

Nov. 22, 1966

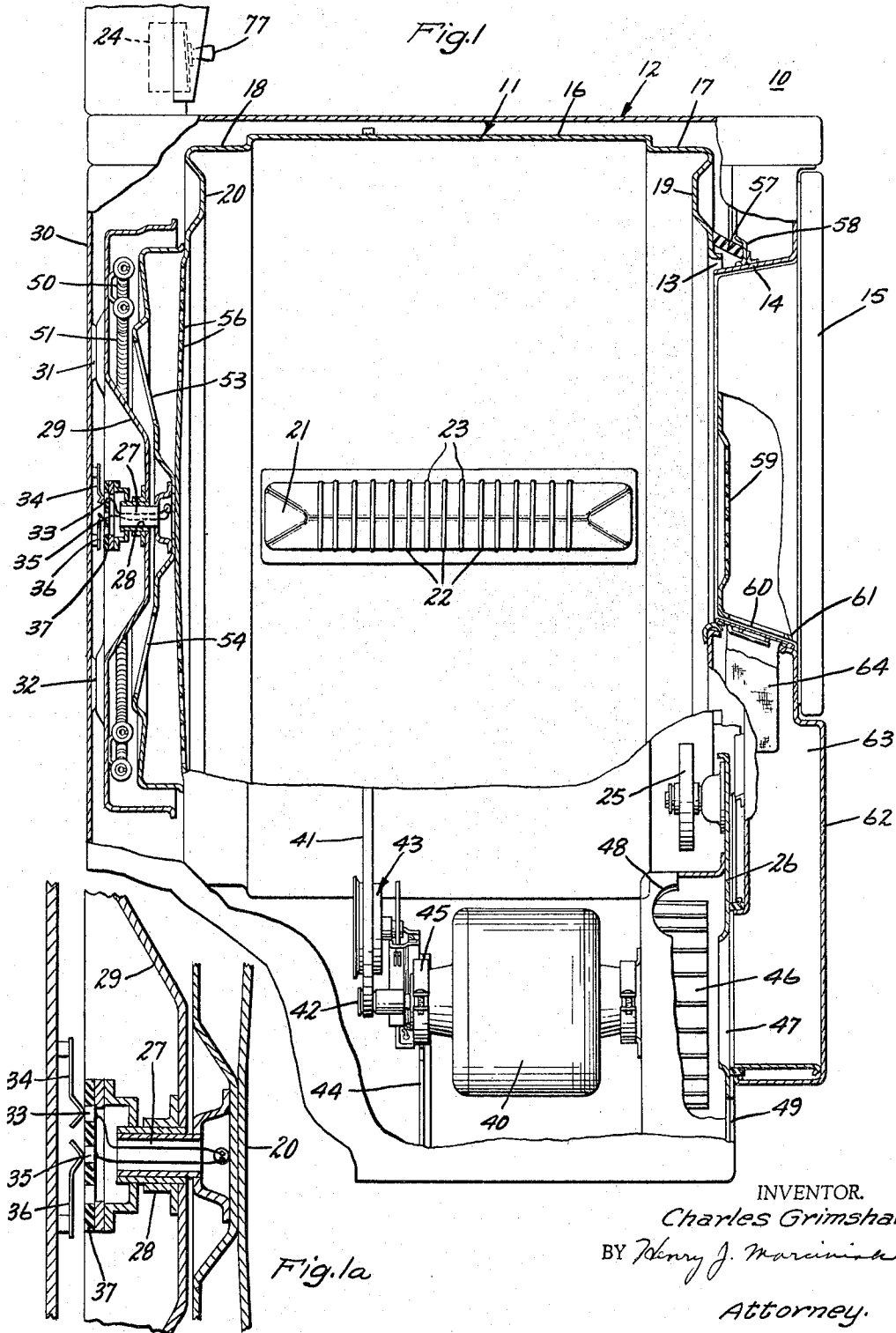
C. GRIMSHAW

3,286,363

FABRIC DRYER CONTROLS

Filed March 24, 1964

6 Sheets-Sheet 1



Nov. 22, 1966

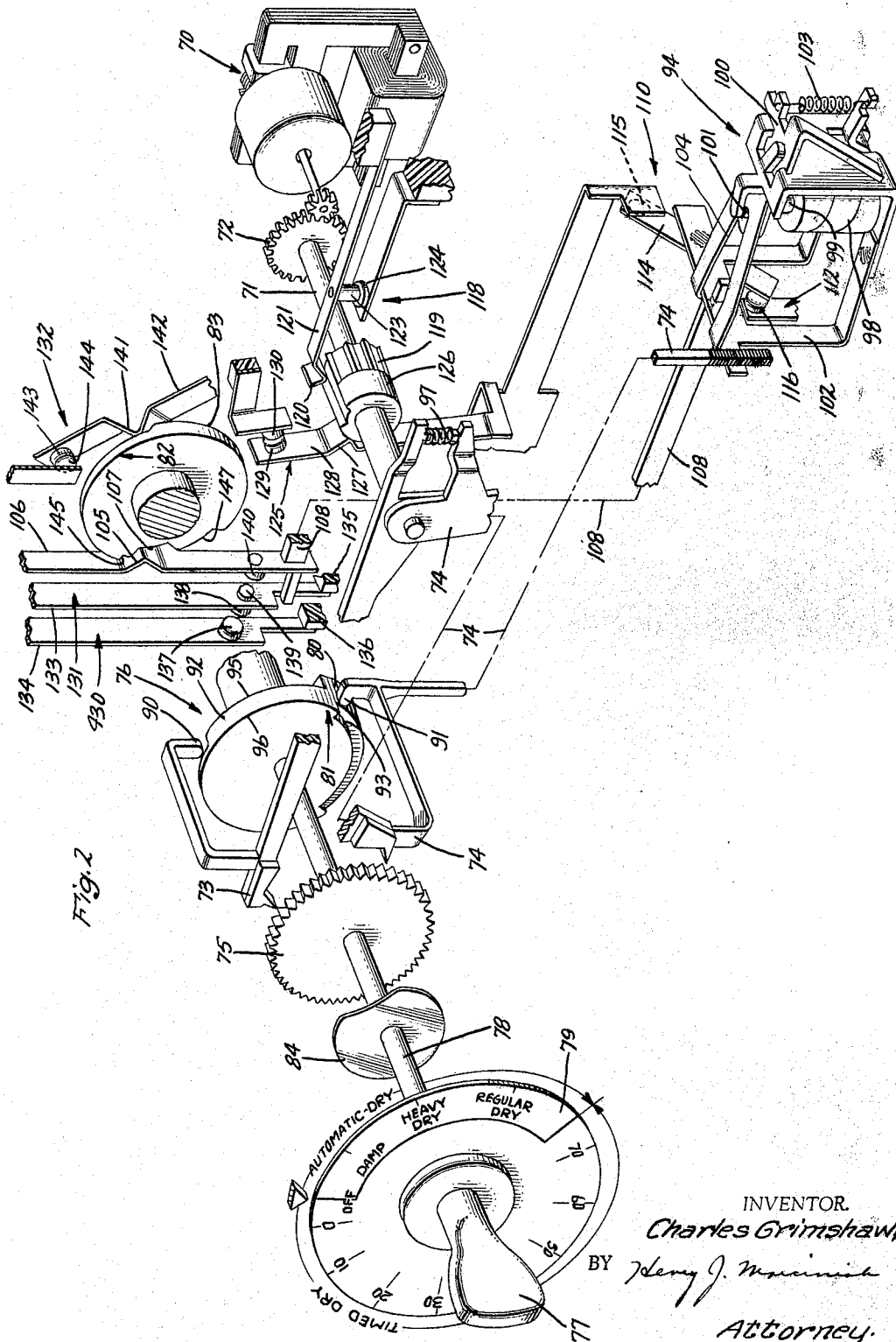
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FABRIC DRYER CONTROLS

Filed March 24, 1964

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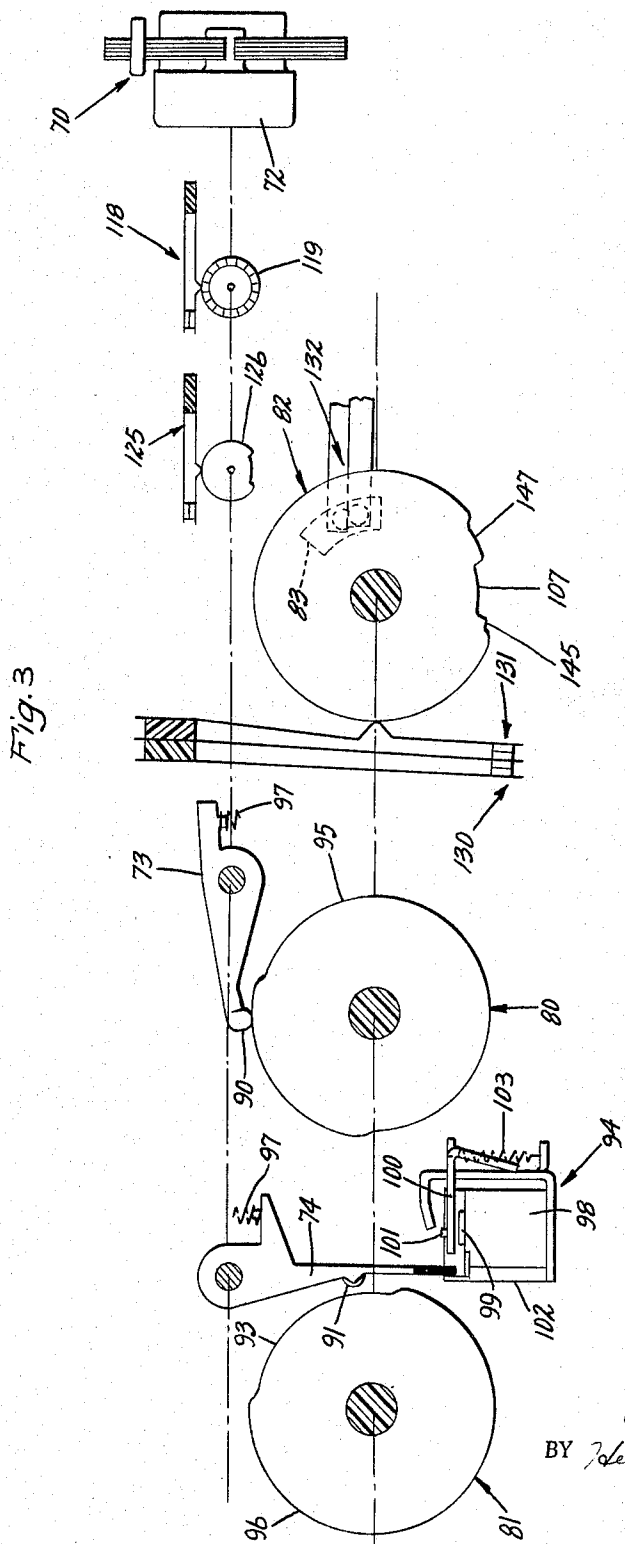
Nov. 22, 1966

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3,286,363

Filed March 24, 1964

6 Sheets-Sheet 3



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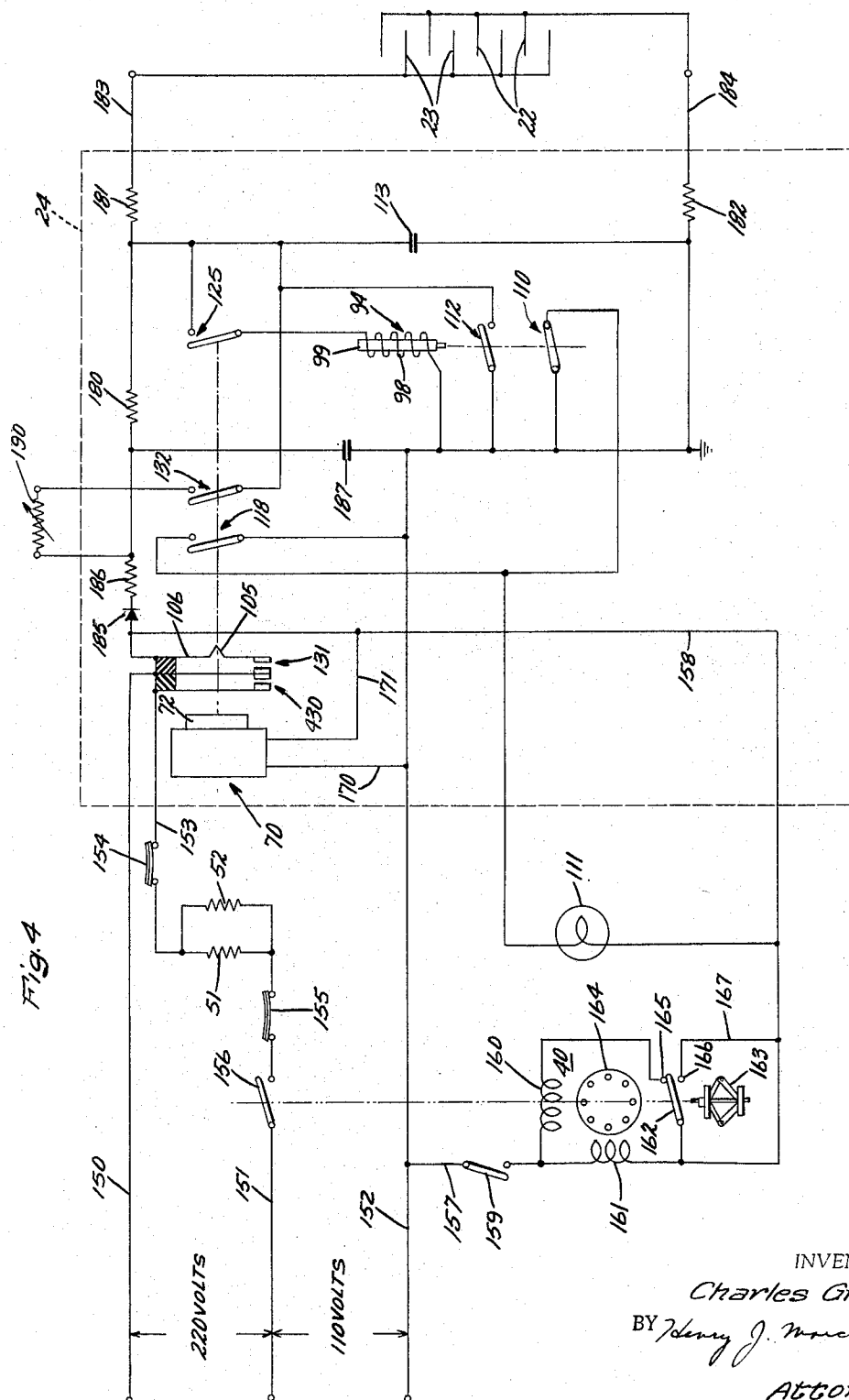
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FABRIC DRYER CONTROLS

Filed March 24, 1964

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FABRIC DRYER CONTROLS

Filed March 24, 1964

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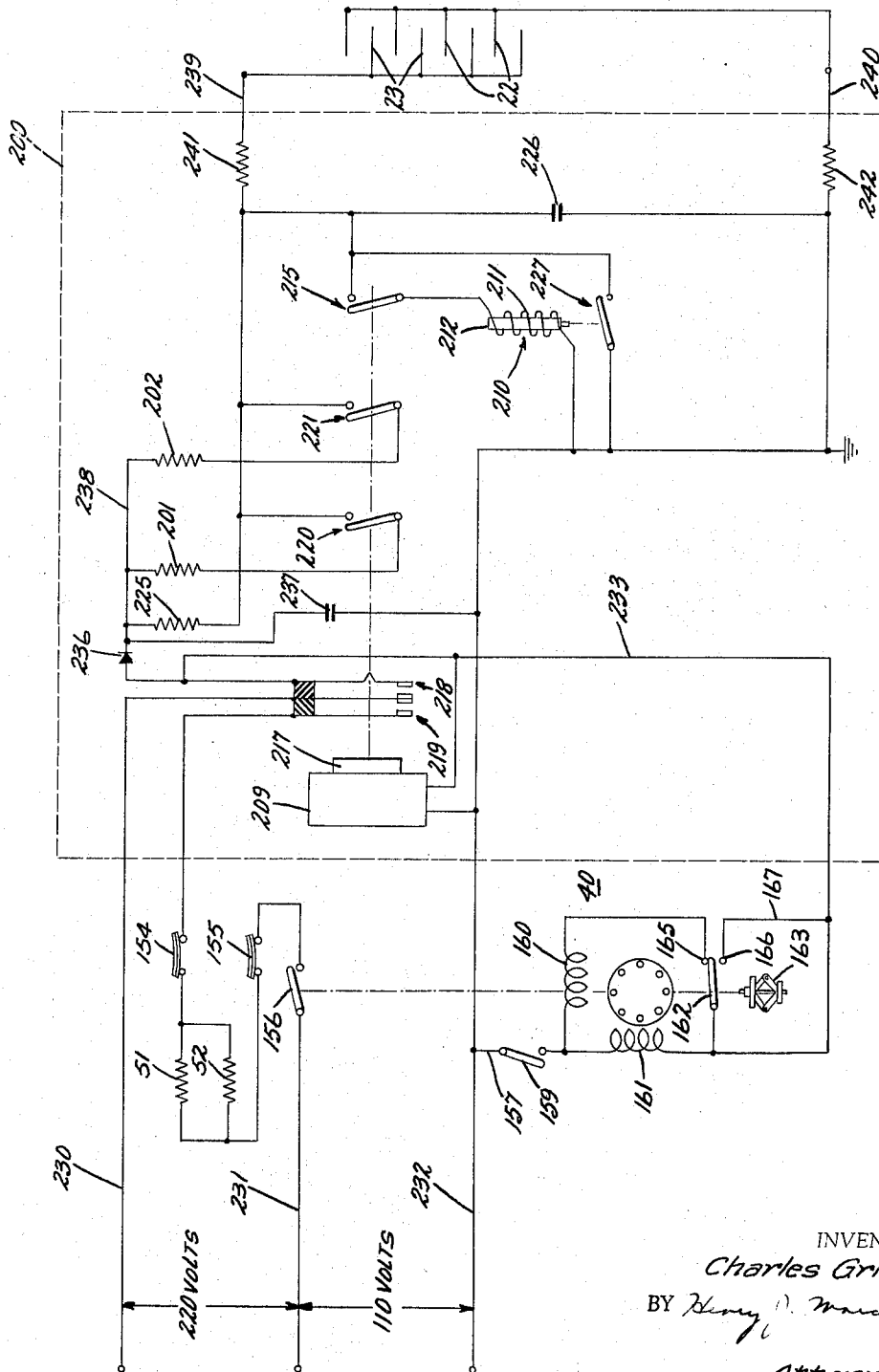


Fig. 5

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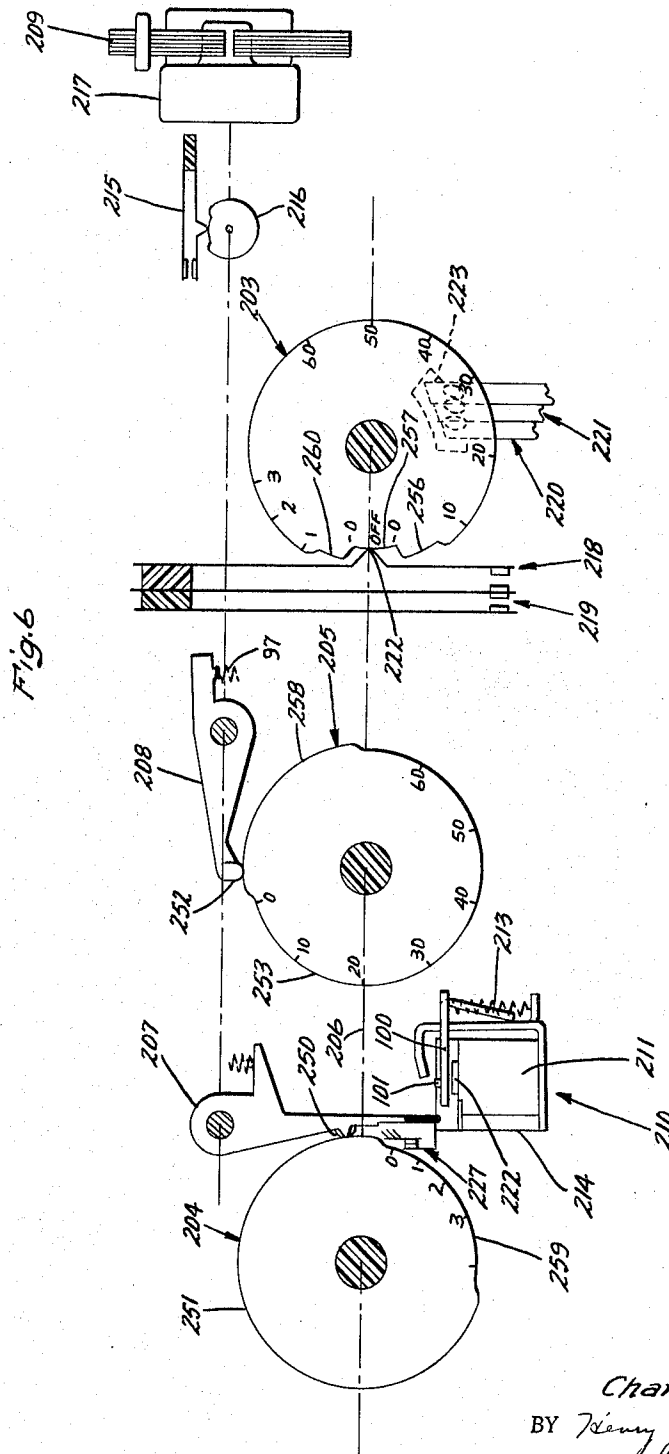
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FABRIC DRYER CONTROLS

Filed March 24, 1964

6 Sheets-Sheet 6



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1

3,286,363

FABRIC DRYER CONTROLS

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Filed Mar. 24, 1964, Ser. No. 354,372
5 Claims. (Cl. 34-45)

This invention relates generally to fabric dryers and more particularly to a fabric dryer control for use in domestic dryers.

The improved control of the present invention is applicable to fabric dryers in which the conductivity or resistance of the fabrics during operation is used as a criterion for initiating the completion of the drying operation. One example of a fabric dryer of the resistance sensing type is described in the Elberty Patent No. 2,045,381. In the dryer control circuit described in the Elberty patent, the control electrode of a cold cathode tube is connected in series with resistance sensing elements in the tumbler. As the moisture is evaporated out of the fabrics being dried, the cathode-to-electrode resistance of the tube increases until the tube stops conducting. The interruption of the current through the tube causes a relay to drop out and initiate the termination of the drying operation.

In other known control arrangements the varying resistance presented by the clothes controls the charging rate of a capacitor connected across the resistance sensing elements. When the charge on the capacitor builds up to some preselected value, the dryer operation is terminated after a suitable runout period. One of the problems encountered with such a capacitor averaging arrangement is that the charge on the capacitor is accumulated over relatively long intervals of time and that capacitors having relatively high capacitive values are required. Also, in such arrangements relatively expensive electronic devices have been employed in the control and sensing circuits.

Accordingly, it is an object of the present invention to provide an improved control for use in conjunction with fabric dryers using a resistance sensing arrangement for determining the dryness of the fabrics.

It is also an object of my invention to provide an improved fabric dryer that initiates the termination of the drying operation in response to a signal indicative of the resistance of the fabrics.

Another object of my invention is to provide an improved control for use in conjunction with a fabric dryer employing a resistance sensing arrangement wherein the resistance presented by the drying fabrics can be precisely averaged.

It is a specific object of the invention to provide an improved control for use in conjunction with a fabric dryer employing a resistance sensing arrangement wherein the magnitude of the reactance required in the sensing circuit is effectively minimized.

In accordance with one form of my invention I have provided an improved control for use in conjunction with a fabric dryer utilizing resistance probing elements to sense the resistance of fabrics as moisture is being evaporated from the fabrics. The control includes a sensing circuit connected with the resistance probing elements and with a source of unidirectional current to provide a signal indicative of the resistance presented by fabrics bridging the probing elements. Also, a control circuit is provided for initiating the termination of the dryer operation of the dryer in response to this signal. In the improved arrangement a look switch is connected with the control and sensing circuits so as to periodically couple and uncouple the control and sensing circuits to respectively provide a "look" and a "no-look" interval.

2

During the no-look interval the sensing circuit is, in effect, averaging the instantaneous values of the varying resistance presented by fabrics bridging the probing elements. However, during the succeeding look interval the control circuit, in effect, evaluates the signal indicative of the resistance in the preceding no-look interval, and if the signal is above a predetermined magnitude, the control circuit initiates the termination of the dryer operation by starting a preselected runout period. If the signal is below a predetermined value, the control circuit allows the drying operation to continue.

According to a more specific aspect of the invention I have provided a control which includes a control member manually settable to an operating position and having an off position for completely terminating the operation of the dryer. The control member includes a cam stack with a switch cam carried on the control member for rotation therewith. When the control member is set to an operating position, the switch cam actuates various switching contacts, including the contacts for energizing the drive motor, the drying means and the timer motor to a closed position. Lift cams are also provided to selectively allow one of a pair of pawls to engage a ratchet wheel carried on the control member. A latching relay prevents one of the pawls from engaging the ratchet wheel until the fabrics reach a certain degree of dryness as is reflected by the resistance of the fabrics bridging the resistance probing elements.

The fabric resistance sensing circuit includes a capacitor connected with the resistance probing elements and the unidirectional power source so that the charge on the capacitor is varied in response to the resistance presented by the fabrics bridging the resistance probing elements. The look switch is cyclically driven to a closed and an open position by the timer motor to provide a fixed look and no-look interval. During the no-look interval the relay winding is disconnected from the capacitor, and the capacitor is charged during the no-look at a rate dependent on the fabric resistance. When the charge on the capacitor in a particular no-look interval reaches a predetermined value, the discharge of the energy through the relay winding in the succeeding look interval causes the relay to be actuated thereby initiating the termination of the dryer operation. The pawl is released for engagement with the ratchet wheel and returns the control member to the off position after a preselected runout period of operation. Where relatively dry fabrics are not desired the runout period may, of course, be relatively short or eliminated.

The improved look switch arrangement provides an accurate means for reliably gauging the condition of fabric dryness based on the electrical resistance or conductivity of the fabrics bridging the resistance probing elements of the dryer at a selected periodic interval. An important advantage of the look switch arrangement is that it is possible to use relatively less expensive high energy type of electrical relays and also to use relatively less expensive capacitors having less capacitance than would be required in a sensing circuit in which the capacitor is continuously charged for a prolonged period during the drying operation.

The features of my invention which I believe to be patentable are set forth with particularity in the appended claims. My invention both as to organization and method of operation, together with further objects and advantages thereof, may be best understood by reference to the following description taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a diagrammatic partial front plan view of a fabric clothes dryer, to which the improved control

may be applied with sections of the dryer partially broken away to illustrate detail;

FIGURE 1(a) is a fragmentary enlarged view of the arrangement for bringing out the leads connecting with the resistance probing elements from the dryer drum;

FIGURE 2 is a perspective view of a timer control mechanism of a type that can be used in conjunction with the improved control, the mechanism being partially broken apart to show detail and the structural arrangement of various components of the control;

FIGURE 3 is a schematic illustration showing the relative positions of the lift cams and the switch cam when the control knob is set in the automatic dry range;

FIGURE 4 is a simplified schematic circuit diagram of one form of the improved control and the associated components of the dryer;

FIGURE 5 is a simplified schematic circuit diagram of another embodiment of the improved control shown connected with the resistance probing elements of the dryer, the dryer heater circuit and the drive motor circuit; and

FIGURE 6 is a schematic illustration showing the relative positions of the lift cams and the switch cam for the control of FIGURE 5.

Having more particular reference now to FIGURE 1, I have illustrated therein a domestic clothes dryer 10, which is representative of the various fabric dryers in which my new and improved control may be utilized. The dryer 10 includes a rotatable drum or chamber 11, which is mounted for rotation about a generally horizontal axis. The drum 11 is disposed within a cabinet 12. In order to provide access to the interior of the dryer 10 for loading and unloading fabrics suitable openings 13, 14 are provided in the front wall of the drum or basket 11 and cabinet 12. The openings 13, 14 are flanged as shown to prevent clothes from dropping down between the drum 11 and the cabinet 12. A door 15 is hingedly mounted on the cabinet 12 and closes the opening 14.

The drum 11 for tumbling fabrics or clothes to be dried is substantially cylindrical in shape, and includes a first cylindrical wall portion 16 and a pair of outer wall portions 17 and 18 located respectively at the front and back of the drum 11. The drum 11 also includes a front wall 19 and a back wall 20. The cylindrical wall portions 16, 17, 18 are imperforate over their entire length so that the entire outer shell of the drum 11 is imperforate.

On the interior surface of the central cylindrical portion 16 of the drum 11, I have provided a plurality of ribs 21 to aid in producing the tumbling action as the drum 11 is revolved during operation. The ribs 21 are formed of a suitable heat resistant electrically insulating material. Each rib 21 includes a number of resistance probing elements, the groups 22 and 23 comprising alternate resistance probing elements are connected in electrical circuit with the improved control 24. The purpose of the groups 22, 23 of resistance probing elements and their relationship to the improved control 24 will hereinafter be more fully explained in connection with the description of the circuit diagram shown in FIGURE 4.

At the front side the drum 11 is rotatably supported by suitable idler wheels 25 only one of which is shown in FIGURE 1. The wheels 25 are rotatably engaged with the cylindrical portion 17 and are secured to a support member 26 which extends from the base of the dryer 10. The rear side of the drum 11 is supported by means of a stub shaft 27 journaled within a bearing 28 supported by a baffle plate 29. The baffle plate 29 is rigidly secured to the back wall 30 of the cabinet 12 by any suitable connecting means such as the welds 31, 32.

In the dryer 10 shown to illustrate one form of my invention, the group 22 of resistance probing elements is connected to the conductive outer ring portion 33 engaging the brush contact 34 and the other group 23 is connected to a conductive ring portion 35 engaging the brush

contact 36. In order to insulate the ring portions 33 and 35 from each other, they are embedded in a disc 37 made of suitable insulating material, as is best seen in FIGURE 1(a). During operation of the dryer the groups 22, 23 of resistance probing elements are electrically connected to the control 24 by suitable leads connecting the contacts 34 and 36 with control 24.

For rotating the drum 11 during operation of the dryer 10, there is provided an electrical motor 40 which is connected to the drum 11 by a suitable belt 41. The belt 41 extends around a pulley 42 and also around the cylindrical wall section 16 of the drum 11. The diameter of the pulley 42 relative to the diameter of the cylindrical wall section 16 is such that the drum 11 is driven by the motor 40 at a speed that will cause fabrics placed in the drum 11 to tumble. In order to effect proper tensioning of the belt 41 a suitable idler assembly 43 is carried on the support 44 to which one end of the motor 40 is attached by the clamping member 45.

Besides driving the drum 11, it will be noted that the motor 40 also serves to drive the blower 46. The blower 46 draws air from the dryer through the opening 47 which serves as the blower inlet. The air from the blower 46 is discharged through an opening 48 which may be connected to an appropriate duct so that the air can be suitably exhausted from the dryer 10. The air is drawn into the cabinet 12 through the opening 49. From the opening 49 the air is drawn over air heaters 51, 52 through the holes 53, 54 in the baffle plate member 55 and enters the drum 11 through the perforations 56 provided in its rear wall 20. The stream of drying air leaves the drum 11 through the central opening 13 provided in the front wall 19 of the drum 11. In order to prevent any substantial leakage as the air leaves the drum 11, a suitable ring seal 57, preferably of felt material, is secured to flanged member 58.

The air leaves the drum 11 through perforated openings 59 formed in the inner wall of the hollow door 15. An opening 60 formed in the bottom wall section of the door 15 and aligned with an opening 61 in the cabinet section 62 provides an entrance for the passage of air into the duct 63. A lint trap 64 comprising a fine mesh bag is preferably positioned across the opening 61. The duct 63 guides the air into the blower inlet 47.

From the foregoing description it will be apparent that the blower 46 draws air through a suction path which includes the heaters 50, 51, the interior of the drum 11, the door 15, the lint trap 64 and duct 63. The heated air circulating through the drum 11 as fabrics are tumbled causes evaporation of the moisture from the fabrics. The vapor and air is carried off from the drum where it is drawn through the lint trap 64 into the suction inlet 47 of the blower 46. The vapor laden air is then discharged through the opening 48 to a duct (not shown).

Having more specific reference now to the timer control mechanism as shown in FIGURE 2, I have shown therein a type of timer mechanism which may be used in conjunction with the improved look switch arrangement of the invention. Certain specific features of the control mechanism shown are more fully described and claimed in the copending application Serial No. 354,375, filed March 24, 1964, assigned to the same assignee as the present invention and which issued February 15, 1966, as Patent No. 3,234,805. It will be appreciated that this mechanism was used in the embodiment of the invention which was reduced to practice by me.

As will be best seen in FIGURE 2, a timer motor 70 is provided to drive a first cam shaft 71 through a speed reduction gear train 72. A pair of pawls 73, 74 are eccentrically driven at the end of cam shaft 71 and are selectively engageable with the ratchet wheel 75 to effect a step-by-step return of the control member 76 to the off position in either counterclockwise or clockwise direction. The control member 76 includes a control knob 77 attached to a shaft 78, a position indicator dial 79 attached

to the control knob 77, lift cams 80, 81, a radial switch cam 82, a surface or face cam 83, and a torque spring 84. The ratchet wheel 75 is frictionally engaged with the shaft 78 and when the knob 77 is turned in a clockwise direction to set the indicator dial 79 in the timed dry range, pawl 73 drops into engagement with the ratchet wheel 75. Thus, the ratchet wheel 75 is held by the pawl 73, and slippage occurs between the shaft 78 and the ratchet wheel 75 while the control knob 77 is manually rotated in a clockwise direction. However, when the control knob 77 is turned in a counterclockwise direction, neither of the pawls 73, 74 drop into engagement with the ratchet wheel 75 (as will be more fully explained below). As a result, the ratchet wheel 75 rotates with the shaft 78 as the control knob 77 is manually set in a counterclockwise direction to set the control member 76 in an operating position in the automatic dry range of the indicator dial 79. In the automatic dry range of the control indicator dial 79, it will be seen that three settings denoting a progressively increasing degree of dryness, "Damp," "Heavy Dry" and "Regular Dry" are marked on the dial face. The control knob 77 may be set, of course, to intermediate positions between the marked settings on the dial 79 to provide a desired degree of dryness.

It will be noted that the two pawls 73 and 74 drive the ratchet wheel 75 in two directions so that the control member 76 is driven by the pawls 73, 74 to a single off position. Thus, timed dry pawl 73 drives the ratchet wheel 73 in a counterclockwise direction to return the control member 76 to the off position from a preset position in the timed dry range on the dial 79. On the other hand, the automatic dry pawl 74 drives the ratchet wheel 73 in a clockwise direction to return the control member 76 to the off position from a selected setting in the automatic dry range of the dial 79.

Continuing further with the description of the mechanical features of the improved control 24, I will now more fully describe the cam and switching arrangements as were employed in the illustrative embodiment of my invention. It will be seen that the pawls 73, 74 have cam followers 90, 91, which are associated with the lift cams 80 and 81 respectively. When the control dial 79 is set to the off position as shown, both pawls 73 and 74 are lifted out of engagement with the ratchet wheel 75. Thus, cam follower 90 of pawl 73 is resting on the raised section 92 of cam 82. Although the other cam follower 91, mounted on pawl 74, is in position over a recessed section 93 of cam 81, it is held out of contact with cam 81 by a latching relay 94.

When the control knob 77 is turned from the off position in a clockwise direction to a timed dry position, on dial 79, the cam follower 90 drops into a recessed section 95, which is shown in the cam layout illustrated in FIGURE 3. The cam follower 91 of the pawl 74 is prevented from engaging the ratchet wheel 75 by the raised portion 96 of cam 81.

Referring now more particularly to FIGURE 3, I have shown therein the relative disposition of the cams 80, 81 and 82 when the control knob is rotated in a counterclockwise direction to the "Regular Dry" setting in the automatic dry range of control 10. For this setting the raised section 92 of cam 80 holds the timed dry pawl 73 out of engagement with the ratchet wheel 75, and the cam follower 91 of the automatic dry pawl 74 is held by the latching relay 94. When the cam follower 91 is released by the latching relay 94 in response to a predetermined condition of dryness of the fabrics, the pawl 74 biased by the spring 97 will engage the ratchet wheel 75 to cause the control member 76 to be driven to the off position.

As is best seen in FIGURE 2, the latching relay 94 includes a coil or winding 98, a core 99, an armature 100, a latching element 101, a latch spring 102, and an armature spring 103. When the electrical energy supplied to

the coil 98 is sufficient to actuate the relay 94, the armature 100 is pulled down toward the core 99 to release the latching element 101 from its engagement in the slot 104. The element 101 is relatched whenever the control member 76 is returned to the off position. In the off position the cam follower 105 of the switch arm 106 falls into the recess 107 of the switch cam 82 and imparts a lateral movement to the push rod 108. This lateral movement causes the latch spring 102 to bend thereby moving the slot 104 over the latching element 101 to effect a relatching of the relay 94.

The movement of the latch spring 102 also actuates a shunt switch 110 of the flasher lamp 111 (see FIGURE 4) and a switch 112 for discharging a capacitor 113 (see FIGURE 4). When the relay 94 is tripped to release the latch spring 102, the conductive strip 114 engages contact 116 to close switch 112 and disengages contact 115 to open switch 110. When the shunt switch 110 is closed, the lamp 111 provides a steady light to indicate visually that the drying operation is in progress. The closing of the switch 112 causes any charge left on the capacitor 113 of the resistance sensing circuit to be bled off upon completion of the drying operation and prevents a charge from building up on the capacitor 113 so that capacitor 113 will not provide a false indication of the fabric resistance when the dryer is again operated in an automatic dry control setting.

To intermittently open and close the flasher switch 118, a cam 119 is provided on the timer motor driven shaft 71. A cam follower 120 is formed on a resilient switch blade 121 and is actuated by the rotation of the cam 119 to open and close the contacts 123 and 124 of the flasher switch 118. The periodic opening and closing of the switch 118 causes the lamp 111, which may be placed on the front panel of the dryer 10 where it can be seen by the operator, to flash on and off when the shunt switch 110 is opened by release of the latch spring 102.

When the lamp 111 shows a steady light, this indicates to the operator that the control 24 is operating, or in other words that the fabrics in the dryer 10 are in the process of being dried. When the lamp 111 shows a flashing light, this indicates that the control 24 is no longer sensing the fabric resistance and is in its runout period.

In my preferred embodiment the look switch 125 of the improved control arrangement is opened for a no-look interval of approximately one minute and closed for an approximate look interval of 10 seconds by the cam 126 and follower 127 on the resilient blade 128. Preferably, the no-look interval should not be more than two minutes. As shown in FIGURE 2, the contacts 129 and 130 of the look switch 125 are in the open or no-look position. During this condition, the control circuit which includes the relay 94 is electrically disconnected from the sensing circuit. Preferably, the sensing circuit includes the capacitor 113 and a source of unidirectional current to build up a charge on the capacitor 113 indicative of fabric resistance.

When the look switch 125 is closed, the capacitor 113 is discharged through the relay coil 98. In the exemplification of the invention a voltage across the capacitor 113 of 65 volts caused the relay 94 to trip and unlatch the latch spring 102. With the latch spring 102 unlatched, the pawl 74 is allowed to engage the ratchet wheel 75 and return the control member 76 step by step to the off position.

Having more specific reference now to the switch cam 82 and the face cam 83, I will now more fully describe how the heater switch 430, the motor switch 131 and the damp switch 132 are actuated. In the off position of the control member, as shown in FIGURE 2, the cam follower 105 is engaged in the recess 107, and the switch arms 133, 134 abut the stops 135 and 136 so that the contacts 137 and 138 of the heater switch 430 and the

contacts 139 and 140 of the motor switch 131 are open. Also, in the off position of the control member 76, the cam follower 141 of the switch arm 142 is engaged against the face cam 83 so that contacts 143 and 144 of the damp switch 132 are closed. When the control knob 77 is moved to the "Damp" setting on the dial 79, the cam follower 105 is engaged in the recess 145 of cam 82, and the switch arm 106 has been displaced to close the heater switch 430 and the motor switch 131. Also, for this setting of the control knob 77 the cam follower 141 of the damp switch 132 is not yet on the raised surface of the face cam 83, and the contacts 143, 144 of the damp switch 131 are closed. However, when the control knob is moved in a counterclockwise direction beyond the "Damp" setting, the cam follower 141 will ride on the raised portion of the face cam 83 and open the damp switch 132.

The cooldown period of dryer operation at the end of a timed dry operation is provided by a surface 147 on cam 82. With the cam follower 105 engaged with this surface, the switch arm 106 is displaced to close the switch contacts 139 and 140 of the motor switch 131 but does not close the heater switch contacts 138, 139. During this switching condition, unheated air will circulate through the fabrics tumbling in the dryer.

To explain the operation of the improved control 24 for the different clothes treating operations, let us assume first that the operator has set the control knob 77 to the 30-minute point on dial 79 in the timed dry range. For this setting the switch cam 82 has caused a lateral displacement of the contact arm 106 to close both the heater and motor switches 430 and 131. Thus, the heating elements 51, 52, the drive motor 40 and motor 70 are all energized. The time drive pawl 73 engages the ratchet wheel and begins to rotate the control member 76 step by step in a clockwise direction towards the off position.

Preferably, as shown in FIGURE 4 the motors 40, 70 and heating elements 51, 52 are energized from a three-wire alternating source. The supply leads 150, 151 are adapted for connection to the two high potential lines of a 220-volt supply and lead 152 is provided for connection to the neutral or grounded supply line. It will be understood, of course, that the improved control of the invention is not necessarily limited to dryers for use with a 220-volt, three-wire supply, but may also be applied to dryers for use with available two-wire 110-volt power supplies.

It will be seen in the circuit diagram of FIGURE 4 that the heating elements 51, 52 are energized across the supply leads 150 and 151 through the heater switch 130. Starting with supply lead 150 the heater circuit may be traced through the heater switch 430, the lead 153, the thermostat 154, the centrifugally operated switch 156 and supply lead 151. Thermostat 155 is a conventional thermostatic safety device. If the dryer should rise above the temperature setting of the temperature controlling thermostat 154, the thermostat 154 opens the contacts until the machine cools down to a predetermined lower temperature. Accordingly, the heating elements 51, 52 are either continuously energized or continuously cycled during the timed drying operation. Of course, if the drive motor 40 should stop rotating for any reason, the heating elements 51, 52 are immediately deenergized by action of the centrifugal operated switch 156.

The drive motor 40 is also energized continuously during the timed drying operation. As will be seen in FIGURE 4, the drive motor 40 is energized by the connections 157, 158 which place the motor across the neutral lead 152 and the supply lead 150 and is energized with a 110-volt alternating supply. Commencing with the neutral lead 152, the drive motor circuit includes the connection 157 and a door switch 159. The door switch 159 is actuated by the door 15 of the dryer 10 so that whenever the door 15 is opened during the drying operation

the switch 159 is opened. From the switch 159 the drive motor circuit extends through the start and main windings 160, 161 of the drive motor 40. The start winding 160 is disconnected from its parallel connection across the main winding 161 by the switch 162 which is controlled by a centrifugal mechanism 163. When the rotor 164 is at rest the switch arm 162 engages contact 165. As the rotor 164 reaches a predetermined speed, the switch arm 162 is moved to engage contact 166 and also switch 156 is closed. After the rotor 164 comes up to speed, the drive motor circuit is completed through the connections 167, 158, through the motor switch 131 to the supply lead 150.

With this circuit arrangement it will be seen that the motor 40 remains energized so long as the door switch 159 and the motor switch 131 are closed. If the dryer door should be opened, the operation of the motor 40 is interrupted, and also the heating elements 51 and 52 are deenergized because of the opening of switch 156 due to the action of the centrifugal mechanism 163. The motor 40 and the heating elements 51, 52 will however again be energized as soon as the dryer door is closed.

The timer motor 70 is also continuously energized during the timed drying operation. Specifically, it is energized by the connection 170 to the neutral lead 152 and by the connection 171 to lead 153 which joins the timer motor 70 in electrical circuit with the motor switch 131 and supply lead 150. With these circuit connections, the timer motor 70 is continuously energized throughout the timed drying operation and drives the pawl 73 with an oscillatory motion to progressively step the ratchet wheel in a counterclockwise direction to return the control member 76 to its off position.

Thus, as the clothes are being tumbled in the drum 11, and moisture is being removed therefrom due to the hot air stream flowing through the drum, the timer motor 70 is progressively advancing the control member 76 towards the off position. When the switch cam 82 is in a position where the cam follower 105 drops into engagement with surface 147, a cooldown period begins. With the cam follower 105 so engaged, the heater switch 430 is opened to cut off the power to the heating elements 51, 52. However, neither the timer motor 70 nor the drive motor 40 are affected since the motor switch 131 remains in a closed position during the cooldown period.

In domestic clothes dryers a cooldown period of approximately five minutes is sufficient to permit the clothes to cool to a temperature that allows the fabrics to be comfortably handled when removed from the dryer 10. At the end of the cooldown period the cam follower 105 drops into recess 107 in the switch cam 82 to open the motor switch 131 and deenergize the timer motor 70 and the drive motor 40 thereby completing the timed drying operation. It will be appreciated, of course, that during the timed drying operation that the fabric resistance sensing circuit is ineffective in controlling the dryer operation because cam follower 91 rises on the raised section 96 of the lift cam 81.

Let us now assume that the operator desires to have the fabrics automatically dried to a "Regular Dry" condition. The operator turns the control knob 77 until the "Regular Dry" point on the dial 79 is aligned with the pointer. The control member 76 is thereby rotated in a counterclockwise direction. During a rotation in a counterclockwise direction the ratchet wheel 75 is rotated with the shaft 78 since the cam follower 90 rides on the raised section 92 of cam 80 and holds pawl 73 out of engagement with the ratchet wheel 75. Further, the automatic dry pawl 74 is latched out of engagement with the recessed section 93 of cam 81 by the latch spring 102. Thus, the pawls 73 and 74 do not restrain the movement of the ratchet wheel 75. It will be noted that the automatic dry pawl 74 is not prevented by the lift cam 81 from engaging the ratchet wheel 75 but that when released will lock in with the ratchet wheel 75. Also, in the "Regular Dry" posi-

tion the cam follower 105 is displaced laterally by the switch cam 82 so that the heater switch 130 is closed and the motor switch 131 is closed to energize the drive motor 40, the timer motor 70, and the groups 22, 23 of resistance probing elements.

As soon as the main drive motor 40 comes up to its normal operating speed, the centrifugal switch 156 is actuated to its closed position to complete the circuit to the main heating elements 51 and 52. Thus, the dryer 10 is now in full operation to initiate the drying of fabrics tumbling in the drum 11. Although the timer motor 70 continuously drives the pawl 74, it is not coupled with the ratchet wheel 75 until a sufficient amount of electrical energy is supplied to the relay coil 98 to pivot the spring-biased armature 100 of the relay 94 and release the latch spring 102.

During this condition of the control 10, the resistance sensing circuit, which in the exemplification included a 22 megohm resistor 180, and a pair of .47 megohm resistors 181, 182 connected in the sensor leads 183, 184 respectively, comes into play (see FIGURE 4). The resistor 180 limits the current available for charging the capacitor 113, and the resistors 181 and 182 isolate the resistance probing elements to prevent a shock hazard to personnel in the event that the leads 150 and 152 are improperly connected to the alternating supply.

As long as the fabrics bridging the groups 22, 23 of resistance probing elements have a relatively high moisture content, charging current will be diverted or bypassed from the capacitor 113. The look switch 125 is being cyclically closed and opened by cam 126 to provide a look interval and a no-look interval. During the look interval, the capacitor 113 is connected to the grounded supply lead 152 through the relay winding 98, which presents a relatively low impedance. Consequently, the capacitor 113 discharges through the winding 98 but the energy is not sufficient to actuate the relay. In each no-look interval, however, the relay winding 98 is electrically disconnected by the look switch 125 from capacitor 113, and a charge is built up on the capacitor 113 which is indicative of the average value of the resistance presented by the fabrics bridging the resistance probing elements during the no-look interval.

As the moisture content of the fabrics diminishes, the resistance presented by fabrics bridging the resistance probing elements increases. Also, the charge accumulated on the capacitor during successive no-look intervals will gradually increase since less current is being diverted from the capacitor 113. When the charge on the capacitor 113 reaches a predetermined value in a particular no-look interval, the flow of current through the winding 94 in the look interval that follows develops sufficient magnetic flux in the core 99 to attract the armature 100 and release the pawl 74 for engagement with the ratchet wheel 75.

The preset runout period is now initiated as the oscillatory motion of pawl 74 steps the ratchet wheel 75 in a clockwise direction to progressively advance the control member 76 to the off position. Also, the release of the latch spring 102 causes switch 112 to close and switch 110 to open. With switch 112 closed, it will be seen from the circuit diagram of FIGURE 4 that the charging current now completely shunts the capacitor 113. Also, with switch 110 open, lamp 111 will now flash to inform the operator that the runout drying period has been initiated.

It will be understood that relatively dry fabrics present a relatively high resistance that is not readily capable of evaluation. A runout time period from about 5 to 15 minutes may preferably be provided after the resistance sensing circuit and its responsive control means have performed their functions. This runout period is pre-selected in advance by turning the control knob 77 to the desired setting on the automatic dry range of dial 79. For the "Regular Dry" setting a runout period of approximately 15 minutes was provided.

Near the end of the runout period for the automatic dry operation, it will be noted that in the illustrated embodiment of FIGURE 2 a cooldown period has not been provided. If desired, the switch cam 82 can be formed with a recess similar to the one used during the timed dry operation to provide a cooldown period.

From the foregoing description of the drying operation, it will be apparent that the automatic dry operation differs from the timed dry operation in that the latter does not run merely for a selected length of time. Rather, in the automatic dry operation the control 24 essentially determines the period of time required to dry the fabrics and causes the termination of the dryer operation to be initiated when the fabrics in the dryer have reached a predetermined degree of dryness as is reflected in the electrical conductivity or resistance of fabrics bridging probing elements in the dryer. To provide the operator with some selectivity as to the degree of dryness, the angular position to which the control member 76 is set provides runout periods of varying periods. Of course, a longer runout period will result in fabrics with a lower moisture content.

If the operator desires that the fabrics be damp at the end of the drying operation, the control knob 77 is rotated in a counterclockwise direction to the "Damp" setting on the dial 79. With the control knob 77 in this setting, the cam follower 105 engages a recess 145 formed in the switch cam 82. Also, for this setting the cam 80 lifts the cam follower so that timed dry pawl 73 is out of engagement with the ratchet wheel 75. Also, the automatic dry pawl 74 is positioned over the recessed section 93 of cam 81 and is prevented from engaging the ratchet wheel by the latch spring 102. Also, the motor and the heater switches 130, 131 are closed. As soon as the main drive motor 40 comes up to its operating speed, the centrifugal switch 156 is activated to its closed position to complete the circuit to the heating elements 51 and 52.

With the control knob 77 on the "Damp" setting, the cam follower 141 has not been displaced laterally, and the damp switch 132 is in a closed position. As will be seen in the circuit diagram of FIGURE 4, a variable resistor 190 is now effectively in the charging circuit and provides a control over the charging current supplied to the capacitor 113. In the illustrated exemplification of my invention, the variable resistor provided from 0 to 2 megohms, as compared with the 22-megohm resistor 180 with which it is connected in parallel. As moisture is evaporated from the fabrics, the fabric resistance is increased, and the capacitor 113 will be charged at a relatively higher rate than it was when the 22 megohm resistor 180 was effective in the charging circuit. Thus, the capacitor 113 will reach the predetermined voltage at which it will trip the relay 94 while the fabrics are still damp. Decreasing the resistance introduced into the charging circuit by the variable resistor 190 will, of course, increase the degree of dampness of the fabrics in the dryer 10. When capacitor 113 in a particular look interval discharges sufficient electrical energy through the winding 98 to actuate the relay 94, the pawl 74 is released for engagement with the ratchet wheel 75 and drives the wheel 75 to return the control member 76 to the off position thereby completing the damp dry operation.

From the foregoing description, it will be apparent that I have provided an improved dryer control 24 which can selectively provide a number of different operations for the dryer 10. Specifically, it provides a timed dry operation in which up to 70 minutes of drying time may be selectively provided. By moving the control knob to the automatic dry range, the dryer control 24 is set to provide a drying operation controlled by the moisture content of the fabrics, as reflected in the electrical conductivity or resistance of fabrics bridging probing elements in the dryer. When a certain condition of dryness is reached, a controllable run-out period, as determined

by the manual setting of the control knob, provides the operator with a control over the degree of dryness of the fabrics. If a damp condition of the fabric is desired, the operator needs only to set the control knob to the "Damp" position and may select the degree of dampness by adjusting the variable resistor 190.

Referring now to FIGURES 5 and 6, I have shown therein an alternate embodiment of my invention. This embodiment is similar in many respects to the embodiment of FIGURES 2-4 and includes the same circuits for energizing the drive motor 40, and the heating elements 51 and 52 of the dryer 10. Accordingly, I have identified the identical elements of the circuits with the same reference numerals. Whereas in the previously described embodiment of my invention a variable resistor is provided to control the degree of dampness, in the control 200 shown schematically in FIGURE 5, a pair of resistors 201 and 202 are selectively switched into the charging circuit to provide two degrees of dampness. The control 200 of this embodiment is somewhat simplified since a separate variable resistor is not required for setting the degree of dampness. Also, in this embodiment a flashing light has not been included.

Since the control timer arrangement except for the cams is similar in most respects to that of the first embodiment, I have shown in FIGURE 6 the cam and switching arrangement as used in this embodiment and for convenience, have identified the three control positions for the automatic dry range on the switch cam 203 and lift cam 204 by the numerals 1, 2 and 3 respectively. Also, I have indicated the timed dry positions in ten-minute intervals on switch cam 203 and its associated lift cam 205. The switch cam 203 and the lift cams 204, 205 rotate with a shaft represented by the dashed line 206, and are manually set to a selected position. The cams 203, 204, 205 are returned to the off position, as shown in FIGURE 6 by a timer motor 209. The pawls 207 and 208 are engaged with a ratchet wheel as controlled by the lift cams 204, 205 and a latching relay 210. Latching relay 210, which includes a winding 211, a core 212, an armature 213 and a latching spring 214, comes into play during the automatic drying operation to release pawl 207. The lock switch 215 is intermittently opened and closed by a cam 216 driven through a reduction gear train 217 by the timer motor 209.

In the off position, as shown in FIGURE 6, the motor switch 218 and heater switch 219 are open. Also, the switches 220, 221 actuated by face cam 223 are closed. When the switch cam 203 is rotated to a position where the cam follower 222 is aligned with the number 1 position in the automatic dry range, the switches 220 and 221 remain in the closed position. However, when switch cam 203 is moved to position number 2, face cam 223 causes switch 220 to open, and switch 221 remains closed. In position number 3, both switches 220 and 221 are opened by the face cam 223, and resistor 225 limits the charging current to capacitor 226. As in the other embodiment, the shunting switch 227 is actuated to an open position when the latch spring 214 is released.

As shown in FIGURE 5, the leads 230, 231 and 232 will normally be connected across a 220-volt power supply with 110 volts appearing between the neutral lead 232 and either of the supply leads 230 or 231. The drive motor 40 is connected across leads 232 and 230 by means of the conductors 157, 167 and 233. The motor 40 is a single phase induction motor having a main winding 161 and a start winding 160.

A conventional door switch 157 is closed when the dryer door 15 is closed and open when the door 15 is opened. A centrifugal speed responsive device 163 controls the starting switch 162 and is engageable with either contact 165 or contact 166. It will be noted that speed responsive device 163 is also coupled with the switch 156 in the supply line 231 to which the heater elements 51 and 52 are connected. When the motor 40 is at rest, the

starting switch 165 is in the position as shown in FIGURE 1 so as to connect the starting winding 160 in parallel with the main winding 161, and also switch 156 is open so that the heating elements 51, 52 cannot be energized unless the motor 40 is up to speed. After the motor 40 has been brought up to speed, the starting switch 162 engages the contact 166 to deenergize the starting winding 160, and switch 156 in series with the heater elements 51, 52 is closed.

In the control 200 as shown schematically in FIGURE 5, the unidirectional current for the resistance sensing circuit is supplied through a diode 236 and is filtered by a capacitor 237 connected across the D.C. supply lead 238 and the neutral lead 232. Leads 239 and 240 are brought out from the control 200 for connection to the groups 22, 23 of resistance probing elements. Resistors 241 and 242 connected with leads 239 and 240 are provided to prevent a shock hazard in the event that the neutral lead 232 is accidentally connected to the high potential side of the power supply. In the illustrated embodiment of the invention resistors 241, 242 were $\frac{1}{3}$ megohm resistors. Resistor 225 had a resistance of 22 megohms, and the resistors 201 and 202 had a resistance of 1 and 5 megohms, respectively. Capacitors 237 and 226 had a capacitance of .02 and 2 microfarads, respectively.

To initiate a timed dry operation of the control 200 as shown in FIGURES 5 and 6 the operator can select up to 60 minutes of timed drying by manually rotating the cam shaft 206 in a clockwise direction. When lift cam 204 is rotated in a clockwise direction, it will be seen that the cam follower 250 on the automatic drive pawl 207 rides on the exterior cam surface 251, in which position the pawl 207 is out of engagement with the ratchet wheel. However, it will be noted that when the lift cam 205 is rotated in a clockwise direction, the cam follower 252 drops into the recessed surface 253 so that the timed dry pawl 208 can return the cams to the off position. The rotation of the switch cam 203, of course, causes the motor switch 218 and the heater switch 219 to close so that the motor and heater circuits and the timer motor 209 are energized. The switch cam 203 is then driven in a counterclockwise direction to the off position. As the cam 203 nears the off position, the cam follower 222 will ride in the recess 256 for a period of several minutes, during which period the dryer 10 will be operated without heat to effect a cooldown of the fabrics. When the cam follower 222 drops into the off recess 257 the operation of the dryer is completely terminated.

If the operator desires to dry clothes using the automatic dry operation, he turns the control knob in a counterclockwise direction to effect a rotation of cam 203 to one of three indicated positions. If switch cam 203 is rotated so that the number 3 is essentially aligned with the cam follower 222, in this position both switches 220, 221 are opened by the face cam 223. Relatively dry fabrics will be obtained since the charging current flows through a 22-megohm resistor 225 to decrease the current available for charging capacitor 226. Further, it will be noted that when cam shaft 206 is rotated to a counterclockwise direction to position 3, the raised portion 258 of cam 205 raises the timed dry pawl 208 so that it cannot drive the ratchet wheel. Also, the automatic drive pawl 207 is capable of being released for engagement with the ratchet wheel since it is in position over the cam recess 259. However, it is held in a latched position by the relay 210 and does not move into the cam recess 259 until the relay 210 is actuated by the discharge from capacitor 226.

As wet fabrics tumbling in the dryer 10 bridge the resistance probing elements, it will be appreciated that the charge on the capacitor 226 does not build up to a level where it will provide sufficient energy to actuate the relay when lock switch 215 is closed. However, as moisture is evaporated from fabrics bridging the resistance probing elements, the resistance of fabrics increases thereby increasing the charge accumulated on the capacitor 226

during a no-look interval. In the illustrated exemplification of the invention when the capacitor voltage reached 65 volts, sufficient energy was provided to the winding 211 to actuate the relay 210. When relay 210 is actuated, the automatic dry pawl 207 is engaged with the ratchet wheel to thereby cause the switch cam 203 to be returned to the off position. As during the timed drying cycle, at the end of the runout period a short cooldown is provided when the cam follower 222 engaged the recess 260 to open the heater switch 219.

If a damp dry condition is desired in the fabrics, the operator rotates the control knob to manually set the switch cam 203 in the position identified by number 1. When the switch cam 203 is in this position, both of the switches 220 and 221 are closed. Essentially, the one megohm resistor 201 limits the charging current to the capacitor 226. As a result, the fabrics will be relatively damp because the capacitor 226 will be charged at a relatively faster rate during each no-look interval than for the other two positions 2 and 3. If a medium dry condition of the fabrics is desired, the switch cam 203 is set so that number 2 on switch cam 203 is aligned with the cam follower 222. The face cam 223 causes switch 220 to open and switch 220 remains closed. In this condition the five-megohm resistor 202 essentially limits the charging current.

From the foregoing description of the improved control arrangement and its operation, it will be apparent that the control, in effect, looks in at the fabrics in the dryer at regular periodic intervals to determine their condition by intermittently coupling a control circuit with a resistance sensing circuit. An important advantage of the look switch arrangement is that an accurate averaging of the resistance presented across the probing elements can be achieved in a system employing a capacitor of relatively small capacitance and also that high energy type of inexpensive relays can be utilized. Further, it will be apparent that the improved control arrangement is readily adaptable for use in conjunction with timed dry and damp dry operations to provide a wide range of control over these operations.

Although I have described above various embodiments of my invention in which specific features are incorporated, it will be apparent to those skilled in the art that many changes and modifications may be made therein without departing from the invention. For example, the control can be simplified by eliminating the timed dry and the damp dry control operations. Further, the look switch can be readily actuated by other means. It is therefore intended in the appended claims to cover all such equivalent variations as fall within the true spirit and scope of my invention.

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

1. A control for use in conjunction with a fabric dryer having a chamber for receiving fabrics to be dried, means for tumbling the fabrics, means for drying the fabrics, and resistance probing elements positioned in said chamber so as to be bridged by tumbling fabrics, said fabrics bridging said elements presenting a resistance varying with the amount of moisture in said fabrics, said control comprising: a control member including ratchet means manually settable to an operating position and having an off position for terminating the operation of the dryer; a timer motor; switch means actuated by said control member to cause the tumbling means, drying means and timer motor to be energized when the control member is set to an operating position and to be turned off when the control member is in the off position; pawl means engageable with said ratchet means for moving said control member step by step to the off position from a set operating position; said timer motor coupled with and driving said pawl means; a capacitor connected in circuit with the resistance probing elements and a direct current source so as to be charged from said source; control means responsive to the

charge on said capacitor for providing a preselected runout period of operation, circuit means including a look switch connecting said capacitor, current source, and resistance probing elements in circuit with said switch and control means; and means actuated by said timer motor for closing and opening said look switch intermittently to provide a look interval during which said control means is coupled with said capacitor, source, and probing elements, and a no-look interval during which said control means is uncoupled from said capacitor, source, and probing elements; said capacitor being charged during a no-look interval in accordance with the magnitude of the resistance presented by fabrics bridging the probing elements and said capacitor being discharged during a look interval to provide a signal indicative of the resistance presented by the fabrics bridging said elements during the preceding no-look interval; said control means initiating the runout period by causing said pawl means to engage said ratchet means when the energy discharged from said capacitor to said control means during the look interval exceeds a predetermined value, and said control means preventing said runout period from starting when said energy supplied to the control means by the discharge of said capacitor is below said predetermined value.

2. A control for use in conjunction with a fabric dryer having a chamber for receiving fabrics to be dried, a drive means for driving said chamber, a drying means for causing evaporation of moisture from the fabrics, and spaced resistance probing elements positioned in said chamber with respect to the fabrics so that fabrics tumbling within said chamber bridge said elements, said control comprising: a control member manually settable to an operating position and having an off position for completely terminating the operation of the dryer, a timer motor, a switch cam carried on said control member for rotation therewith, switch means actuated by said switch cam to cause the drive means, the drying means and timer motor to be energized when the control member is set to an operating position and to be turned off when the control member is in the off position, a ratchet wheel connected to said control member, a pawl for rotating said ratchet wheel step by step to return said control member to the off position from a set operating position, said timer motor coupled with said pawl for driving said pawl, a capacitor for connection with a source of unidirectional current so as to be charged therefrom and for connection in circuit with said resistance probing elements so that the charge on said capacitor is varied in response to the resistance presented by fabrics bridging said resistance probing elements, a relay including a movable armature, a core and a winding connected in parallel circuit relation with said capacitor without intermediate electronic elements, said relay including means for normally holding said pawl in a latched position out of engagement with the ratchet wheel and when energized releasing said pawl out of latched engagement, a look switch connected in series circuit with said winding across said capacitor, and a cam driven by said timer motor for closing said look switch periodically to provide a predetermined no-look interval during which the capacitor is charged and also to provide a predetermined look interval during which said capacitor is discharged through said winding, said relay being actuated when the charge on said capacitor exceeds a predetermined value, and said ratchet wheel thereupon being driven by said pawl to return said control member to the off position to completely terminate the operation of the dryer.

3. A control for use in conjunction with a fabric dryer having a chamber for receiving fabrics to be dried, means for tumbling the fabrics, means for drying the fabrics and a resistance probing means including elements positioned in said chamber so as to be bridged by tumbling fabrics, said fabrics bridging said elements presenting a resistance thereacross varying with the amount of moisture in said fabrics; said control comprising: a control

member including ratchet means manually settable to an operating position and having an off position for terminating the operation of the dryer; a single timer motor; switch means actuated by said control member to cause the tumbling means, drying means and timer motor to be energized when the control member is set to an operating position and to be turned off when the control member is in the off position; pawl means engageable with said ratchet means for moving said control member step by step to the off position from a set operating position; said timer motor coupled with and driving said pawl means; a direct current source connected in series circuit relation with the resistance probing means; sensing means connected in electrical circuit with the elements of the resistance probing means, said sensing means providing a signal indicative of the resistance presented by fabrics bridging said elements; a control means including a single relay responsive to said electrical signal for initiating the termination of the operation of the drying means; and circuit means connecting said relay in circuit with said sensing means, current source, and probing means without intermediate electronic circuit elements, including a look switch actuated by said timer motor for alternately coupling and uncoupling said control means with said sensing means, current source, and probing means in repeated succession for fixed intervals, said control means initiating the termination of the dryer operation by causing said pawl means to engage said ratchet means when said signal supplied by said sensing means through said look switch exceeds a predetermined value, and preventing the initiation of said termination when said signal is less than said predetermined value.

4. A control for use in conjunction with a fabric dryer having a chamber for receiving fabrics to be dried, means for tumbling the fabrics, means for drying the fabrics, and resistance probing elements positioned in said chamber so as to be bridged by tumbling fabrics, said fabrics bridging said elements presenting a resistance varying with the amount of moisture in said fabrics, said control comprising: a control member including ratchet means manually settable to an operating position and having an off position for terminating the operation of the dryer; a timer motor; switch means actuated by said control member to cause the tumbling means, drying means and timer motor to be energized when the control member is set to an operating position and to be turned off when the control member is in the off position; pawl means engageable with said ratchet means for moving said control member step by step to the off position from a set operating position; said timer motor coupled with and driving said pawl means; a source of unidirectional current; capacitor connected in circuit with the resistance probing elements and the source of unidirectional current so as to be charged from said source; the resistance presented by fabrics bridging said probing elements causing the charge on said capacitor to be varied in accordance with the magnitude of said resistance; control means for initiating the termination of the operation of said drying means in response to the charge on said capacitor; circuit means including a look switch for coupling and uncoupling said control means with the capacitor, source, and probing elements; means actuated by said timer motor for driving said look switch in repeated succession alternately from an open to a closed position to provide a no-look interval during which said control means is disconnected from said capacitor and to provide a predetermined look interval when said control means is connected with said capacitor, the resistance presented by fabrics bridging the resistance probing elements causing the charge on said capacitor to be varied in accordance with the magnitude of said resistance during a no-look interval; the circuit between said source and resistance being uninterrupted by said look switch; said capacitor discharging through said control means during each of said look intervals to provide a

signal indicative of said resistance, said control means initiating the termination of the operation of said drying means by causing said pawl means to engage said ratchet means when the energy supplied to the control means during a particular look interval exceeds a predetermined value and said control means preventing the initiation of said termination when the energy supplied by the discharge of said capacitor is below said predetermined value.

5. A control for use in conjunction with a fabric dryer having a chamber for receiving fabrics to be dried, drive means for driving said chamber, a drying means for causing evaporation of moisture from the fabrics, and spaced resistance probing elements positioned in said chamber so that fabrics tumbling within said chamber bridge said elements, said control comprising: a manually settable control member including ratchet means having two operating positions and an off position for terminating dryer operation; a timer motor; switch means actuated by said control member to cause the tumbling and drying means and timer motor to be energized when the control member is set to either operating position and to be turned off when the control member is in the off position; pawl means driven by said time motor and engageable with said ratchet means for moving said control member step by step to the off position from either of said operating positions; sensing means including a capacitor for connection in electrical circuit with the resistance probing elements and with a direct current source so as to charge said capacitor, a control means for initiating the termination of the operation of the drying means, said control means including a relay having a relay winding, and circuit means including a look switch, said circuit means connecting said relay winding in series circuit with said look switch, and connecting the serially connected relay winding and look switch directly across said capacitor, current source, and probing elements without intermediate electronic elements, means for alternately closing and opening said look switch to provide a look interval during which said relay winding is connected in electrical circuit with said capacitor and to provide a no-look interval during which said relay winding is disconnected from said capacitor, said capacitor being charged during said no-look interval at a rate controlled essentially by the magnitude of the resistance presented by fabrics bridging said resistance probing elements during the no-look interval, said capacitor being discharged through said relay winding during said look interval, said control means initiating the termination of the dryer operation by causing said pawl means to engage said ratchet means when the energy discharged from said capacitor through said relay winding exceeds a predetermined value, said control means preventing the initiation of said termination when the energy supplied by the discharge of said capacitor is below said predetermined value; and means providing an auxiliary discharge path for said capacitor upon termination of the dryer operation.

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