This invention relates to laundry dryers and more particularly to a system for accurately controlling the period of dryer operation.

Laundry dryers, in general are provided with a compartment in which damp or wet fabrics or clothes are placed, and through which air is circulated or translated to evaporate the moisture therefrom. In the usual arrangement, heated air is circulated through the laundry, while undergoing tumbling in a revolving drum. To effect drying within a reasonably short time, the air, before circulation through the clothes, is raised to as high a temperature as permissible, within limits dictated by the ability of the fabrics to withstand dry heat. Such temperature limits have been imposed to protect the fabrics from overheat scorching, and damage, due to continued and unnecessary prolonged operation of the dryer, after all of the moisture has been evaporated from the fabrics. So long as the fabrics contain moisture, and are being cooled by evaporation, scorching and damage cannot occur, even with high air temperatures.

It will be appreciated that the operation of the dryer should be discontinued, once the fabrics have reached the desired state of dryness. Various attempts have been made to provide for automatic termination of the dryer operation, when the moisture has been evaporated from the fabrics, but for the most part, such attempts are based on timers which are set by the operator, in accordance with the best guess as to the drying period required. Since a longer period than necessary will generally be selected, the operator is given the opportunity to select several maximum safe drying temperatures in accordance with the fabrics being dried, since prolonged operation of the dryer after evaporation is completed, would injure certain fabrics if a high temperature were permitted to prevail during such prolonged operation following completion of drying. Thus the heat input during drying must be curbed to protect the fabrics from damage that might occur by reason of the unnecessary prolonged operation of the dryer, after drying of the fabrics has actually been completed.

During the evaporation of moisture from the fabrics, hot air delivered to the tumbling drum is cooled by the evaporation, and such air entering the exhaust duct of the dryer is well below the temperature normally set as a safe maximum, but as soon as the fabrics approach a dry state, due to the rate of evaporation being severely reduced, the exhaust duct air temperature rises rather sharply. Attempts to use this temperature rise to terminate the dryer operation, have not been satisfactory, because, when the temperature rise occurs, the clothes are not yet actually dry. The use of such temperature rise to start a mechanical timer which may then operate the dryer for an arbitrary period has been proposed. However, such period as may be selected, still bears no relation to the actual time required to complete the drying of the particular fabrics in the dryer.

The present invention is directed to a dryer control requiring no timer, and operative to control the drying time in direct response to the evaporative characteristics and moisture content of the fabrics to be dried, whereby the fabrics drying time will be correlated with the actual dryer operation time. The invention is further directed to a dryer in which maximum heat input may be utilized during drying, regardless of fabric characteristics, by reason of coordination between fabric drying time and dryer operation. The invention further has to do with a dryer control in which the change in humidity of the discharged air effects a control over the operational period of the dryer. Further, the invention is directed to a dryer control in which the application of heat to the dryer is terminated by the delayed operation of an exhaust air duct thermostat. The operation of such thermostat is delayed by a moisture absorbing shield or blanket, the evaporative drying of which by the exhaust air delays the dryer operation, by a time interval commensurate with the time required to bring the fabrics from the almost dry state to the usual desired state of dryness. Such blanket also acts as a heat insulator, which in part is responsible for delayed thermostat operation.

The above and other novel features of the invention will appear more fully hereinafter from the following detailed description when taken in conjunction with the accompanying drawings. It is expressly stated that the drawings are employed for purposes of illustration only and are not designed as a definition of the limits of the invention, reference being had for this purpose to the appended claims.

In the drawings, wherein like reference characters indicate like parts:

Figure 1 is a diagrammatic showing of a laundry dryer of the type to which the invention may be applied;

Figure 2 is a diagrammatic view of the ducting in such dryer with parts broken away to show the thermostat;

Figure 3 is a control circuit diagram;

Figure 4 is an alternative control circuit diagram;

Figure 5 is a diagrammatic showing of a thermostat acting two independent single pole single throw switches as employed in Figure 3; and

Figure 6 is a diagrammatic showing of a thermostat acting a single pole double throw switch as employed in Figure 4.

Referring to Figures 1 and 2 there is shown a dryer cabinet 10 having therein a stationary drum housing 12 and a rotatable laundry tumbling drum 14 disposed within the stationary housing 12. The drum 14 has a front access opening 16 in alignment with a door 18. Air is circulated through the drum after being heated in a box containing resistance heating units 21. The air is caused to flow through the tumbling laundry contained in the drum 14 and thence into a discharge duct 22 which leads to the suction end of a blower 24. The tumbling drum 14 and blower are driven by a motor 28, which for the purpose are provided with belt drives 30 and 32 respectively. An overall protective thermostat 26 is provided in the wall of the drum housing 12 and low and high temperature thermostats 38 and 40 are mounted in the wall of the duct 22. The blower 24 discharges into a lint collecting chamber 26 after which the air is exhausted. Start and stop switches 44 and 46 are conveniently located upon the dryer cabinet, and a door switch 42 may be provided to stop the motor whenever the door is open.

Lamps 32 and 34, one for illumination and the other for ultra-violet rays, may be suitably disposed in relation to the drum 12 as indicated.

Referring to the circuit diagram of Figure 3 there are shown terminals 50, 52 and 54 for connection to a 220 volt source of supply. The terminal 52 and the terminal 50 are connected to a solenoid actuated double pole
single throw switch 56, actuated to closed position by energization of the solenoid 58. The low temperature thermostat 38 may be of a single pole single throw type which will open the circuit when the maximum temperature for which it is set is reached. This temperature may be about 130° F. The thermostat may also have an additional set of contacts 112 and 120 as shown in figure 5, which will close a circuit when the maximum temperature is reached. Such thermostat upon cooling through a range of 5° or such other range as may be desired, from the maximum set temperature of 130° may reclose the one set of contacts 105 and 106 and open contacts 112 and 120. A connection from the terminal 60 of the switch 56 leads to the thermostat 38, and then to a thermostat 40 which latter thermostat may be set to open at a temperature such as 170° F. The thermostat 40 is connected to the heater resistance coils 21 and then to a pair of contacts 70 of a centrifugal switch operated by the motor 28, such centrifugal switch contacts 70 closing whenever the motor approaches full speed operation. Such circuit is connected through a high temperature safety thermostat 36, with a return circuit to the double pole double throw switch 56 and the terminal 80 thereof. A signal or warning device 82 may be bridged across the thermostat 36, since the opening of such thermostat which may be intermittent will generally indicate improper operating conditions which may be due, for example, to a clogged lint trap impeding normal air flow.

The motor 28 has a field winding 90 connected to the ground terminal 54 and one terminal 95 of a double throw single pole door switch 42. The motor has a starting winding 92 connected through a pair of centrifugally operated contacts 94 which are closed during the starting operation of the motor 28. The common terminal 97 of the door switch 42 is connected to the terminal 80 of the switch 56 and the other contact 96 of the door switch 42 is connected to the line terminal 50. When the door is in closed position a circuit is established to the motor field 90 through contact 95, and when the door is open an auxiliary circuit is established through contact 96 through lamps 32 and 34 which are connected to ground as at 98 so that whenever the switch 56 is open, illumination may still be had.

Circuits for starting and stopping the operation of the dryer, including a normally open start switch 44 connected to terminal 52, and a normally closed stop switch 46 connected through the contacts 106 and 105 of the thermostat 38 to the terminal 40 respectively, are connected through the solenoid 58 to the ground so that either circuit, when closed, will energize the solenoid. It will be appreciated that momentary closing of switch 44 will energize solenoid 58 and close switch 56, after which the normally closed stop circuit will hold the switch closed until switch 46 is momentarily opened, or thermostat 38 opens contacts 105 and 106.

The auxiliary contacts 112 and 120 of the thermostat 38 are connected in a circuit extending from terminal 80 of the switch 56 to the line terminal 50. When the thermostat 38 acts in response to temperature in the duct 22 to open the stop circuit and thereby deenergize the solenoid 58 to open switch 56, the circuit to the motor 28 is restored by the closing of the contacts 112 and 120 and the motor continues to operate for a period until such thermostat 38 cools through a specified pre-set differential range such as 5°-10° when such thermostat opens contacts 112 and 120. The thermostat 38 is mounted in the side of the duct 22 and is protected from the heated air passing through the duct by a felt layer 124. The layer may be % inch thick or thereabouts and acts to retard the transfer of heat from the air stream within the duct to the thermostat 38 of the dryer. As felt has a tendency to pick up moisture, the air passing through the duct 22 which initially contains moisture evaporated from the laundry within the drum 14 will tend to condense moisture upon and wet the felt. Such air will have been cooled by the considerable evaporative cooling in the drum.

The thermostat 38, during the portion of the drying cycle when substantial evaporation of the moisture from the laundry is taking place is thus not subjected to the temperature of the air passing through the duct. During this period the moisture picked up by the felt from the relatively cool air stream makes for the lower temperature of the thermostat slightly, but the temperature of the thermostat remains below its operating temperature of 130°. When most of the moisture of the laundry is evaporated, evaporative cooling of the air stream from the laundry is substantially lessened, and the temperature of the exhaust air in duct 22 rises rather sharply. Such air becomes relatively dry at this time. If the thermostat 38 were exposed directly to the air stream its pre-set operating temperature of 130° would be promptly exceeded by the rise in temperature of the airstream, and the drying operation would thus be stopped immediately and prematurely. The moisture absorbed by the felt, as well as the heat insulation effect of the felt, act, during this stage of the operation to protect the thermostat from the rise in temperature in the duct 22, until such time as the moisture condensed in the felt is evaporated by the air stream, which has at this point a tendency to dry. After the stage of evaporative cooling of the felt, the heat within the duct slowly travels through the felt insulation, and produces delayed thermostat operation. The evaporation of moisture from the felt, tends to prolong the period that thermostat 38 is held below its set operating temperature of 130°, and the moisture condensed in the felt to the period before the temperature rise of the exhaust air in duct 22 will be effective to actuate the thermostat 38. The thermostat 40 provides an upper limit, so that should the exhaust air exceed 170° the heat will be temporarily cut off. The exhaust air in the duct 22 during operation may exceed 130° for a part of the cycle, but because the moisture absorbed by the felt reaches a maximum during the initial part of the cycle, the thermostat 38 is held below 130° by the insulating quality of the felt as well as by slight loss of moisture, and also by the heat lost from the portion of the thermostat exposed to cooler air outside the duct.

In this manner, a substantially automatic delay is provided before the heat is cut off. The period of such delay permits the dryer to operate long enough after the duct temperature rise, to complete the drying of the fabrics, which were most nearly reached the dry state, and before the duct temperature rise commenced. Thus through the delayed action provided, the dryer continues to operate, after the temperature rise for a period sufficient to complete the drying. The length of time the dryer will operate before the temperature rise in the duct 22 commences, will vary directly with the quantity of clothes and moisture content thereof. Consequently, the overall drying time is nicely controlled and varies automatically in proportion to the size of the laundry load. At the same time, the end of the drying cycle is carried on for a period of sufficient time to complete the drying, and no longer, and even such period appears to vary directly with the size of the load and moisture absorbent characteristics thereof for with a light load, the temperature rise is more abrupt, and the moisture in the felt is more quickly evaporated. Thus overheating of the clothes is prevented since termination of the application of heat is insured after the lapse of approximately the desired optimum period, after the temperature rise. The prolonged application of heat beyond the period required and after drying has been completed is avoided.

If the circuit employing contacts 112 and 120 of the thermostat 38 is employed, when the heat is cut off by opening of contacts 105 and 106, and the motor circuit thus opened by the opening of switch 56, the contacts 112 and 120 establish a bridging circuit to the motor which
causes the motor to continue tumbling and air circulation, until the temperature of the air in duct 22 drops sufficiently to cause the thermostat 38 to open contacts 112 and 120, and reclose contacts 105 and 106. Thus a short run out or cooling off period can be provided.

It will be seen that the foregoing circuits eliminate excessive drying by the setting of a timer or a manual setting of a timer for a period as judged by the operator to be commensurate with the size of the laundry load, or the moisture content thereof. Further the danger from using high temperatures is eliminated, since the heat is cut off automatically when the clothes are dried. There is no danger that clothes, able to safely withstand 130°, will be tumbled for a period after being dried at an elevated temperature such as 170°. The entire operation is automatic without utilizing a timer, and the period over which dryer operation takes place automatically varies in accordance with the length of time it takes to evaporate the moisture in the laundry being dried.

In the circuit shown in Figure 4, provision is also made for a motor run out cooling period after the heat is cut off, by employing a thermostat 138 having a double throw single pole switch, as illustrated in Figure 6. Thus the thermostat is of a more simple design than that of Figure 5. In such circuit, a single pole door switch 142 is employed in a circuit between the motor field and terminal 60 of switch 56, instead of terminal 80. A circuit from terminal 50 to contact 124 and to terminal 128 of the thermostat 138 then completes an auxiliary connection to the motor for a run out period whenever the thermostat contact 126 is opened, as is the case when the temperature rises above the set value of 130 degrees.

In this circuit the lamps 32 and 34 may be illuminated at all times during operation of the dryer. The door switch may have an auxiliary single pole double throw switch comprising leads 150 and 152 to the lamps 32 and 34 will be broken, and an independent connection 154 established to terminal 52, when the door is opened, so that even after completion of the drying cycle, or prior to the initiation of the drying cycle, illumination will be effected on opening of the door.

Drying operation of the dryer is thus divided into three successive stages, the first stage ending with the temperature rise, the second stage ending upon the evaporation of moisture from the moisture absorbent blanket over the thermostat, followed by the travel of heat through the dried blanket, to actuate the thermostat, upon which the dryer heat input is terminated, and preferably the final run out stage during which tumbling and cooling circulation takes place for a brief period. While a thermostat is employed for the main control, its operation is such as to render it a humidity responsive device, since its operation is effective upon a severe drop in the humidity of the air stream.

While the invention has been shown in connection with a dryer in which heat is supplied by an electrical resistance unit, it will of course be apparent that the heater circuit 21 could be the control circuit for a gas fired dryer, as will be well understood in the art. It will also be apparent that while reference has been made to using thermostats pre-set to 130° and 170°, that such operating temperatures have been selected as desirable and for discussion purposes, and may be varied in practice.

While modified forms of the invention have been illustrated and described, it is to be understood that the invention is not limited thereto. As various changes in the construction and arrangement may be made without departing from the spirit of the invention, as will be apparent to those skilled in the art, reference will be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. A laundry dryer comprising, a drying chamber, means for continuously supplying air to said chamber, means for heating the air supplied to said chamber, an exhaust duct leading from said chamber, thermostatic control means in said exhaust duct associated with said heating means and adapted to act in response to a temperature increase impressed thereon to deactivate said heating means, a normally dry moisture absorbing and heat insulating felt shield interposed between and blanketing said thermostat from the flow of said exhaust duct, said shield being adapted to absorb and evaporate moisture from and into the air passing through said exhaust duct each drying cycle to delay response of said thermostatic control means.

2. A laundry dryer comprising, a drying chamber, means for continuously supplying air to said chamber, means for heating the air supplied to said chamber, an exhaust duct leading from said chamber, thermostatic control means in said exhaust duct associated with said heating means and adapted to act in response to a temperature increase impressed thereon to deactivate said heating means, and a normally dry shield interposed between said thermostat and the air in said exhaust duct capable of absorbing moisture evaporated solely from laundry contained within said chamber from the exhaust air stream, said shield being adapted to absorb and evaporate moisture from and into the air passing through said exhaust duct each drying cycle to delay response of said thermostatic control means.

3. A laundry dryer comprising, a drying chamber, means for continuously supplying air to said chamber, means for heating the air supplied to said chamber, an exhaust duct leading from said chamber, thermostatic control means in said exhaust duct associated with said heating means and adapted to act in response to a temperature increase impressed thereon to deactivate said heating means, and a felt shield normally dry interposed between and blanketing said thermostat from the air in said exhaust duct capable of absorbing moisture condensed solely from the exhaust air stream for subsequent evaporation therefrom toward the end of a drying cycle to delay response of said thermostatic control means.

4. A laundry dryer comprising, a drying chamber, means for continuously supplying air to said chamber, means for heating the air supplied to said chamber, an exhaust duct leading from said chamber, thermostatic control means in said exhaust duct associated with said heating means and adapted to act in response to a temperature increase impressed thereon to deactivate said heating means, and normally dry means for effecting evaporative cooling of said control means solely from moisture in the air passing through said duct toward the end of a drying cycle whereby to delay deactivation of said heating means, said cooling means being adapted to absorb and evaporate moisture from and into air passing through said exhaust duct each drying cycle to delay response of said thermostatic control means.

5. A laundry dryer comprising, a drying chamber, means for continuously supplying air to said chamber, means for heating the air supplied to said chamber, an exhaust duct leading from said chamber, thermostatic control means in said exhaust duct associated with said heating means and adapted to act in response to a temperature increase impressed thereon to deactivate said heating means, and normally dry means adapted to deprive moisture solely from the exhaust air stream during the initial portion of a drying cycle and for effecting evaporative cooling of said control means toward the end of the drying cycle whereby to delay deactivation of said heating means.

6. A laundry dryer comprising, a drying chamber, means for continuously supplying air to said chamber, means for heating the air supplied to said chamber, an exhaust duct leading from said chamber, thermostatic control means in said exhaust duct associated with said heating means and adapted to act in response to a temperature increase impressed thereon to deactivate said
heating means, and normally dry means for effecting evaporative cooling of said control means solely from moisture in the air passing through said duct, and for subsequently impeding heat flow thereto from the air of said exhaust duct toward the end of a drying cycle whereby to delay deactivation of said heating means, said cooling means being adapted to absorb and evaporate moisture from and into air passing through said exhaust duct each drying cycle to delay response of said thermostatic control means.

7. A laundry dryer comprising, a drying chamber, means for continuously supplying air to said chamber, means for heating the air supplied to said chamber, an exhaust duct leading from said chamber, thermostatic control means in said exhaust duct associated with said heating means and adapted to act in response to a temperature increase impressed thereon to deactivate said heating means, and normally dry means comprising a felt blanket for effecting evaporative cooling of said control means solely from moisture derived from the air in said duct, and for subsequently impeding heat flow thereto from the air of said exhaust duct toward the end of a drying cycle whereby to coordinate the deactivation of said heating means with the completion of the drying of laundry contained within said chamber, said cooling means being adapted to absorb and evaporate moisture from and into air passing through said exhaust duct each drying cycle to delay response of said thermostatic control means.

8. A laundry dryer comprising a chamber, a laundry tumbling drum therein, a blower and an exhaust duct for removing air from said chamber, electrically operated means for heating air entering said chamber, a motor for driving said drum and blower, a thermostat in said exhaust duct adapted to open one circuit and close another when a preset temperature is exceeded, said one circuit being adapted to terminate operation of said air heating means and open a circuit to deenergize said motor, and said other circuit being adapted to independently energize said motor, and a normally dry moisture absorbent, and heat insulation blanket interposed between said thermostat and the air stream in said exhaust duct, said blanket adapted to absorb and evaporate moisture from and into the exhaust duct air stream during each drying cycle whereby to delay response of said thermostat to exhaust air stream humidity and temperature changes.

9. A laundry dryer comprising a chamber, a laundry tumbling drum therein, a blower and an exhaust duct for removing air from said chamber, electrically operated means for heating air entering said chamber, a motor for driving said drum and blower, a thermostat in said exhaust duct adapted to open one circuit and close another when a preset temperature is exceeded, said one circuit being adapted to terminate operation of said air heating means and open a circuit to deenergize said motor, and said other circuit being adapted to independently energize said motor, and a layer of normally dry felt blanketing said thermostat from the air stream in said exhaust duct, said felt being adapted to absorb and evaporate moisture from and into the air stream during each drying cycle to modify the action of said thermostat.

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