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M. N. SCHERZINGER

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DRYER CONTROL APPARATUS

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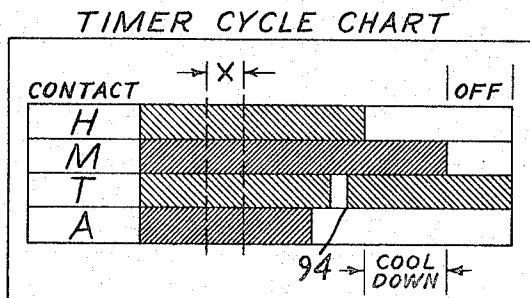
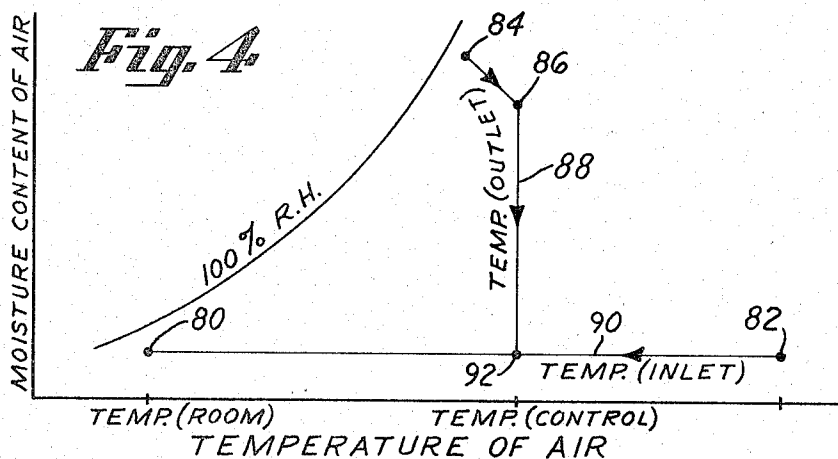
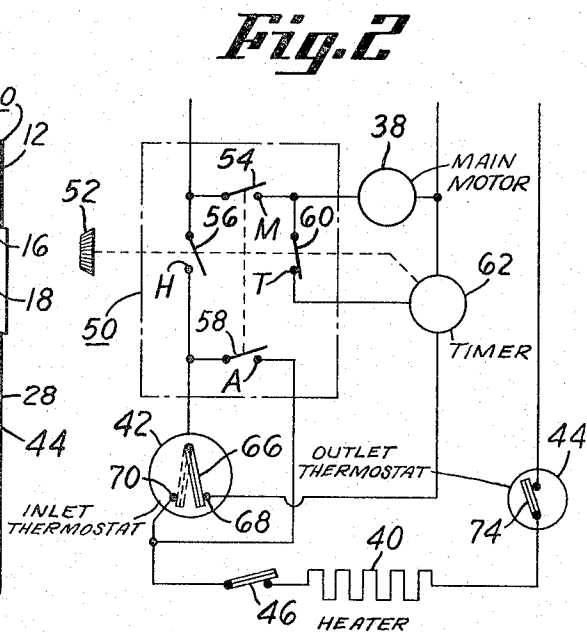
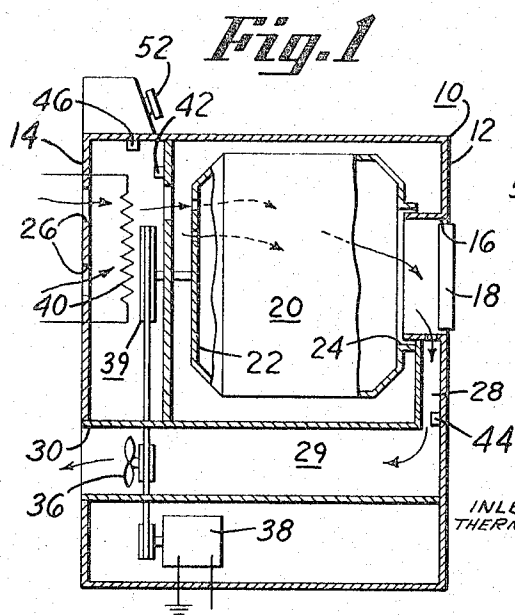


Fig. 3

INVENTOR
MARK N. SCHERZINGER

BY

Frederick M. Ritchie
ATTORNEY

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Mark N. Scherzinger, Dayton, Ohio, assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

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This invention relates to a domestic appliance, and more particularly to an improved cycle termination control system for a clothes dryer.

It is a conventional practice to circulate a stream of heated air into moisture evaporating relationship with a clothes load in the course of a drying cycle. It is also known that the work necessary in the form of thermal energy input to dry the clothes drops as the clothes approach a dry condition, i.e., as moisture evaporation decreases.

Accordingly, it is an object of this invention to provide an improved automatic cycle termination control for a clothes dryer which terminates the drying cycle as soon as evaporative cooling of the circulating air ceases.

A more specific object of this invention is the provision of an automatic dryer control having means for sensing inlet and outlet air temperatures for the tumbling drum in combination with a timer operative to terminate the drying cycle when the inlet and outlet air temperatures are equal.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

FIGURE 1 is a schematic sectional view of a domestic clothes dryer suitable for use with this invention;

FIGURE 2 is a schematic wiring diagram of this invention;

FIGURE 3 is a timer cycle chart showing the relationship of the timer switches illustrated in FIGURE 2; and

FIGURE 4 is a psychrometric representation of an automatic drying cycle in accordance with the teachings of this invention.

In accordance with this invention and with reference to FIGURE 1, a clothes dryer 10 is schematically illustrated. The clothes dryer is comprised of a casing having a front wall 12 and a rear wall 14. The front wall 12 has openings 16 closed by an access door 18. Enclosed within the casing is a rotatably mounted tumbling drum 20 having a perforated rear wall 22 and a front access opening 24 in axial alignment with the cabinet opening 16. The rear wall 14 is open as at 26 to permit the ingress of air to the dryer casing. A front duct 28 and an exhaust duct 29 are in air flow receiving communication with the drum access opening 24—an exhaust opening 30 being formed in the rear wall of the clothes dryer.

To induce a circulation of air through the tumbling drum 20, a blower 36 is positioned in air circulating relationship with the ducts 28 and 29 and is adapted to be driven by a main motor or prime mover 38 which is also adapted to rotate the tumbling drum 20 through a pulley and belt arrangement 39. Thus, an air circulation is set up by the operation of the blower 36. Air is drawn into the cabinet through the rear wall opening 26 and, after flowing over a primary heater 40, enters the tumbling drum 20 through its perforated rear wall 22. Moisture is entrained in the circulating heated air from the fabrics being tumbled therein. The hot humid air then leaves the tumbling drum by way of the drum access opening

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24 and enters the front duct 28—the evaporation of moisture from the clothes causing an air temperature drop across the tumbling drum.

This invention involves a drying cycle having an automatic drying cycle termination control including an inlet air thermostat 42 between the heater and the tumbling drum and an outlet or exhaust air thermostat 44 at the outlet of the drum, such as in the front duct 28 of the dryer. In addition, the control may include a high limit thermostat 46 which will interrupt power to the main heater 40 whenever a malfunction of the control system causes excessively high temperatures within the dryer.

Cooperating with the thermostats 42 and 44 is a timer 50 having a manually operative knob 52 exposed on the control console of the dryer for initiating the start of automatic drying cycle. With reference to FIGURE 2, the timer 50 includes a cam actuated timer switch 54 in series with a timer contact M and the main motor 38 and operative to start and stop the tumbling drum 20 and the blower 36. A cam actuated timer switch 56 operates on a timer contact H in series with the inlet air thermostat 42 while a timer switch 58 operates on a timer contact A to bypass or shunt the inlet air thermostat 42 in a manner to be explained more fully hereinafter. A cam actuated timer switch 60 operates on a timer contact T in series with a timer motor 62 which is operatively associated with the timer switches 54, 56, 58 and 60 to selectively open and close the switches in accordance with the timer cycle chart of FIGURE 3.

The inlet air thermostat 42 includes a temperature sensitive switch means 66 having a normal first position (as shown) on a thermostat contact 68 in series with the timer motor 62 and a second position (phantom line) on a thermostat contact 70 in series with the primary heater 40. Thus, with the temperature sensitive switch 66 on thermostat contact 68 the timer motor 62 will be energized and the timed portion of the automatic drying cycle will be advanced in accordance with the timer cycle chart of FIGURE 3. With the temperature sensitive switch 66 on the thermostat contact 70, the primary heater 40 will be conditioned for energization whenever the temperature sensitive switch 74 on the outlet air thermostat 44 is closed along with the timer switch 56. In particular, the temperature sensitive switch 66 is adapted to engage the thermostat contact 68 when the air temperature sensed is below 140° F. and is adapted to be in engagement with thermostat contact 70 when the temperature sensed is above 140° F. In cooperation therewith, the temperature sensitive switch 74 in the outlet air thermostat is adapted to have an open position at 140° F. or above and a closed position below 140° F. In actual practice the outlet air thermostat 44 is a close tolerance temperature sensor operating on approximately a 1° temperature differential (140° F.—139° F.).

The operation is best described with reference to FIGURES 2, 3 and 4. Initially the user will rotate the cycle start knob 52 to within the indicator setting area X in FIGURE 3. At this point, all of timer contacts H, M, T and A are closed. The main motor 38 will operate to circulate air and rotate the tumbling drum; the timer motor 62 will be energized to sequentially actuate the timer switches, and the main heater 40 will be energized through the circuit shunting the inlet air thermostat 42 through the timer contact A.

Before the shunt contact A opens, the inlet air thermostat 42 senses a temperature in excess of 140° F. and moves from thermostat contact 68 to thermostat contact 70 to energize the dryer heater 40 through the inlet air thermostat rather than the shunt circuit. The outlet air temperature sensitive switch 74 is closed at the start

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of the drying cycle until the dryer drum air passing over it heats to 140° F. The timer 50, during the initial heat-up, continues to operate since the timer motor 62 is energized through timer contacts M and T. The timer will continue to advance until the T contact opens to deenergize the timer motor and place the drying cycle under the exclusive control of the inlet air thermostat 42 and the outlet air thermostat 44.

In the early stages of a drying cycle the clothes are considerably damp and heat must be supplied to the incoming air rather continuously. Temperature at the inlet air thermostat 42 thus remains above 140° F. for an extended period since the operation of the heater 40 depends exclusively on the outlet air temperature sensitive switch 74 and the evaporative cooling of the air passing through the tumbling drum tends to maintain the switch 74 closed. However, as the clothes approach a dry condition, the temperature differential between drum inlet and outlet becomes smaller due to the lesser thermal work necessary to evaporate the gradually lessening amount of moisture in the clothes.

Turning to the psychrometric chart of FIGURE 4, the drying cycle is shown to include a pre-start room ambient condition (*tr*) 80 representative of the air entering the back of the dryer 10. After being heated, this air enters the tumbling drum 20 at an elevated inlet temperature condition (*ti*) 82. After passing through the tumbling drum and picking up moisture from the clothes being dried, the air is shown at a more saturated condition 84. When the water to be evaporated becomes less abundant, there is less evaporative cooling and the outlet air temperature will increase from the condition 84 to a condition 86 which represents the control temperature (*tc*) maintained by the outlet air thermostat 44, i.e. 140° F. Note however, that the inlet air temperature will be above this outlet temperature. From this point until the end of the drying cycle the heater 40 is cycled exclusively by the temperature sensitive switch 74 in the outlet air from the tumbling drum. The temperature path sensed at the outlet air thermostat 44 is shown as a vertical line 88 representing the control temperature, but since it takes less and less heat to maintain the control temperature at the outlet while the moisture in the clothes becomes less and less, the temperature sensed at the inlet air thermostat 42 decreases along a path 90. When the temperature sensed at both the inlet and the outlet of the tumbling drum is equalized as at 92, the inlet air temperature sensitive switch 66 moves to engage the thermostat contact 68 and reenergize the timer motor 62. Immediately following the reenergization of the timer motor through the switch 66, the timer 50 will operate to close the timer contact T as at 94 (FIGURE 3) to substitute timer control for inlet air thermostat control and the drying cycle will terminate with a conventional no heat cool off period until the timer contact M opens to deenergize both the main motor 38 and the timer motor 62.

While the embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. A control system for a clothes dryer having means forming a drying chamber, means for circulating air through said chamber and heating means for heating said air and comprising, means for selectively energizing said circulating means and said heating means, motor driven timing means operable for actuating said selectively energizing means throughout a drying cycle of predetermined time, first temperature sensitive switch means operably responsive to the temperature of air entering said drying chamber and having a first position in series electrical flow relationship with the motor for said timing means when the temperature of the entering air is below 140° F. and a second position in series with said heat-

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ing means when the temperature of said entering air is above 140° F., second temperature sensitive switch means operably responsive to the temperature of air leaving said drying chamber and in series electrical flow relationship with said heating means and having a closed position when the temperature of said leaving air is below 140° F. to energize said heating means and an open position when the temperature of said leaving air is above 140° F. to deenergize said heating means, and by-pass means actuated by said timing means and in series electrical flow relationship with said heating means and said second temperature sensitive switch means and in shunt relation to said first temperature sensitive switch means for by-passing said first temperature sensitive switch means for a predetermined timed period sufficient to permit said first temperature sensitive switch means to move from its first position to its second position, thereafter said second temperature sensitive switch means operating to maintain the temperature of said leaving air at 140° F. only until said first temperature sensitive switch means in response to a sensed inlet temperature below 140° F. returns to said first position sequentially first to de-energize said heating means and then to operate said timing means to deenergize said circulating means and the motor of said timing means to terminate the drying cycle.

2. A control system for a clothes dryer having means forming a drying chamber, means for circulating air through said chamber and heating means for heating said air and comprising, means for selectively energizing said circulating means and said heating means, motor driven timing means operable for actuating said selectively energizing means throughout a drying cycle of predetermined time, first temperature sensitive switch means operably responsive to the temperature of air entering said drying chamber and having a first position in series electrical flow relationship with the motor for said timing means when the temperature of the entering air is below a predetermined temperature and a second position in series with said heating means when the temperature of said entering air is above said predetermined temperature, second temperature sensitive switch means operably responsive to the temperature of air leaving said drying chamber and in series electrical flow relationship with said heating means and having a closed position when the temperature of said leaving air is below said predetermined temperature to energize said heating means and an open position when the temperature of said leaving air is above said predetermined temperature to deenergize said heating means, and bypass means actuated by said timing means and in series electrical flow relationship with said heating means and said second temperature sensitive switch means and in shunt relation to said first temperature sensitive switch means for bypassing said first temperature sensitive switch means for a predetermined timed period sufficient to permit said first temperature sensitive switch means to move to its second position, thereafter said second temperature sensitive switch means operating to maintain the said predetermined temperature of said leaving air only until said first temperature sensitive switch means in response to a sensed inlet temperature below said predetermined temperature returns to said first position sequentially first to deenergize said heating means and then to operate said timing means to deenergize said circulating means to terminate the drying cycle.

3. A control system for the drying cycle of a clothes dryer having means forming a drying chamber, means for circulating air through said chamber and heating means for heating said air and comprising, means for selectively energizing said circulating means and said heating means, timing means operable for actuating said selectively energizing means throughout a drying cycle of predetermined time, first temperature sensitive means

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responsive to the temperature of air entering said drying chamber and in power supply relationship to either said timing means or said heating means and operable for assuming a first condition to facilitate the supply of power to said timing means when the temperature of the entering air is below a predetermined temperature and for assuming a second condition to facilitate the supply of power to said heating means when the temperature of said entering air is above said predetermined temperature, second temperature sensitive means operably responsive to the temperature of air leaving said drying chamber and in temperature responsive power supply relationship with said heating means and having one condition when the temperature of said leaving air is below said predetermined temperature and said first temperature sensitive means is in its said second condition for energizing said heating means and another condition when the temperature of said leaving air is above said predetermined temperature and said first temperature sensitive means is in its said second condition for de-energizing said heating means, and means actuated by said timing means for energizing said heating means only for a predetermined timed period at the start of a drying cycle sufficient to permit said first temperature sensitive means to assume its second condition, thereafter

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said second temperature sensitive means operating to supply power to said heating means to maintain the said predetermined temperature of said leaving air only until said first temperature sensitive means in response to a sensed inlet temperature below said predetermined temperature reassumes its said first condition sequentially first to de-energize said heating means and then to operate said timing means to de-energize said circulating means to terminate the drying cycle.

4. The control system of claim 3 wherein said second temperature sensitive means is a close tolerance temperature sensor operating on approximately a 1° temperature differential.

References Cited by the Examiner

UNITED STATES PATENTS

3,045,993	7/1962	Sidaris	263—33	X
3,096,164	7/1963	Stone	34—45	

FOREIGN PATENTS

926,061	5/1963	Great Britain.
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FREDERICK L. MATTESON, JR., *Primary Examiner.*

D. A. TAMBURRO, *Assistant Examiner.*