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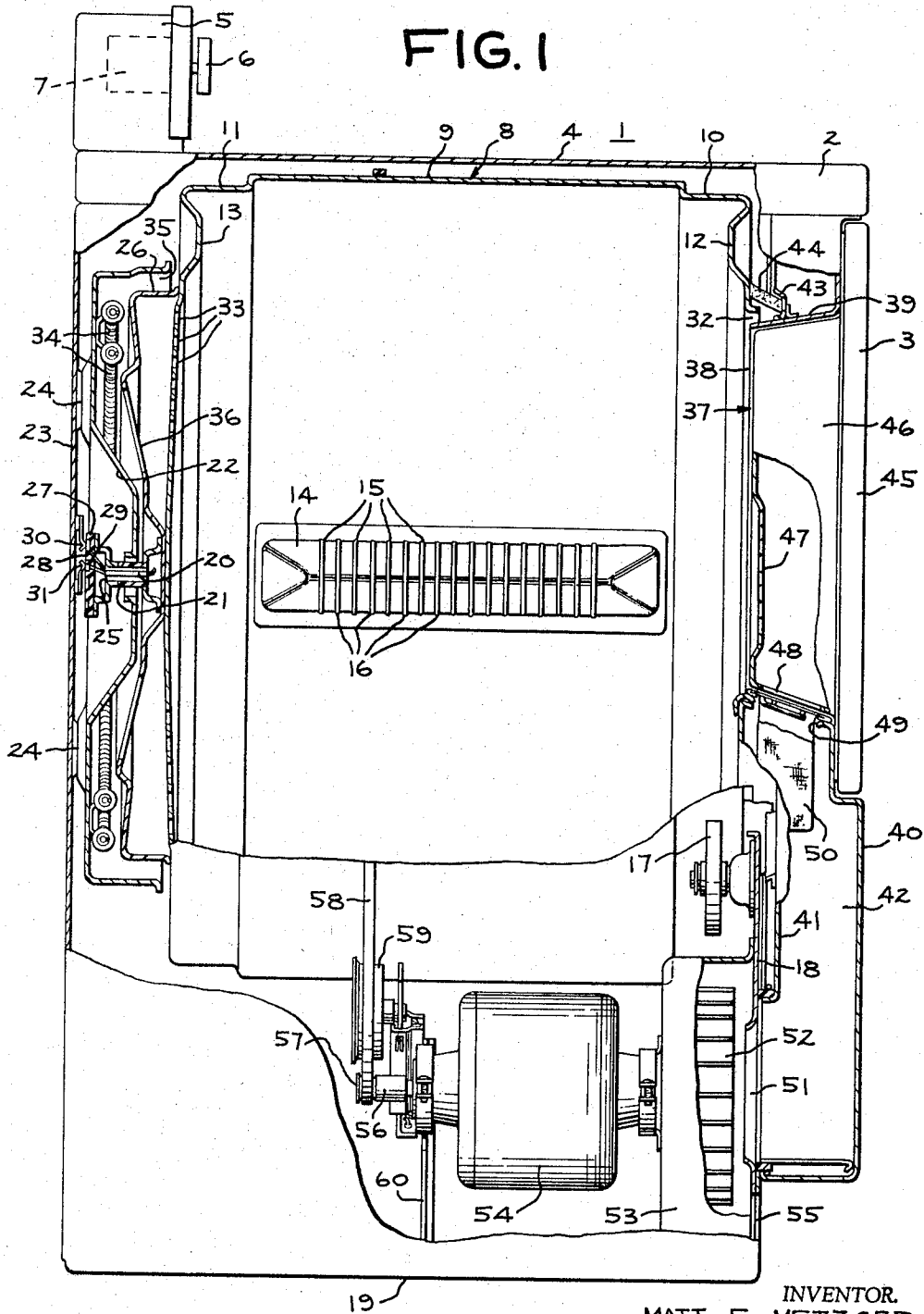
M. F. METZGER

3,318,015

AUTOMATIC DRYER CONTROL CIRCUIT

Filed Feb. 5, 1965

2 Sheets-Sheet 1



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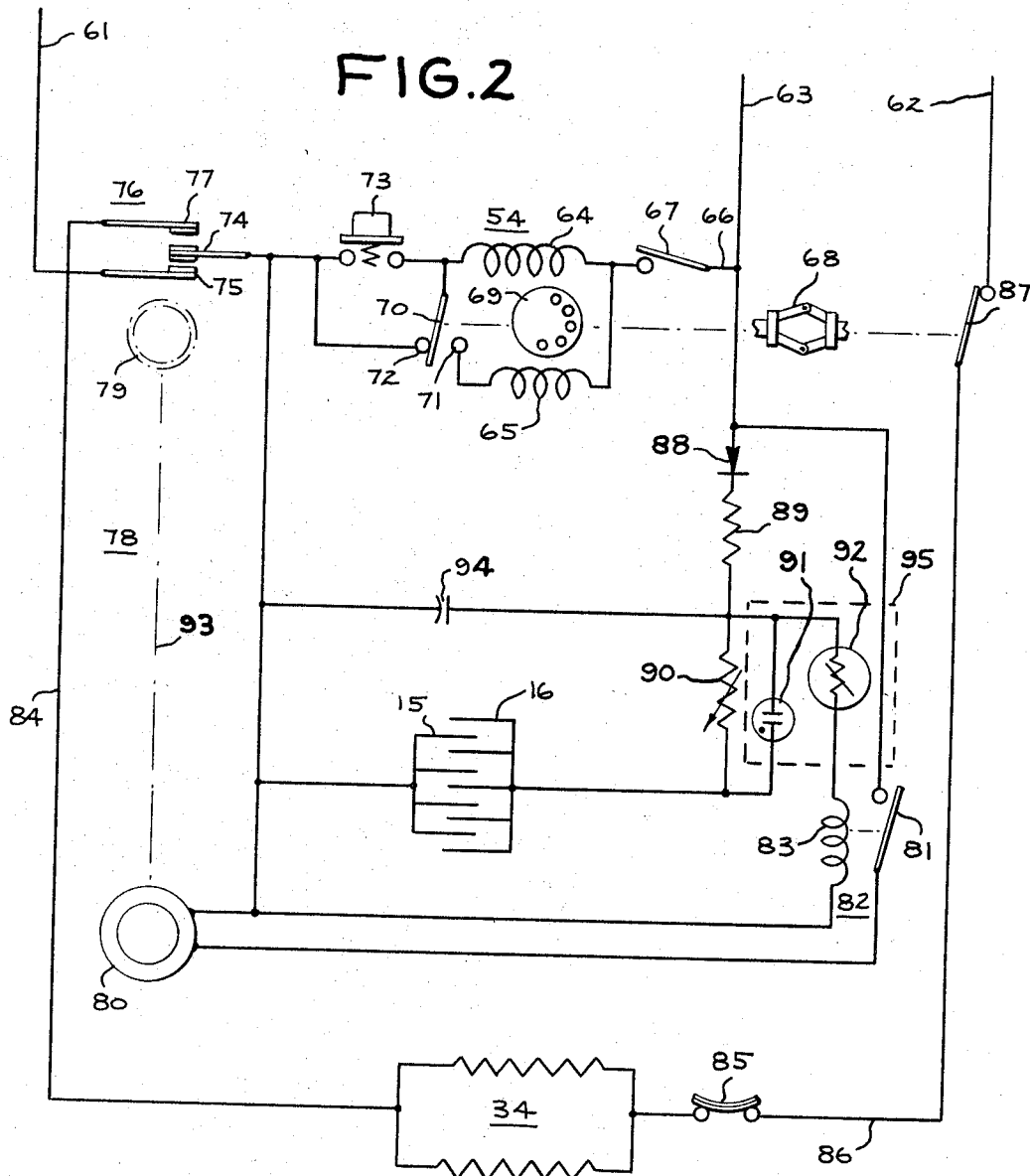
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AUTOMATIC DRYER CONTROL CIRCUIT

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This invention relates to domestic fabric drying machines, and more particularly to control system for use in such machines.

One approach to controlling the operation of fabric dryers is to sense the extent to which the fabrics being dried are electrically conductive. Fabrics themselves normally present a high electrical resistance, and it is only when they have a substantial amount of moisture in them that their resistance decreases appreciably. Thus some domestic fabric dryers on the market today utilize the conductivity of the fabrics to determine when the drying operation will be ended. The usual procedure in such machines is to connect a capacitor in parallel with the sensing elements of the machine. When a high resistance appears across the sensing elements a charge will be built up on the capacitor. This charge is utilized to energize a control circuit for ending the operation of the machine.

The fabrics are normally tumbled within the dryer and some fabrics dry more quickly than others. Thus, at any given moment, the fabrics may be out of contact with the sensing elements or dry fabrics may be in contact with the sensing elements while other fabrics are still wet. Since a high resistance across the sensing elements will cause the charge on the capacitor quickly to build up to a value sufficient to energize the control circuit, such arrangements tend to cause the dryer to be turned off prematurely. In order to compensate for this in prior art machines it has been necessary to utilize relatively expensive components.

It is an object of this invention to provide an improved fabric drying machine control circuit which utilizes the conductivity of the fabrics to terminate the drying operation.

It is another object of this invention to provide such a control circuit that insures the fabrics are dry prior to terminating the drying operation.

It is a further object of this invention to provide such a control circuit that can be constructed from a minimum number of low cost components.

In carrying out my invention, in one form thereof, I provide a fabric drying machine which has a conventional chamber for receiving fabrics to be dried, drying means to cause evaporation of moisture from fabrics placed in the chamber and means for tumbling fabrics in the chamber. Spaced conductors are positioned so as to be bridged by the tumbling fabrics, so that the conductors are provided with a relatively low resistance electrical bridge when there is substantial moisture in the fabrics which bridge the conductors and a relatively high resistance electrical bridge as the fabrics approach dryness. I provide a sequence control mechanism including the parallel combination of a resistance and a glow tube, the parallel combination being connected to a source of electrical energy in series with the spaced conductors. A timer mechanism is provided to terminate the drying operation after a predetermined amount of timer operation. The motor for the timer is connected to a source of electrical energy in series with a normally closed reed switch. A light sensitive resistor and the actuating coil for the reed switch are connected in series with each other, and in parallel with the glow tube and spaced conductors. Thus, with this arrangement of elements, as long as the fabrics are wet the glow tube will emit light, which impinges on the light sensitive resistance and causes it to have a low value. Therefore sufficient current will flow through the

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coil to keep the reed switch open and, thereby, prevent the timer from operating. As the fabrics approach dryness the glow tube will be caused to stop emitting light and the reed switch will close to start the timer for terminating the drying operation.

The subject matter which I regard as my invention is particularly pointed out and distinctly claimed in the concluding portion of this specification. My invention, however, both as to organization and method of operation together with further objects and advantages thereof, may best be understood by reference to the following description taken in conjunction with the accompanying drawings.

In the drawings:

FIGURE 1 is a side elevational view of a clothes dryer incorporating my improved dryer control arrangement, the view being partly broken away and partly sectionalized in order to illustrate details; and

FIGURE 2 is a schematic illustration of my improved control system, as used in the control circuit of the drying machine of FIGURE 1.

Referring now to FIGURE 1, the machine illustrated is a domestic clothes dryer generally indicated by the numeral 1. Dryer 1 is provided in the usual way with a cabinet 2 having a front door 3 to provide access to the interior of the cabinet for loading or unloading of clothes. Provided on the top wall 4 of the cabinet 2 is a control panel 5 which may include a suitable manual control member 6 connected to a sequence control assembly 7. By manually setting control member 6, the machine may be caused to start and, as will be explained below, automatically proceed through a cycle of operations.

Within cabinet 2 there is provided a clothes tumbling container or drum 8 which constitutes a chamber for receiving fabrics to be dried, and which is mounted for rotation on a substantially horizontal axis. Drum 8 is substantially cylindrical in shape, having a first cylindrical outer wall portion 9, second and third cylindrical outer wall portions 10 and 11 located respectively adjacent the front and back of the drum, a front wall 12, and a back wall 13. Outer wall portions 9, 10 and 11 are imperforate over their entire length so that the entire outer shell of the basket is imperforate. On the interior surface of central position 9 there is provided a plurality of clothes tumbling ribs 14 formed of a suitable heat resistant insulating material. Over each rib extend a number of conductors or wires 15 and 16 which are spaced from each other and which alternate with each other along the length of the rib. The purpose of these wires and the structure to which they are related will be more fully described herebelow.

The front of the drum 8 may be rotatably supported within an outer casing 2 by suitable idler wheels, one of which is shown at 17. These wheels are rotatably secured to the top of a member 18 which extends up from the base 19 of the machine. Wheels 17 are disposed beneath the drum in contact with portion 10 on each side thereof to provide a stable support.

The rear end of drum 8 receives its support by means of a stub shaft 20 extending from the center of wall 13. Shaft 20 is secured within a bearing 21 formed in a baffle 22. Baffle 22, in turn, is rigidly secured to the back wall 23 of cabinet 2 by any suitable means such as, for instance, welding at a number of points 24. With the arrangement shown the basket may rotate on a horizontal axis, with wheels 17 providing the front support and stub shaft 20 within bearing 21 providing the rear support.

It will be noted that stub shaft 20 is provided with a central opening 25, the wires 15 and 16 extend from ribs 14 around the back of drum 8 and through suitable openings in a baffle member 26; the wires then extend through opening 25 formed in shaft 20. At the outer end of shaft 20, a disc 27 may be formed, as shown, with the conduc-

tors 15 being secured to a conductive outer ring portion 28 and the conductors 16 being secured to a conductive inner ring portion 29. Portions 28 and 29 are electrically insulated from each other; this may be readily done by making disc 27 of an insulating material, with the conductive ring portions embedded therein. A contact member 30 is continually in contact with ring portion 28, while, similarly, a contact member 31 is continuously in contact with ring portion 29 of the disc. By this construction all of the conductors 15 are connected to stationary contact member 30 and all of the conductors 16 are similarly connected to stationary contact member 31.

In order to provide for the flow of a stream of drying air through the clothes drum, the drum is provided with a central aperture 32 in its front wall 12 and with an opening in the form of a plurality of perforations 33 in its rear wall 13, the perforations in the present case being formed to extend around the rear wall in an annulus.

As has been stated, baffle member 22 is rigidly secured to rear wall 23 of cabinet 2. Baffle member 22 also serves to support suitable heating means such as electrical heating elements 34, which are appropriately insulated from baffle member 22. Elements 34 may be annular in shape so as to be generally coextensive with perforations 33 in drum 8. As previously mentioned, the other baffle member 26 is rigidly secured to the back wall 13 of the drum, outside the ring of perforations 33 and within stationary baffle 22 so that an annular air inlet 35 is, in effect, formed by baffles 22 and 26. In this manner, a passage is formed for air to enter annular inlet opening 35 between the baffles, pass over the heating elements 34, and then pass through openings 36 formed in baffle 26 to the interior of drum 8.

The front opening 32 of the drum is substantially closed by means of a stationary bulkhead, generally indicated by the numeral 37. Bulkhead 37 is made up of a number of adjacent members including the inner surface 38 of access door 3, a stationary frame 39 for the door formed as a flange of the front wall 40 of the cabinet, the inner surface member 41 of an exhaust duct 42 which is formed by the cooperation of member 41 with the front wall 40 of the cabinet, and an annular flange 43 mounted on frame 39 and on the duct wall. It will be noted that a suitable clearance is provided between the inner edge of the drum opening 32 and the edge of bulkhead 37 so that there is no rubbing between the drum and the bulkhead during rotation of the drum. In order to prevent any substantial air leakage through opening 32 between the interior and exterior of the drum, a suitable ring seal 44, preferably formed of felt-like material, is secured to flange 43 in sealing relationship with the exterior surface of drum wall 12.

Front opening 32, in addition to serving as part of the air flow passage through the drum, also serves as a means whereby clothes may be loaded into and unloaded from the drum. Door 3, whose inner surface forms part of the bulkhead closing the opening, is mounted on cabinet 2 so that when the door is open clothes may be loaded into and removed from the drum through the door frame 39. It will be noted that the door includes an outer flat imperforate section 45 and an inwardly extending hollow section 46 mounted on the flat outer section. Hollow section 46 extends into the door frame 39 when the door is closed and the door surface 38 which comprises part of the combination bulkhead 37 is actually the inner wall of the hollow section.

The air outlet from the drum is provided by a perforated opening 47 formed in the inner wall 38 of hollow door section 46. The bottom wall section of door 3 and the adjacent wall of door frame 39 are provided with aligned openings 48 and 49, opening 49 providing the entrance to duct 42. As shown, a lint trap 50, which, for example, may comprise a fine mesh bag, is preferably positioned across duct 42 at opening 49, the filter being supported by the door frame 39. Duct 42 leads downwardly to an

opening 51 formed in the member 18 which supports wheel 17. Opening 51 constitutes the inlet to a blower member 52 contained within a housing 53 and directly driven by an electric motor 54. The motor draws ambient air in through any appropriate openings in the cabinet, such as, for instance, through opening 55. From opening 55 the air is drawn over heating elements 34, through the basket 8, through the door 3, duct 42, and into blower 52. From the blower, the air passes through any appropriate duct (not shown) out of cabinet 2 so as to be exhausted from the machine.

In addition to driving blower 52, motor 54 constitutes the means for effecting rotation of drum 8. In order to accomplish this, motor 54 is provided with a shaft 56 having a small pulley 57 formed at the end thereof. A belt 58 extends around pulley 57 and also entirely around the cylindrical wall section 9 of drum 8. The relative circumferences of pulley 57 and wall section 9 cause the drum to be driven by the motor at a speed suitable to effect tumbling of the clothes therein. In order to effect proper tensioning of belt 58 there may be provided a suitable idler assembly 59 secured on the same support 60 which secures one end of the motor.

Thus, the air is pulled through the drum, and at the same time the fabrics in the drum are tumbled. When air is heated by heating elements 34, it causes evaporation of moisture from the clothes. The vapor is carried out with the air as it passes out of the machine.

The operation of dryer 1 is controlled by my new and improved control system shown in the circuit diagram of FIGURE 2. As shown therein, the entire control system of the machine may be energized across a three-wire power supply system which includes supply conductors 61 and 62 and a neutral conductor 63. For domestic use, the conductors 61 and 62 will normally be connected across a 220 volt power supply, with 110 volts appearing between neutral line 63 (which may be at ground potential) and each of the supply conductors. Motor 54, connected between conductors 61 and 63, is a single-phase, induction-type motor having a main winding 64 and a start winding 65, both connected at their common ends to a conductor 66 through a conventional door switch 67 (which is closed when door 3 is closed and is open when the door is open). Conductor 66 is connected to conductor 63.

Start winding 65 may be connected in parallel with main winding 64 under control of a speed responsive device, such as that shown at 68, which is schematically shown as connected to rotor 69 of the motor. Speed responsive device 68 controls a switch 70 which is engageable either with a contact 71 or a contact 72, being engaged with contact 71 when the motor is at rest and moving into engagement with contact 72 when the motor comes up to speed. It can readily be seen that engagement with contact 71 connects the start winding 65 in parallel with main winding 64 while movement of switch 70 away from this position opens the start winding. Thus, as rotor 69 comes up to speed, the start winding becomes de-energized and the motor continues to run on main winding 64 alone.

The starting of the motor is provided by a manually operable switch 73 which may, for instance, in the structure of FIGURE 1, be moved to its closed position by pulling out on member 6. Switch 73 connects the motor to supply conductor 61 through contacts 74 and 75 of a switch 76 which also has a third contact 77. Switch 73 is normally biased to the open position shown. However, when member 6 is pulled out manually, and provided the switch 76 is closed, energization of the motor is provided. Within less than a second, under normal circumstances, the motor comes up to speed so that switch 70 engages contact 72. As a result of this movement of switch 70, the main winding 64 of motor 54 continues to be energized by the bypass around switch 73 when member 6 is released and switch 73 opens.

A sequence control mechanism or assembly, schemati-

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cally indicated at 78, is provided and includes a cam 79 which controls switch 76. It will be understood that cam 79 is movable by rotation of member 6 in the usual way, so that, when operation of the machine is desired, member 6 may be rotated until cam 79 causes switch 76 to close all three of its contacts. The machine operation is terminated, as will be seen herebelow, when cam 79 has been rotated sufficiently to open the contacts of switch 76. Cam 79 and switch 76 may constitute the sequence control assembly 7 of FIGURE 1. During operation of the dryer cam 79 may be rotated by means of cam motor 80 which is connected between supply line 61 and neutral line 63 by a circuit including the switch portion 81 of a reed switch 82, the reed switch including an actuating coil 83.

An energizing circuit is completed for heating elements 34 through the following circuit: starting at conductor 61, the circuit proceeds through contacts 75 and 77 of switch 76 and then through a conductor 84 to heating elements 34. From heating elements 34 the circuit proceeds through a conventional safety thermostat 85 to a conductor 86 leading back to conductor 62 through a switch 87. Switch 87 is controlled by speed responsive device 68, being closed only when the motor has come up to speed, so that heating elements 34 can be energized only when motor 54 is operating properly.

The spaced conductors 15 and 16 are connected between contact 74 and neutral conductor 63 in series with a rectifier 88, a dropping resistor 89 (which may be approximately 100,000 ohms), and the parallel combination of a biasing resistor 90 and a glow tube 91. The glow tube 91 may be an inexpensive commercial type such as that marketed by General Electric Company under Model No. NE-2 and resistance 90 may be of a value of about 30 megohms. Resistance 90 may be manually variable for calibration and to change the degree of clothes dryness at which my new and improved circuit will function to terminate the drying operation.

A light sensitive means, which may include a light sensitive resistor 92 and the actuating coil 83 for reed switch 82, is connected in parallel with the parallel combination of the glow tube 91 and biasing resistor 90 and with the spaced conductors 15 and 16.

It will be seen that, with this assembly of parts, when control member 6 is pulled out to close switch 63 and rotated to close contacts 74, 75 and 77 of switch 76, motor 54 will quickly come up to speed, moving switch 70 from contact 71 to contact 72 and closing switch 87. The dryer drum then rotates at tumble speed and heating elements 34 are energized to provide heat for evaporating moisture from fabrics within the dryer drum. As long as the clothes in the drum are wet they form a low resistance bridge across conductors 15 and 16 which results in a voltage division between the conductors 15 and 16 and the biasing resistor 90 such that the voltage drop across biasing resistor 90 is sufficient to cause glow tube 91 to conduct and emit light. This light impinges upon light sensitive resistor 92, which is of the type which has a low resistance when light impinges upon it and a high resistance when light is not impinging upon it. The low resistance of light sensitive resistor 92 allows sufficient current to flow through actuating coil 83 to open switch portion 81 of reed switch 82 so that the timer motor 80 is disconnected from the source of electrical energy and thereby is prevented from rotating cam 79 through the mechanical linkage generally indicated at 93.

As the clothes in the dryer approach dryness the resistance across the spaced conductors 15 and 16 increases until it reaches a value which causes the voltage drop across biasing resistor 90 to be insufficient to cause glow tube 91 to conduct. At this point the glow tube ceases to emit light and the resistance of light sensitive resistor 92 increases and reaches a value large enough that the current flowing through the light sensitive means is insufficient to cause actuating coil 83 to maintain reed

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switch 82 open and switch portion 81 closes, thus activating motor 80 which, in turn, rotates cam 79. As cam 79 rotates it first opens contact 74 and 77 to de-energize heating elements 34 so that heat is no longer supplied to the dryer. Motor 54 continues to rotate so that the clothes continue tumbling and air is drawn through the dryer to cool the fabrics down to a temperature that is pleasant for handling by the user of the dryer. At this time cam 79 causes contacts 74 and 75 to separate which completely terminates the operation of the dryer.

My new and improved control circuit performs in a completely satisfactory manner as described; however, an even more improved operation may be provided by connecting a capacitor 94 in parallel with the biasing resistor 90 and glow tube 91 and with the spaced conductors 15 and 16. Capacitor 94 may have a value of about .2 microfarad and serves as a power reservoir, causing glow tube 91 to emit a stronger light which further reduces the resistance of light sensitive resistor 92.

Light sensitive resistor 92 is of the type that decreases in resistance very rapidly as a result of light impinging upon the resistance and increases in resistance very slowly when light ceases to impinge upon the resistor. Thus, a substantial period of time elapses after glow tube 91 ceases to emit light before coil 83 ceases to hold reed switch 82 open. Therefore, a brief extinguishment of glow tube 91 as a result of dry fabrics bridging conductors 15 and 16 while wet fabrics are still in the machine, no fabrics bridging spaced conductors 15 and 16 although fabrics are in the machine, or any other reason will not cause reed switch 82 to close and thus prematurely activate the sequence control mechanism 78.

Although the usual fabric drying machines is sufficiently light proof to insure proper response of light sensitive resistor 92 to glow tube 91; as an added precaution, the light sensitive resistor and glow tube may be mounted within a light-proof enclosure which is schematically indicated at 95 so that the incidence of ambient light upon light sensitive resistor 92 is absolutely precluded.

Thus, it will be understood that I have provided a new and improved control circuit for a fabric drying machine which prevents premature termination of the drying operation, yet, still without undesirable overdrying, by preventing the control circuit from responding to a temporary inaccurate "dry signal."

It will be understood that while a particular form of my invention has been illustrated many others will occur to those skilled in the art. While in accordance with the patent statutes I have described what at present is considered to be the preferred embodiment of my invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from my invention, and it is therefore aimed in the appended claims to cover all such equivalent variations that fall within the spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a fabric dryer including a chamber for receiving fabrics to be dried, drying means arranged to cause evaporation of moisture from the fabrics, and means for tumbling fabrics in the chamber; a control system for the dryer comprising:

- (a) a timer mechanism for inactivating the dryer after a predetermined period timer operation, said timer being adapted to be connected across a source of electrical energy by a circuit including a normally closed switch,
- (b) spaced conductors positioned so as to be bridged by fabrics tumbling in the chamber so that the electrical resistance across said conductors is low when there is substantial moisture in the fabrics bridging said conductors and increases as the fabrics approach dryness,
- (c) said conductors being adapted to be connected

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across the source of electrical energy in an electric series circuit arrangement with a glow tube so that said glow tube emits light when the resistance across said conductors is low and ceases to emit light as the resistance increases, and

(d) light sensitive means positioned in light receiving relationship with said glow tube and operatively connected with said switch to cause said switch to be open when said glow tube is emitting light.

2. A control system as set forth in claim 1 wherein said switch is magnetically operated and said light sensitive means includes a serially connected light sensitive resistor and an actuating coil for said switch, the resistance of said resistor decreasing relatively rapidly when light impinges on it and increasing relatively slowly when light ceases to impinge on it.

3. In a fabric dryer including a chamber for receiving fabrics to be dried, drying means arranged to cause evaporation of moisture from the fabrics, and means for tumbling fabrics in the chamber; a control system for the dryer comprising:

(a) a timer mechanism for inactivating the dryer after a predetermined period timer operation, said timer being adapted to be connected across a source of electrical energy by a circuit including a normally closed switch,

(b) spaced conductors positioned so as to be bridged by fabrics tumbling in the chamber so that the electrical resistance across said conductors is low when there is substantial moisture in the fabrics bridging said conductors and increases as the fabrics approach dryness,

(c) said conductors being adapted to be connected across the source of electrical energy in an electric series circuit arrangement with the parallel combination of a glow tube and a biasing resistor so that said glow tube emits light when the resistance across said conductors is low and ceases to emit light as the resistance across said conductors increases, and

(d) light sensitive means positioned in light receiving relationship with said glow tube and operatively connected with said switch to cause said switch to be open when said glow tube is emitting light.

4. A control system as set forth in claim 3 wherein said switch is magnetically operated and said light sensitive means includes a serially connected light sensitive resistor and an actuating coil for said switch, the resistance of said resistor decreasing relatively rapidly when light impinges on it and increasing relatively slowly when light ceases to impinge on it.

5. A control system as set forth in claim 3 wherein said biasing resistor is adjustable to vary the resistance value across said conductors at which said glow tube ceases to emit light.

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6. In a fabric dryer including a chamber for receiving fabrics to be dried, drying means arranged to cause evaporation of moisture from the fabrics, and means for tumbling fabrics in the chamber; a control system for the dryer comprising:

(a) a timer mechanism for inactivating the dryer after a predetermined period timer operation, said timer being adapted to be connected across a source of electrical energy by a circuit including a normally closed reed switch,

(b) spaced conductors positioned so as to be bridged by fabrics tumbling in the chamber so that the electrical resistance across said conductors is low when there is substantial moisture in the fabrics bridging said conductors and increases as the fabrics approach dryness,

(c) said conductors being adapted to be connected across the source of electrical energy in an electric series circuit arrangement with a rectifier, a dropping resistor and a light source including the parallel combination of glow tube and a biasing resistor so that said glow tube emits light when the resistance across said conductors is low and ceases to emit light as the resistance across said conductors increases, and

(d) a serially connected light sensitive resistor and an actuating coil for said reed switch connected in parallel with said light source and said conductors, said light sensitive resistor being positioned in light receiving relationship with said glow tube to cause said reed switch to be open when said glow tube is emitting light, the resistance of said light sensitive resistor decreasing relatively rapidly when light impinges on it and increasing relatively slowly when light ceases to impinge on it.

7. A control system as set forth in claim 6 wherein said biasing resistor is adjustable to vary the resistance value across said conductors at which said glow tube ceases to emit light.

8. A control system as set forth in claim 6 wherein a capacitor is connected in parallel with the series arrangement of said conductors and said light source to enhance the light emitted by said glow tube.

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