuit comprising the combination of a source of electrical power, a pair of spaced-apart electrodes connected in circuit with said source of electrical power and adapted to be placed in contact with the fabrics for sensing the presence of moist spots therein, a timer circuit connected to said electrodes and said source of power for controlling the drying period in response to the moisture condition of the fabrics, said timer circuit comprising a charging capacitor, resistance means connected in series with said charging capacitor, a first normally open electronic switch means connected across said charging capacitor, and a further normally open electronic switch means being adapted to be closed and to discharge said charging capacitor whenever said electrodes contact a moist spot in said fabrics.

6. In apparatus for drying fabrics, the improvement of an electrical drying control circuit comprising the combination of a source of electrical power, a pair of spaced-apart electrodes connected in circuit with said source of electrical power and adapted to be placed in contact with the fabrics for sensing the presence of moist spots therein, a timer circuit connected to said electrodes and said source of power for controlling the drying period in response to the moisture condition of the fabrics, said timer circuit comprising a charging capacitor, a first normally open electronic switch means connected across said charging capacitor, and said source of power for controlling the drying period in response to the moisture condition of the fabrics, said timer circuit comprising a charging capacitor, a resistance means connected in series with said charging capacitor, a first normally open electronic switch means connected across said charging capacitor, and a further normally open electronic switch means in series with said pair of electrodes, said second electronic switch means being adapted to be closed and to discharge said charging capacitor whenever said electrodes contact a moist spot in said fabrics.

7. In apparatus for drying fabrics, the improvement of an electrical drying control circuit comprising the combination of a source of electrical power, a pair of spaced-apart electrodes connected in circuit with said source of electrical power and adapted to be placed in contact with the fabrics for sensing the presence of moist spots therein, a timer circuit connected to said electrodes and said source of power for controlling the drying period in response to the moisture condition of the fabrics, said timer circuit comprising a charging capacitor, resistance means connected in series with said charging capacitor, and said source of power for controlling the drying period in response to the moisture condition of the fabrics, said timer circuit comprising a charging capacitor, resistance means including a selectively variable re-
3,324,568

7. Resistance member for enabling the timer circuit to be preset to a desired value corresponding to the degree of dryness desired for said fabrics, a first normally open electronic switch means connected across said charging capacitor and adapted to be closed when the capacitor is charged to the preset value to cause termination of the drying period, second normally open electronic switch means, a unidirectional current flow circuit connecting said second normally open electronic switch means across said charging capacitor, and a further unidirectional current flow circuit connecting said second normally open electronic switch means in series with said pair of electrodes, said second electronic switch means being adapted to be closed for discharging said charging capacitor whenever said electrodes contact a moist spot in said fabrics.

8. In apparatus for drying fabrics, the improvement of an electrical drying control circuit comprising the combination of a source of electrical power, a pair of spaced-apart electrodes connected in circuit with said source of electrical power and adapted to be placed into contact with the fabrics for sensing the presence of moist spots therein, a timer circuit connected to said electrodes and said source of power for controlling the drying period in response to the moisture condition of the fabrics, said timer circuit comprising a charging capacitor, resistance means connected in series with said charging capacitor, said resistance means including a selectively variable resistance member for enabling the timer circuit to be preset to a desired value corresponding to the degree of dryness desired for said fabrics, a first normally open electronic switch means connected across said charging capacitor and adapted to be closed when the capacitor is charged to the preset value to cause termination of the drying period, second normally open electronic switch means, a unidirectional current flow circuit connecting said second normally open electronic switch means across said charging capacitor, a further unidirectional current flow circuit connecting said second normally open electronic switch means in series with said pair of electrodes, said second electronic switch means being adapted to be closed for discharging said charging capacitor whenever said electrodes contact a moist spot in said fabrics, and resistance means connected between said electrodes and said source of power for enabling the static charges which build up on said electrodes to be dissipated.

9. In a fabric dryer of the type including a pair of spaced-apart electrodes positioned to contact said fabric, the instantaneous impedance presented by the current path between said electrodes through the contacting fabric being inversely related to the moisture content of said fabric, an improved control arrangement comprising, in combination, a timing device adapted to change from an initial condition to a final condition in a predetermined period of time, means connected to said electrodes for completely resetting said timing device to said initial condition each time said instantaneous impedance falls below a predetermined value, and means responsive to said timing device for terminating the operation of said dryer whenever said timing device is allowed to reach said final condition.

10. The improvement as set forth in claim 9 wherein said timing device comprises a capacitor, a resistor circuit for varying the charge on said capacitor from an initial charge magnitude to a final charge magnitude in said predetermined period of time, and wherein said means for resetting said timing device comprises a second circuit connected to said capacitor for reestablishing said initial charge magnitude across said capacitor each time said instantaneous impedance falls below said predetermined value.

11. The improvement as set forth in claim 10 wherein said means for terminating the operation of said dryer comprises means connected to said capacitor for de-energizing said dryer in response to the establishment of said final charge condition across said capacitor.

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FREDERICK L. MATTESON, Jr., Primary Examiner.
JOHN J. CAMBY, Examiner.