

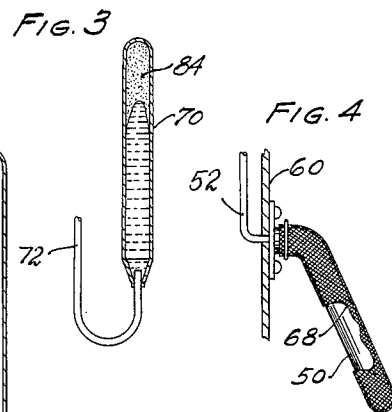
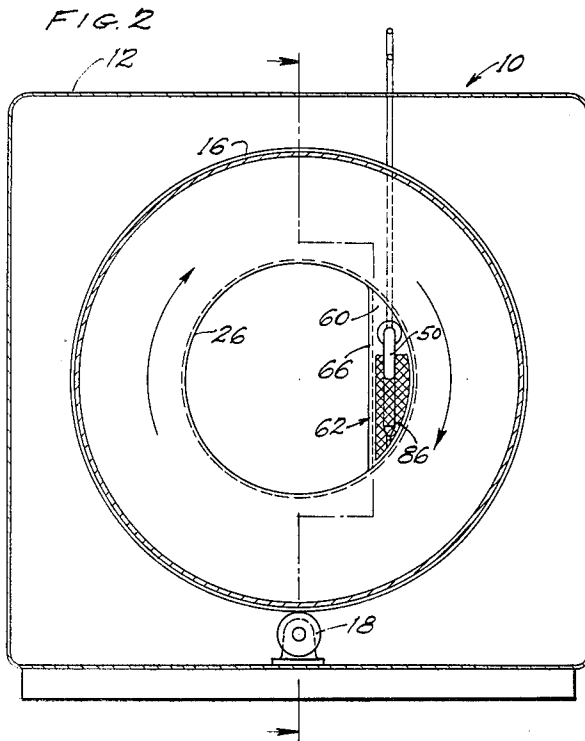
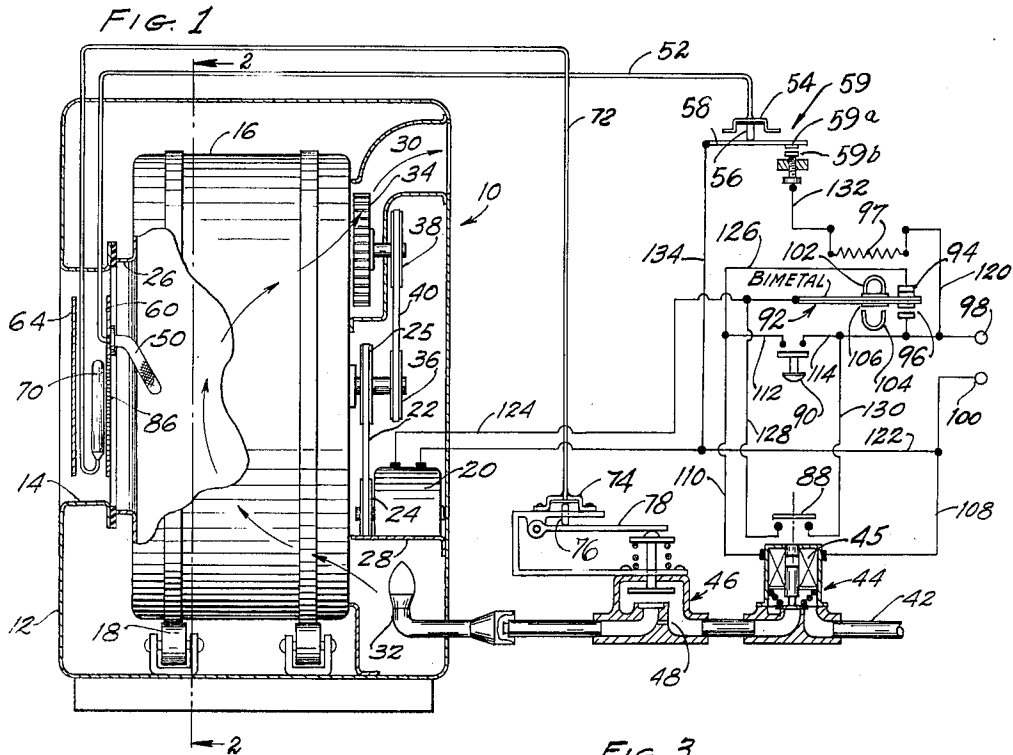
May 24, 1966

T. P. FLEER

3,252,227

BURNER CONTROL SYSTEM FOR CLOTHES DRYERS

Filed May 21, 1962



INVENTOR
THOMAS P. FLEER
BY *Charles E. Markham*
HIS AGENT

3,252,227

BURNER CONTROL SYSTEM FOR CLOTHES DRYERS

Thomas P. Fleer, Affton, Mo., assignor to White-Rodgers Company, St. Louis, Mo., a corporation of Missouri
Filed May 21, 1962, Ser. No. 196,268
10 Claims. (Cl. 34-45)

This invention relates to control systems for clothes dryers and particularly to fully automatic systems in which the heat input to the dryer is automatically modulated to maintain a predetermined drying temperature and in which the drying cycle is automatically terminated by means responsive to the moisture content of the load being dried.

The primary object of the invention is to provide a generally new and improved fully automatic control system for clothes dryers which is particularly simple and economical in construction and reliable in operation.

A further object is to provide a fully automatic control system for clothes dryers wherein once temperature responsive means functions to modulate the heat input so as to closely maintain a predetermined drying drum temperature and wherein another temperature responsive means including a sensing element contacted by the load being dried functions to cut off the heat supply and terminate dryer operation when the temperature of its sensing element closely approaches the predetermined drying drum temperature being maintained.

A further object is to provide a control system as above in which the sensing element contacted by the load being dried is a metal bulb containing a thermally expansible fluid, which bulb is covered with a moisture absorbent material and projects into the dryer drum so as to be contacted by articles of the load being dried as they are tumbled in the revolving drum.

A further object is to provide a control system as above in which a predetermined delay of the heat cut-off is provided following indication by the sensing element contacted by the load being dried that the load is closely approaching a dry condition, thereby to provide an interval during which random contact of the sensing element by articles in a light load, or by individual slower drying articles in an average load, may occur so as to preclude a premature cut off.

A further object is to provide a control system as above in which the first temperature responsive device regulating the heat input to the dryer is a particularly sensitive and positive-acting device comprising; a sensing bulb and expansible chamber connected by a capillary tube and having a fill consisting of a quantity of paraffin wax in the bulb as a thermally expansible material and a non-solvent liquid of higher specific gravity filling the remainder of the bulb, the capillary, and expansible chamber, and functioning as a motion transmission liquid.

Other objects and advantages will appear from the following description when read in connection with the accompanying drawing.

In the drawing:

FIG. 1 is a sectionalized view of a clothes dryer having schematically illustrated in association therewith a control system constructed in accordance with the present invention;

FIG. 2 is a cross-sectional view of the clothes dryer shown in FIG. 1, taken on line 2—2 of FIG. 1;

FIG. 3 is a longitudinal cross-sectional view of the "dry" bulb; and

FIG. 4 is an enlarged detail view of the sensing bulb contacted by the load.

Referring to the drawing, numeral 10 generally indicates a gas-fired clothes dryer having a casing 12 in the front side of which is formed a circular door frame 14.

The usual door has been omitted to simplify the illustration. Within the casing is a drying drum 16 mounted for rotation as on rollers 18 and the drum is rotated in the direction indicated by arrows in FIG. 2 by a driving motor 20 through a belt 22 and pulleys 24 and 25. The front of the drum has a circular opening 26 concentric with the door frame 14. Inlet and exhaust ducts 28 and 30, respectively, are formed in the casing on the rear side of the drum and heat from a gas burner 32 is induced by a blower 34 to enter the drum through perforations in the rear wall thereof and to flow through the drum and again pass through the drum perforations and exteriorly through exhaust duct 30, as indicated by direction arrows in FIG. 1. The blower 34 is driven by motor 20 through pulleys 36 and 38 and belt 40.

Gas is supplied to burner 32 through a supply pipe 42 in which is interposed in series arrangement a normally closed, electromagnetically operated, cutoff valve 44 and a normally open throttling valve 46. A bypass 48 is provided in the body of the throttling valve 46 to permit a minimum flow to the burner when the valve is completely closed.

A first temperature responsive actuator comprising an elongated bulb 50 mounted in the door frame 14 of the dryer casing, a capillary tube 52, and an expansible chamber 54 operates through a push pin 56 and a lever 58 to close a pair of normally open switch contacts 59a and 59b of a switch 59 when the fill of bulb 50 attains a predetermined temperature. The bulb 50, the capillary tube 52, and expansible chamber 54 form a sealed system containing a liquid fill such as xylene. The bulb 50 is supported at its inner end on the inner wall 60 of a casing 62 mounted in the door frame 14 at the right side thereof with reference to FIG. 2. The casing 62 also has an outer wall 64 and a side wall 66. The bulb 50 extends inwardly and downwardly into the dryer drum through the drum opening 26 so as to be contacted by articles of the load being dried as they are tumbled in the rotating drum. It will be seen from FIG. 2 that the bulb 50 is positioned at the righthand side of the drum opening and slightly above the axis of rotation of the drum so that when the drum is rotated clockwise, as indicated by direction arrows, articles of the load being tumbled in the drum will fall upon the bulb. The bulb 50 is constructed of metal such as copper and is provided with a moisture absorbing fabric sock 68, see FIG. 4.

A second temperature responsive actuator comprising an elongated bulb 70, a capillary tube 72, and an expansible chamber 74 operates through a push pin 76 and a lever 78 to vary the flow through valve 46 in accordance with the temperature of the thermally expansible fill of bulb 70. The bulb 70 is constructed of metal and is partially filled with paraffin wax as indicated at 84 in FIG. 3. The remainder of the bulb 70, the capillary 72, and expansible chamber 74 are filled with a liquid, such as water, which is heavier than the wax and is a non-solvent with respect to the wax. The elongated bulb 70 is mounted within the casing 62 adjacent the inner wall 60 in a vertical position. The bulb 70 is formed with a closed upper end and a reduced diameter lower open end into which the end of capillary 72 is inserted. The inner wall 60 of casing 62 is provided with a perforated or open grill portion 86 so as to permit the circulation of air from the dryer drum about the bulb 70.

The electrically operated elements and circuit controlling devices of FIG. 1 comprise the driving motor 20, the electromagnetic valve 44 having a winding 45 and a normally open circuit holding switch 88, a normally open push-button switch 90, the normally open switch 59, a double throw, snap-action, bimetal warp switch 92 having two pairs of contacts 94 and 96, and a resistance heater 97 to heat the bimetal blade of

switch 92. A pair of terminals 98 and 100 are provided for connection to a suitable electrical power source. The double throw warp switch 92 is provided with permanent magnets 102 and 104 and an armature 106 to provide a snap-action operation of the switch and to increase the operating differential of the switch. The switch 92 when unheated by resistance heater 97 assumes the position shown in FIG. 1, that is, with the pair of contacts 94 closed.

In operation

In a cold, room temperature condition, switches 59, 92, and 88 and valves 46 and 44 will be in the positions shown in FIG. 1. Under these conditions when it is desired to dry a wet load in the dryer drum, push-button switch 90 is pressed closed. This action completes circuits for energizing electromagnetic gas valve 44 and driving motor 20. The electromagnetic valve circuit is traced from terminal 100 through a lead 108, the electromagnetic winding 45, a lead 110, a lead 112, push-button switch 90, and a lead 114 to terminal 98. The circuit for motor 20 may be traced from terminal 100 through lead 108, a lead 122, motor 20, a lead 124, the bimetal blade of switch 92 and contacts 94, a lead 126, the lead 112, the push-button switch 90, and lead 114 to terminal 98. When winding 45 of valve 44 is energized the valve opens and circuit holding switch 88 closes completing a holding circuit for motor 20 and valve winding 45 when push-button 90 is released. This holding circuit is completed through a lead 128, the switch 88, and a lead 130. Fuel now flows to burner 32 where it is ignited by suitable means, and the dryer drum and blower 34 are in operation. Under these starting conditions throttling valve 46 is fully open and the burner is operating at maximum output.

As the dryer drum temperature increases, the temperature of the fill in both bulbs 50 and 70 increases. Due to the contact of wet articles of the load with the sock 68 on the bulb 50, the temperature increase of bulb 50 lags that of bulb 70. As the temperature sensed by the bulb 70 approaches a preselected drying temperature to be maintained, the valve 46 is gradually moved toward a closed position to closely maintain this temperature throughout the drying period. This preselected drying temperature is one at which light loads or fast drying articles will not be unduly heated and yet is sufficiently high to dry heavy loads or slow drying articles with reasonable speed and would lie in a range from 140° to 160° Fahrenheit. In this range of temperatures the coefficient of expansion of paraffin wax is extremely high which, with an incompressible, motion transmission liquid, results in a very sensitive and positive control of the throttling valve 46 and provides whereby the preselected drying temperature may be maintained as closely as one degree Fahrenheit variation.

The bypass 48 through valve 46 provides a minimum flow to burner 32 to insure proper ignition and is of such capacity as to maintain a dryer drum temperature, either empty or with a dry load, at a point which is slightly below the preselected drying temperature. For example, in a particular dryer, I have selected 154° Fahrenheit as the optimum drying temperature, and the bypass 48 is sized to maintain 150° Fahrenheit with a dry load or an empty drum. Also, in this same example, the switch 59, is adjusted to close when the temperature of the fill in bulb 50 reaches 151° Fahrenheit or within 3° Fahrenheit of the preselected drying temperature being maintained.

During the drying period the temperature of the fill in bulb 50 is maintained at some point more than 3° Fahrenheit below the preselected drying temperature due to evaporation of moisture in sock 68. As the load approaches a dry condition less and less moisture is transferred from the articles being dried to the sock 68 and the temperature of the fill in bulb 50 rises. When the tem-

perature of bulb 50 approaches to within 3° Fahrenheit of the preselected drying temperature, switch 59 closes contacts 59a-59b. This action completes an energizing circuit for resistor 97 which may be traced from terminal 98 through a lead 120, the resistor 97, a lead 132, contacts 59a-59b of switch 59, a lead 134, and lead 122 to terminal 100. When the bimetal blade of switch 92 has been heated for a predetermined period by resistance heater 97, it pulls away from the attraction of magnet 102 and moves to the magnet 104 with a snap action, thereby separating contacts 94 and closing contacts 96.

The separation of contacts 94 breaks the described holding circuits for electromagnetic fuel valve 44 and motor 20, but the closing of contacts 96 completes a second circuit for motor 20 to maintain rotation of the blower and drum for some predetermined cool-down period after the fuel valve 44 closes to cut off the heat supply. This second circuit for motor 20 may be traced from terminal 100 through lead 122, motor 20, lead 124, the bimetal blade of switch 92, the now closed contacts 96, and the lead 114 to terminal 98.

As the dryer cools down the fill of bulb 50 contracts and results in the reopening of contacts 59a-59b of switch 59. This action breaks the energizing circuit for resistance heater 97, whereafter the bimetal blade of switch 92 cools and returns with a snap action to its original position with contacts 94 closed and contacts 96 open. The drying and cool-down cycle is now completed.

The time required after closure of switch 59 to heat and effect operation of double throw switch 92, and consequently cut off of heat, provides an interval during which random contact of bulb 50 by any of the damper articles of a load may occur. If at any time within this interval the bulb sock 68 is dampened by a slower drying article, the temperature of the bulb 50 will again drop and switch 59 will reopen to further extend the drying period.

The desired dry condition of the load may be selected by the adjustment of adjustable contact 59b of switch 59. Adjustment in a direction to further separate the contacts will result in a drier load condition, and adjustment in a direction to move the contacts closer together will result in a damp-dry condition.

The interval required to heat the bimetal blade of switch 92 after closure of switch 59 may be varied by variably shorting out portions of resistor 97. It will be noted that the cool-down period during which the drum and blower are in operation after heat is cut off is the sum of the time required for bulb 70 to cool and open switch 59 and the time required for the bimetal blade to cool after switch 59 is opened.

In the illustrated and described construction, the bulb 70 is relatively closely associated with the bulb 50 so that the bulb 70 senses substantially the same temperature as does the bulb 50 that is, the interior drum temperature at that point. It is to be understood, however, that the bulb 70 may be located in any suitable place in the dryer so long as the temperature at that place varies in a fixed relationship with the temperature being sensed by the bulb 50. It is also essential to accuracy of function of the device that "dead" spots with respect to air circulation be avoided when locating the bulb 70 lest the temperature being sensed by the bulb 70 lag that being sensed by the bulb 50. It may be necessary in some clothes dryer designs, due to the air circulation pattern, to project the bulb 70 into the dryer drum as is the bulb 50 in order that the temperature sensed by both bulbs changes at the same rate and in some fixed relationship.

I claim:

1. In a clothes dryer, a casing, a rotatable drying drum having a central axial opening, a heat producer, means for rotating said drum and means for circulating heated air therethrough; a first control means for varying the heat output of said heat producer, a first thermostatic device responsive to the temperature in said drum, said thermo-

5

static device being operatively connected to said control means and being operative to vary the heat output of said heat producer in accordance with requirements to closely maintain a predetermined drying temperature within said drum, a second on and off control means operative to permit or prevent operation of said heat producer and being normally in an on position, a second thermostatic device including a temperature sensing element supported on said casing and projecting into said drum through said opening, and said sensing element being arranged to be contacted by articles of the load being dried, and said second thermostatic device being operative to effect the movement of said second control means to an off position when the temperature of its said sensing element closely approaches the predetermined drying temperature being maintained in said drum.

2. In a clothes dryer having a casing, a rotatable drying drum therein having an opening therein, a heat producer, means for rotating the drum, and means for circulating air heated by said heat producer through said drying drum, a first control means operative to vary the heat output of said heat producer, a second on and off control means operative to permit or prevent operation of said heat producer and having a normal on position, a first thermostatic device disposed so as to be responsive to temperature variations in an area of said dryer in which the temperature varies substantially in fixed relationship with temperature variations in an area within said drum adjacent said opening therein, said first thermostatic device being operatively connected to said first control means and being operative to vary the output of said heat producer in accordance with requirements to maintain a substantially constant drying temperature in said area within said drying drum, a second thermostatic device including a temperature sensing element supported on said casing and projecting into said drum through said opening and being arranged to be contacted by articles of the load being dried, and said second thermostatic device being operative to effect the movement of said second control means to an off position when the temperature of its said sensing element closely approaches the constantly maintained temperature ambient thereto.

3. The arrangement of claim 2 in which said second thermostatic device consists of an elongated temperature sensing bulb, an expandable chamber, and a connecting capillary tube forming a sealed system containing a thermally expandable fluid and in which said bulb is covered with a moisture absorbing material.

4. The arrangement of claim 2 in which the drying drum rotates on a horizontal axis and includes an axial loading opening and in which said temperature sensing element of said second thermostatic device extends into the drum through the loading opening at a point wherein articles of a load being dried will fall upon it as they are tumbled in a rotational manner in the drum.

5. In a clothes dryer having a casing, a rotatable drying drum therein having a loading opening, a heat producer, a circulator for circulating heated air through said drum, and an electric motor for driving said drum and said circulator; a first control means for varying the output of said heat producer and a first thermostatic device including a temperature sensing element responsive to temperature variations at a point in the dryer wherein the temperature varies in substantially fixed relationship with a predetermined area within said dryer adjacent the loading opening therein, said first thermostatic device being operatively connected to said first control device and being operative to vary the heat output of said heat producer in accordance with requirements to closely maintain a predetermined temperature in said predetermined area, electrically operated means which when energized permits operation of said heat producer and when de-energized cuts off the operation thereof an energizing circuit including said electrically operated means and said motor, push-button switch means and electrically operated drop-

6

out holding switch means for initially completing and holding completed said energizing circuit, a double throw, snap-action, thermal time switch in said circuit which when in a cold position completes the circuit at that point and when in a heated position breaks said circuit at that point and completes a circuit branch to maintain operation of said motor only, an electrical resistance heater for heating said double throw switch, an energizing circuit for said heater including a normally open switch, a second thermostatic device including a temperature sensing element supported on said casing and extending into said drum through said loading opening and into said predetermined area whereby it is contacted by articles of a load being tumbled in said drum, said second thermostatic device being operatively connected to said normally open switch and being operative to close it when the temperature of its sensing element closely approaches the temperature being maintained in said predetermined area, whereby a delay occurs between closure of said normally open switch and the operation of said double throw switch from its cold to heated position during which said double throw switch is being heated and whereby operation of said dryer drum and circulator is maintained after cut off of said heat producer for the period required for the temperature of said sensing element of said second thermostatic device to drop sufficiently to permit reopening of said normally open switch plus the period required for said double throw switch to cool and return to its cold position.

6. In a clothes dryer having a casing, a rotatable drying drum therein having a loading opening, a heat producer, and means for rotating the drum and for circulating heated air through the drum; control means for varying the output of said heat producer, a first thermostatic device including a temperature sensing element responsive to interior drum temperature, said first thermostatic device being operatively connected to said first control means and being operative to vary the heat output of said heat producer in a manner to closely maintain a predetermined interior drum temperature, electrically operated means which when energized permits operation of said heat producer and when de-energized cuts off the operation thereof, an energizing circuit for said electrically operated means including a normally closed switch which when heated for a predetermined period opens to break said circuit, an electrical resistance heater for heating said switch, an energizing circuit for said resistance heater, a normally open switch controlling said heater energizing circuit, a second thermostatic device including a temperature sensing element supported on said casing and extending into said drum through said loading opening, thereby to be contacted and dampened by articles of a load being dried, and said second thermostatic device being operatively connected to said normally open switch and operative to close said switch in said heater energizing circuit when the temperature of its sensing element closely approaches that predetermined interior drum temperature being maintained, whereby a delay between the closure of said normally open switch and the cut off of said heat producer occurs due to the time required to heat said normally closed switch.

7. An arrangement as set forth in claim 6 in which said normally open switch has a movable contact operatively connected to said second thermostatic device and an adjustable stationary contact whereby the temperature at which said normally open switch closes may be varied.

8. An arrangement as set forth in claim 6 in which said temperature sensing element of said second thermostatic device includes a moisture absorbing outer covering.

9. An arrangement as set forth in claim 6 in which said temperature sensing element of said first temperature responsive device is positioned closely adjacent said temperature sensing element of said second temperature responsive device but is shielded from contact by articles of the load being dried.

10. In a clothes dryer having a rotatable drying drum, a heat producer, and means for circulating heated air through the drying drum control means for varying the heat output of said heat producer, a first thermostatic device responsive to the air temperature within said dryer drum, said thermostatic device being operatively connected to said control means and being operative to vary the output of the heat producer in accordance with requirements to maintain a constant predetermined temperature in said drying drum while a load is being dried therein, electrically operated means operative when energized to permit operation of said heat producer and operative when de-energized to cut off the operation thereof, an energizing circuit for said electrically operated device including a normally closed switch, electrically operated time delay means which when energized for a predetermined period effects the opening of said normally closed switch, an energizing circuit for said time delay means including a normally open switch, and a second thermostatic device including a temperature sensing element extending into said drying drum to sense the temperature therein and arranged to be contacted by articles of a load being dried, and said second temperature responsive device being operatively connected to said normally open switch and being operative to close said normally open switch when the temperature of its sensing element closely approaches said predetermined temperature being maintained in said drum.

tending into said drying drum to sense the temperature therein and arranged to be contacted by articles of a load being dried, and said second temperature responsive device being operatively connected to said normally open switch and being operative to close said normally open switch when the temperature of its sensing element closely approaches said predetermined temperature being maintained in said drum.

References Cited by the Examiner

UNITED STATES PATENTS

2,820,304	1/1958	Horecky	34—45
2,895,230	7/1959	Reiley	34—45
3,045,993	7/1962	Sidaris	34—45
3,151,850	10/1964	Wellford	34—45 X
3,186,105	6/1965	Nye et al.	34—45

WILLIAM F. O'DEA, *Primary Examiner.*

NORMAN YUDKOFF, *Examiner.*

JOHN J. CAMBY, *Assistant Examiner.*