March 29, 1966 J. C. WORST 3,242,585

AUTOMATIC DRYER CONTROL SYSTEM

Filed Nov. 22, 1963 2 Sheets-Sheet 1

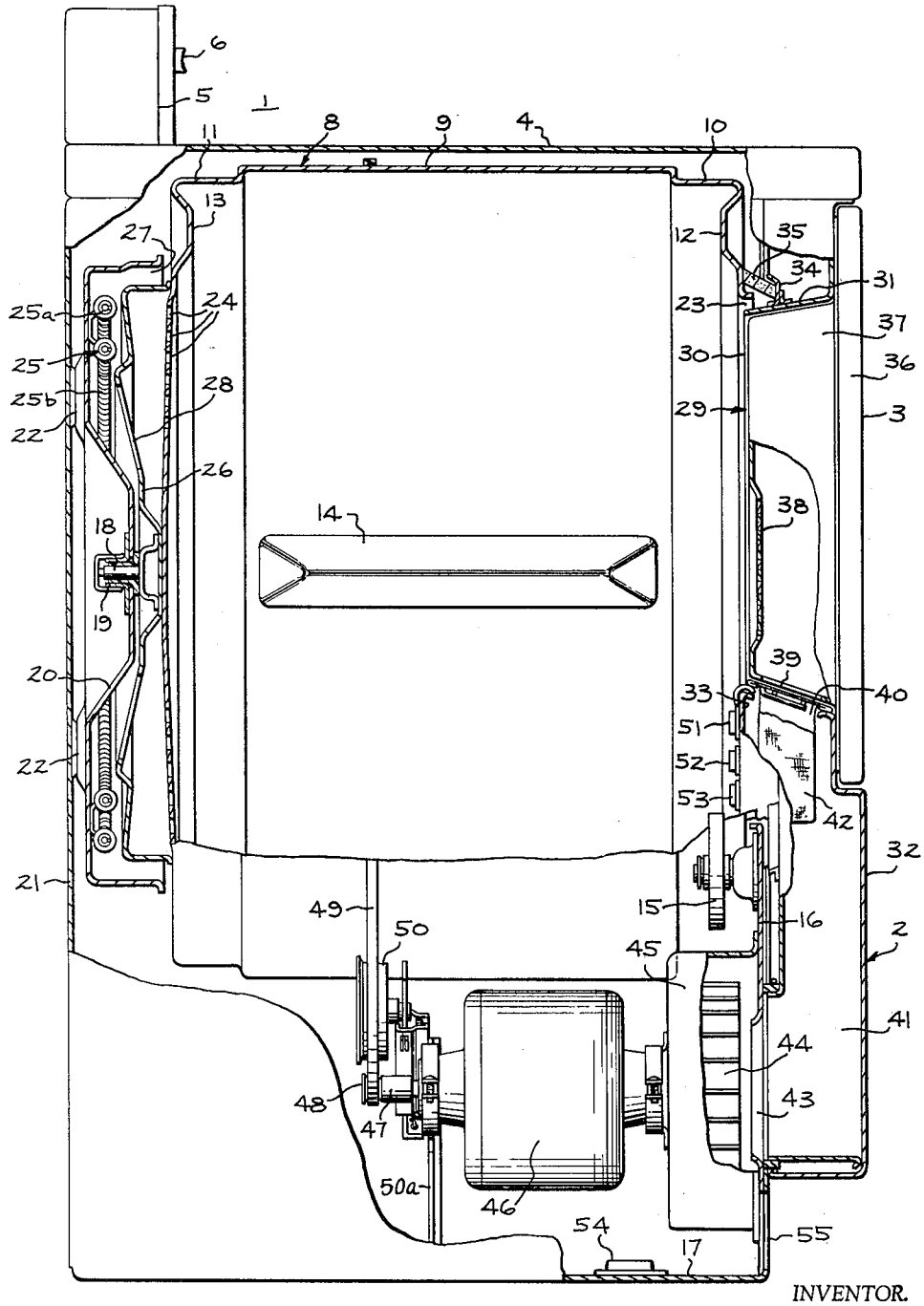


FIG. 1

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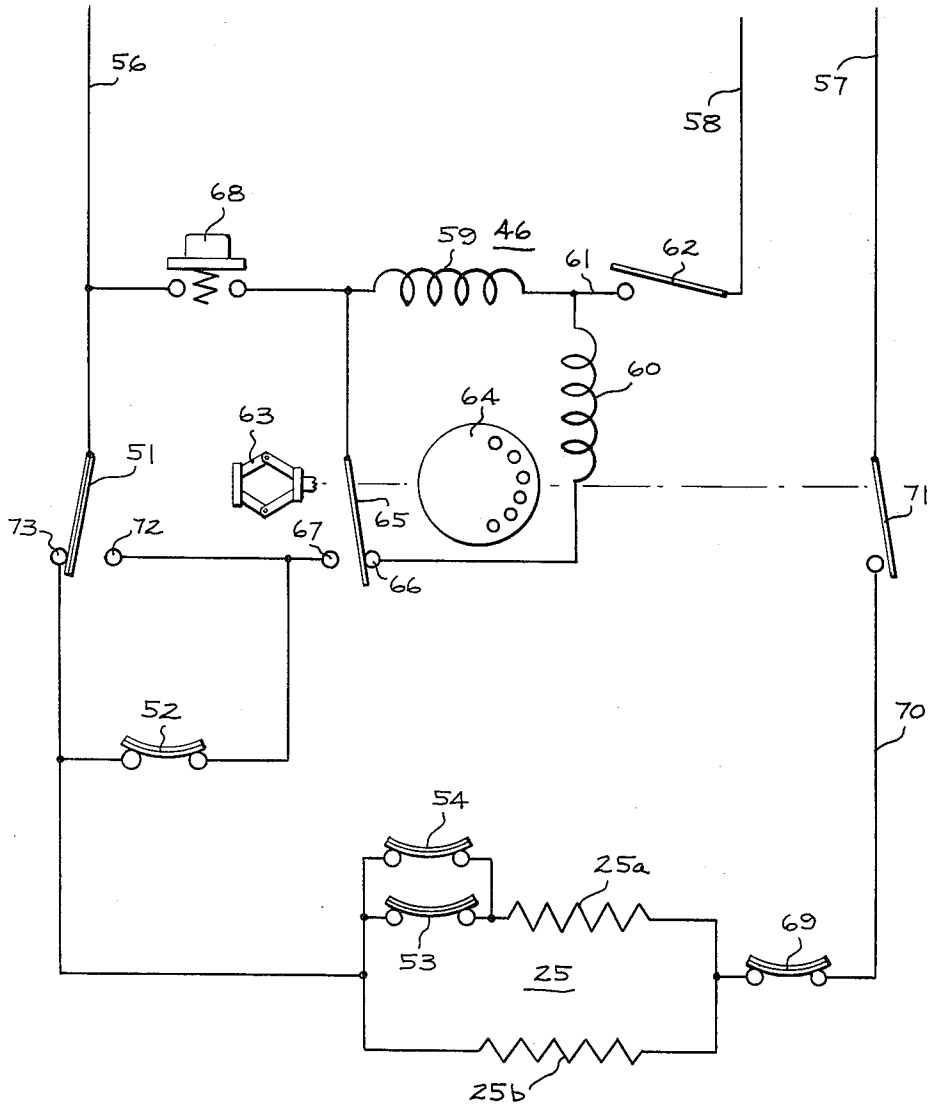


FIG. 2

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3,242,585

AUTOMATIC DRYER CONTROL SYSTEM

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1 Claim. (Cl. 34—45)

This invention relates to automatic clothes dryers, and more particularly to systems for electric dryers wherein termination of the drying operation is brought about primarily by the condition of the clothes rather than purely by elapse of time.

There are available at the present time domestic clothes dryers which provide a drying operation wherein, when the clothes are substantially dry, the machine automatically terminates operation. Most of the systems wherein the operation is thus terminated are based on the temperature of the air used in the drying operation after it has contacted the clothes. Such systems are based on the proven logic that, initially, when clothes have a substantial amount of moisture available to be evaporated, most of the energy put into the clothes in the form of heat is used to evaporate the moisture in the clothes. In other words, this heat energy input causes only a gradual rise in temperature once the point is reached at which the rate of energy used to evaporate moisture almost equals the energy input in heat. It is only after substantially all of the available moisture has been evaporated that there is a surplus of heat energy to cause a substantial temperature rise. Therefore, during the drying operation, there will be a temperature plateau, that is, a gradual rise while the clothes are drying, followed by a relatively sharp rise once the clothes are dry.

Such systems have been found to be highly effective. However, in order to obtain optimum results in the past, it has been found necessary to vary the trip temperature, that is, the temperature at which the clothes are presumed dry, in accordance with changes in the ambient atmosphere from which the drying air is taken. In other words, in present machines, different ambient temperatures, unless compensated for, cause the plateau to be established at different temperatures, and the rapid temperature rise at the end of the plateau will therefore also start at different temperatures. Dryers which have not included compensation for differences in the ambient temperature have shown a tendency to under-dry when the ambient temperature is quite high such as, for instance, in the nineties; similarly, such dryers have had a tendency to over-dry when the ambient temperature is quite low, for instance, in the fifties. Such variations in temperature, incidentally, may often be found when a dryer is located in a basement or on a back porch.

It is accordingly an object of my invention to provide a simple ambient compensation system so as to preclude over-drying or under-drying as a result of variations in the ambient temperature.

More specifically, it is an object of my invention to achieve such a goal with a single trip temperature, by varying the rate of energy input to the clothes toward the end of a cycle, depending upon the ambient temperature, but without letting the ambient temperature affect the energy input rate during the initial part of the drying operation.

In carrying out my invention in one form thereof, I provide a fabric drying machine in which ambient air is circulated through a fabric container by appropriate air circulating means. Electric heating means are provided for heating the air which is passing into the container, and my invention contemplates the use of a type of heating means wherein at least two electric resistance elements are used. Means for automatically causing termination of the operation of the heating means are

provided so that the heating means ceases to operate after the fabrics attain a predetermined temperature which indicates dryness. Such means are well known in the art, and may take any of a number of particular forms.

One of the resistance heating elements is controlled by two separate thermostatically controlled switches. The first one of these switches is positioned to sense ambient temperature, enabling operation of the heater below a predetermined temperature and preventing it above the predetermined temperature. The second switch is connected in parallel with the first switch, and is positioned so as to respond to the temperature of fabrics in the container. This second switch is arranged to remain in a first position enabling energization of the element until a predetermined high temperature is sensed which indicates partial dryness of the clothes. When this high temperature is reached, the second switch then moves to a second position preventing energization of the element. As a result of this, it is insured that both elements will be energized during the initial part of a dry-operation, when the clothes are very wet and a maximum energy input is desirable. This will occur regardless of the position of the first switch because the second switch is closed. However, at the end of an operation, the second switch will open, and the ambient temperature will then determine, through the first switch, whether the operation is terminated with or without energization of the one element.

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 to illustrate details; and

FIGURE 2 is a schematic illustration of my improved control circuit.

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 clothes. Provided on the top wall 4 of cabinet 2 is a control panel 5 which may, in the conventional way, include a suitable pushbotton control 6 mounted in panel 5. By manual depression of button 6, the machine may be caused to start, and automatically proceed through a cycle of operation.

Within cabinet 2, there is provided a clothes tumbling container, or drum, 8 mounted for rotation on a substantially horizontal axis. Drum 8 is substantially cylindrical in shape, having a first cylindrical wall portion 9, second and third outer cylindrical 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 outer shell of the basket is imperforate. On the interior surface of central portion 9 there may be provided a plurality of clothes tumbling ribs 14 so that clothes are lifted up when the drum rotates, and then tumble back down to the bottom of the basket.

The front of drum 8 may be rotatably supported within outer casing 2 by suitable idler wheels, one of which is shown by the numeral 15. These wheels are rotatably secured to the top of a member 16 which extends up from base 17 of the machine. Wheels 15 are disposed beneath

the drum in contact with portion 10 thereof so as to support portion 10 on each side to provide a stable support.

The rear end of drum 8 receives its support by means of a stub shaft 18 extending from the center of wall 13. Shaft 18 is secured within a bearing 19 formed in a baffle 20 which in turn is rigidly secured to the back wall 21 of cabinet 2 by any suitable means such as, for instance, welding at a number of points 22. With the arrangement shown the basket may rotate on a horizontal axis, with rollers 15 providing the front support and stub shaft 18 within bearing 19 providing the rear support.

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 23 in its front wall 12 and with an opening in the form of a plurality of perforations 24 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 20 is rigidly secured to rear wall 21 of cabinet 2. Baffle member 20 also serves to support heating means 25 which includes two electrical resistance heating elements 25*a* and 25*b* appropriately insulated from the baffle member. Elements 25*a* and 25*b* may be annular in shape so as to be generally coextensive with perforations 24 in drum 8. A baffle member 26 is rigidly secured to the back wall 13 of the drum outside the ring of perforations 24 and within the stationary baffle 20, so that an annular air inlet 27 is in effect formed by baffles 20 and 26. In this manner a passage is formed for air to enter annular inlet opening 27 between the baffles, pass over the heater 25, and then pass through openings 28 formed in baffle 26 to the interior of drum 8.

The front opening 23 of the drum is substantially closed by means of a stationary bulkhead generally indicated by the numeral 29. Bulkhead 29 is made up of a number of adjacent members including the inner surface 30 of access door 3, a stationary frame 31 for the door formed as a flange of front wall 32 of the cabinet, the inner surface member 33 of an exhaust duct which is formed by the cooperation of member 33 with the front wall 32 of the cabinet, and an annular flange 34 mounted on frame 31 and on the duct wall. It will be noted that a siutable clearance is provided between the inner edge of the drum opening 23 and the edge of bulkhead 29 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 23 between the interior and the exterior of the drum, a suitable ring seal 35, preferably formed of felt-like material, is secured to flange 34 in sealing relationship with the exterior surface of drum wall 12.

Front opening 23, in addition to serving as part of the air flow path 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 opened clothes may be inserted into or removed from the drum through the door frame 31. It will be noted that the door includes an outer flat imperforate section 36 and an inwardly extending hollow section 37 mounted on the flat outer section. Hollow section 37 extends into the door frame 31 when the door is closed, and the door surface 30 which comprises part of the combination bulkhead 29 is actually the inner wall of the hollow section.

The air outlet from the drum is provided by a perforated opening 38 formed in the inner wall 30 of hollow door section 37. The bottom wall section of door 3 and the adjacent wall of door frame 31 are provided with aligned openings 39 and 40, opening 40 providing the entrance to the duct 41 formed by the cooperation of member 33 with front wall 32. As shown, a lint trap 42, which may comprise a fine mesh bag, is preferably positioned in the exhaust duct 41 at opening 40, the bag being supported by the door frame 31.

Duct 41 leads downwardly to an opening 43 formed in the member 16 which supports wheels 15. Opening 43 constitutes the inlet to a blower member 44 contained within a housing 45 and directly driven by an electric motor 46. The blower draws ambient air in over the heater 25, then through the basket, then through the door 3 and the duct 41, and then into the blower. 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 44, motor 46 constitutes the means for effecting rotation of drum 8. In order to effect this, motor 46 is provided with a shaft 47 having a small pulley 48 formed at the end thereof. A belt 49 extends around pulley 48 and also entirely around the cylindrical wall section 9 of drum 8. The relative circumferences of pulley 48 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 49, there may be provided a suitable idler assembly 50 secured on the same support 50*a* 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 the air is heated by heating elements 25*a* and 25*b*, the heated air passing through the drum causes vaporization of moisture from the clothes. The vapor is carried off with the air as it passes out of the machine.

In order to control the operation of dryer 1, four thermostats, which may for the sake of economy be of the relatively simple bimetallic type, are provided. Three of these, 51, 52 and 53 are positioned on wall 33 of duct 41 adjacent outlet opening 38 so that their temperature varies essentially with the temperature of the clothes being tumbled within drum 8. A fourth thermostat 54 is positioned so as to be responsive to the ambient air temperature. This may readily be effected by positioning it adjacent an opening 55 provided in the lower front part of the cabinet, so that air being drawn over the heater 25 is drawn in through opening 55 and passes over thermostat 54.

The thermostats 51, 52 and 53, may, of course, have different operating values for differently designed machines. In the present case, I have chosen, for the proper operation of the machine shown, a thermostat 51 designed to open its associated switch at 155° F., and reclose it at 135° F. Thermostat 52 is designed to open its associated switch at 175° F. and to re-close it at 120° F. Thermostat 53 is designed to open and close at the same temperatures as thermostat 51. Thermostat 54 may for instance, be of the type which will open at a temperature of about 80° F. and re-close at a temperature about 70° F. Bimetallically controlled switches of the type described are readily available at very low cost as standard articles of commerce.

The operation of dryer 1 is controlled by the 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 56 and 57 and a neutral conductor 58. For domestic use, conductors 56 and 57 will normally be connected across a 220 volt power supply, with 110 volts appearing between the neutral line 58 and each of the conductors, and with the neutral line being at ground voltage. Motor 46, connected between conductors 56 and 57, is a single phase induction type motor having a main winding 59 and a start winding 60, both connected at a common end to a conductor 61. Through a conventional door switch 62 (which is closed when door 3 is closed and is opened when the door is open) conductor 61 is connected to conductor 58.

Start winding 60 is connected in parallel with main winding 59 under the control of a speed responsive device such as that shown at 63, which is schematically shown as connected to rotor 64 of the motor. The speed re-

sponsive device 63 controls a switch 65 which is engageable with either a contact 66 or a contact 67. Switch 65 is engaged with contact 66 when the machine is at rest, and moves into engagement with contact 67 as the motor comes up to speed. It can readily be seen that engagement with contact 66 connects the start winding 60 in parallel with main winding 59, while movement of switch 65 away from this position opens the start winding. Thus, as rotor 64 comes up to speed the start winding becomes de-energized and the motor then continues to run on the main winding 59 alone.

The starting of the motor is provided by a manually operable switch 68 which may, for instance, in the structure of FIGURE 1, be moved to its closed position be depressing pushbutton 6. Switch 68 connects the motor to supply conductor 56, and is normally biased to the open position shown. When member 6 is depressed, energization of the motor is provided, and within less than a second then, under normal circumstances, the motor comes up to speed so that switch 65 engages contact 67. As a result of this movement of the centrifugally operated switch 65, the main winding 59 of motor 46 continues to be energized by a bypass around switch 68 when member 6 is released and switch 68 opens. This bypass is completed through switch 51, which is in the position shown when it is at temperatures up to 155° F., and switch 52 which is closed up to 175° F., as previously mentioned.

An energizing circuit is also completed for heater 25 through the following circuit: Starting at conductor 56, the circuit proceeds through switch 51, in the position shown, to the heater 25, and then through a conventional safety thermostat 69 to a conductor 70 leading back through a switch 71 to conductor 57. Switch 71 is controlled by centrifugal member 63, being closed only when the motor has come up to speed so that there can be no energization of the heater assembly 25 except when motor 46 is operating properly.

As described in connection with FIGURE 1, both thermostats 51 and 52 are positioned so as to sense the clothes temperature, or a temperature which varies substantially directly with the clothes temperature. When operation of the machine starts with energization of assembly 25, the energizing circuit for the heater is through the path described. As the temperature rises, at 155° F. the thermostatic switch 51 moves over into engagement with contact 72. This completes a path directly to the motor without the need for switch 52, and further completes a path for the energization of the heater assembly 25 through the switch 51 in engagement with contact 72 and through switch 52.

When the clothes are at a temperature which indicates dryness, thermostat 52 will open. This de-energizes the heater assembly 25 completely, but lets motor 46 remain energized through switch 51. As explained, thermostat 51 re-closes at 135° F. and thermostat 52 at 120° F. Consequently, thermostat 51 snaps back to its initial position in engagement with contact 73 while switch 52 is still open. This then opens the motor circuit to de-energize the motor, and the de-energization of the motor opens switch 71 to terminate operation of the machine.

As stated, thermostat 52 is designed to open at a temperature indicating dryness of the clothes. As also stated however, a very high ambient temperature will cause under-drying unless some compensation is made, and a very low ambient temperature will cause over-drying. In order to take care of this in the most economical manner possible, I have provided an improved arrangement for effecting additional control of the heater assembly 25. Switches 53 and 54 are connected in parallel with each other and in controlling relationship to element 25*a* of the heater assembly. Specifically, in the present structure, the two switches are in series with the element in order to effect control thereof.

As previously described, switch 53 is always closed at the beginning of a drying operation because the temperature within the dryer is below the switch closing temperature of 135° F. Switch 54, since it responds to ambient temperature, may either be open or closed, depending upon whether the ambient temperature is high or low. Thus, at the beginning of an operation, switch 54 may be open or closed, but switch 53 is always closed and therefore insures that during the initial part of a drying operation energization of element 25*a* as well as of element 25*b* will be provided. This assures maximum input of energy to the clothes, and this is important at the time when the clothes are quite wet. It is during the initial part of an operation, when the clothes are quite wet, that full energy input is desirable in order to achieve the shortest drying time possible.

Toward the end of an operation, however, I have found that it is important that the proper amount of power be provided to the clothes in order to effect drying at the proper rate based on the ambient temperature. In other words, compensation is effected by causing heat to be provided to the clothes at different rates at the end of a drying operation. What this means is that a relatively low power input compensates for a relatively high ambient temperature and, by causing the clothes to be dried over a substantially longer period, ensures full dryness rather than permitting the underdrying that might otherwise occur. By the same token, the provision of a substantial amount of heat energy, when the ambient temperature is low, ensures that a minimum amount of time will elapse before the tripping of thermostat 52 and that, therefore, the clothes will not be over-dried as they might otherwise be with a low ambient temperature.

As has been stated, switch 53 is designed to open at a temperature of 155° F. This is a temperature which insures that the clothes are well on their way to dryness, but are still far from being completely dry as measured by the 175° F. opening temperature of switch 52. In other words, switch 53 is intended to open at an intermediate portion of the cycle at a time when the need for maximum power input may have passed, dependent on ambient conditions, and it is time for the compensation to be provided to prevent under-drying or over-drying.

When switch 53 opens, the control of the energization of element 25*a* is then up to switch 54. As shown in FIGURE 1, switch 54 is positioned to sense ambient temperature, being open at temperatures of 80° F. and above and being closed at temperatures of 70° F. and below. What this means is that at a low temperature, on the order of 60° F., for instance, such as may prevail in a basement in the winter time, switch 54 will be closed to ensure energization of element 25*a* throughout the drying operation. On the other hand, if it is a hot summer day with the temperature in the nineties, the switch 54 will assuredly be open and thus, during the terminal portion of a drying operation, element 25*a* cannot be energized since both switches 53 and 54 will be open. This will ensure a more prolonged drying operation and a consequent correction of the possible under-drying which might otherwise occur as a result of the high ambient temperature.

Thus, there is a special relationship of thermostats 53 and 54 to element 25*a* which, as proven by tests on the structure described, provides improved compensation for variations in ambient temperature so that a very simple temperature-based automatic drying system may be utilized.

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 the invention, and it is therefore aimed in the appended claim 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:

A fabric drying machine comprising:

(a) a fabric container having an air inlet opening communicating with atmosphere and an air outlet opening;

(b) means for circulating ambient air through said container;

(c) electric heating means for heating the air passing into said container, said heating means comprising at least two resistance elements;

(d) means for automatically causing termination of the operation of said heating means after the fabrics attain a predetermined temperature indicating dryness, said means including a first thermostatically controlled switch controlling said heating means, said first switch opening at a predetermined temperature to terminate operation of said heating means;

(e) a second thermostatically controlled switch in series with one of said elements, said second switch being positioned to sense ambient temperature, said second switch being arranged to be closed below a predetermined temperature and to be open above said predetermined temperature;

(f) and a third thermostatically controlled switch connected in parallel with said second switch and in series with said one element, said third switch being positioned to respond to the temperature of fabrics in said container, said third switch being arranged to remain closed until a predetermined high temperature is reached which is substantially below the predetermined high temperature at which said first switch opens and thus indicates partial dryness of the clothes, said third switch thereupon opening, said electric heating means being in series with said first switch whereby said one element is controlled by said second switch only during the later part of the drying operation.

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