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CONTROL SYSTEM FOR CLOTHES DRYERS

Filed March 22, 1962

3 Sheets-Sheet 1

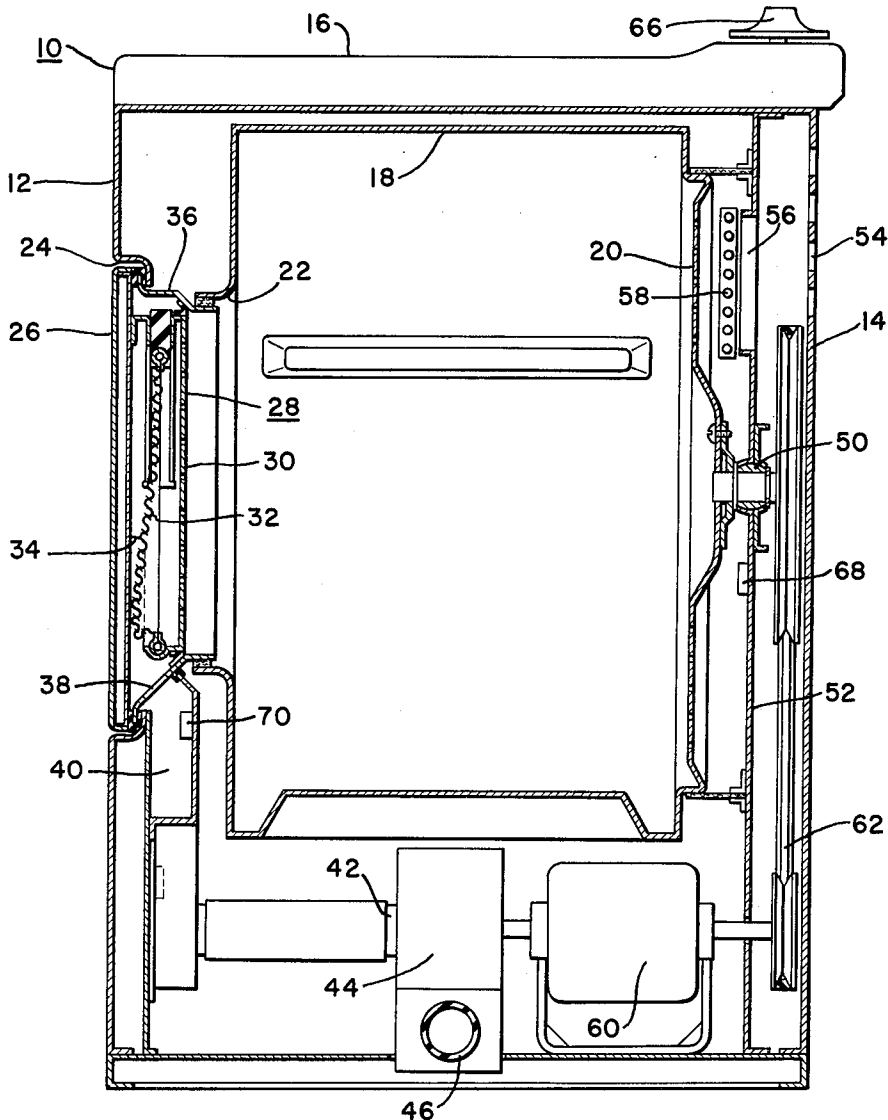


Fig. 1

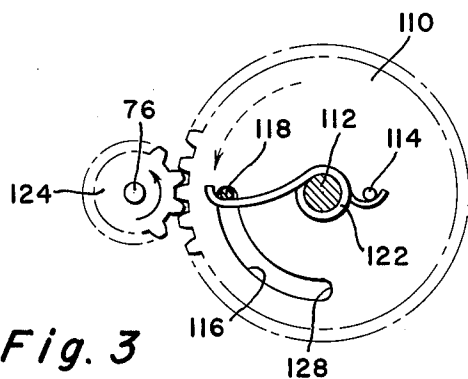


Fig. 3

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3 Sheets-Sheet 2

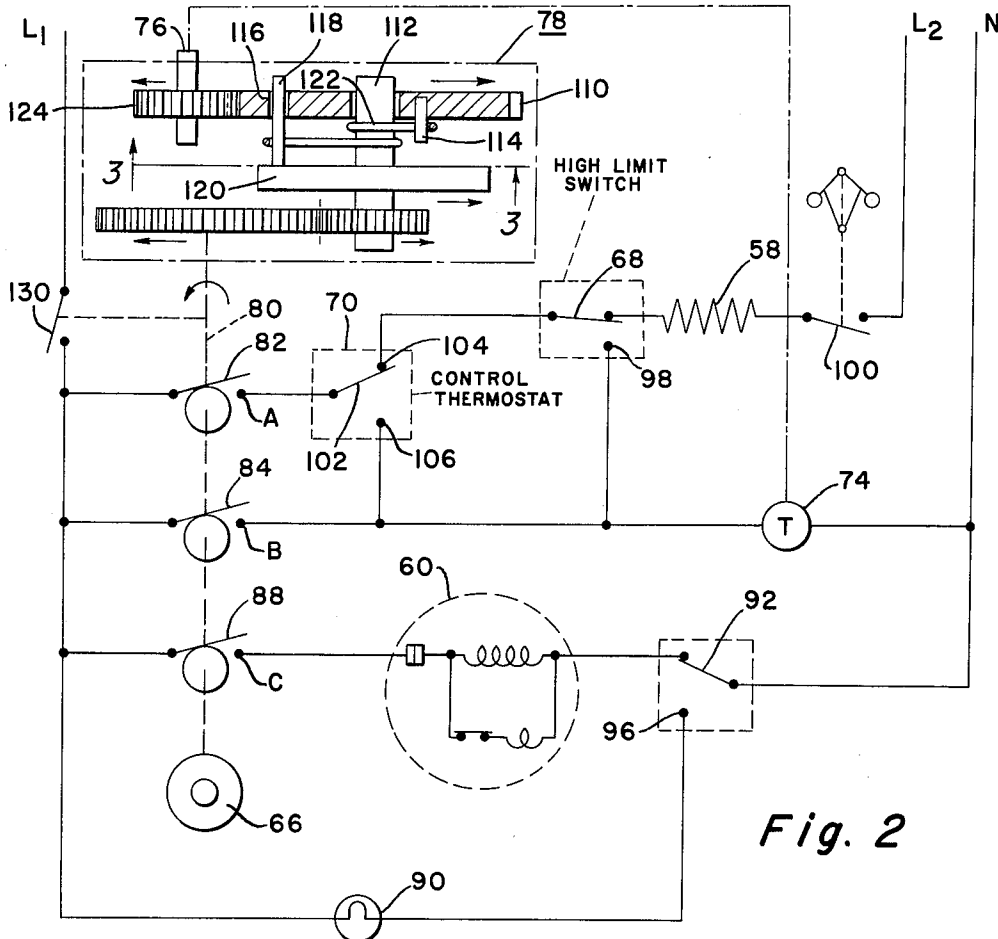


Fig. 2

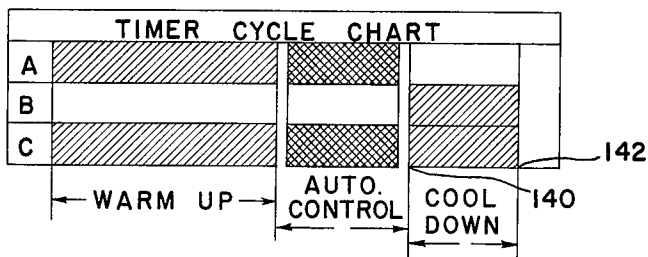


Fig. 4

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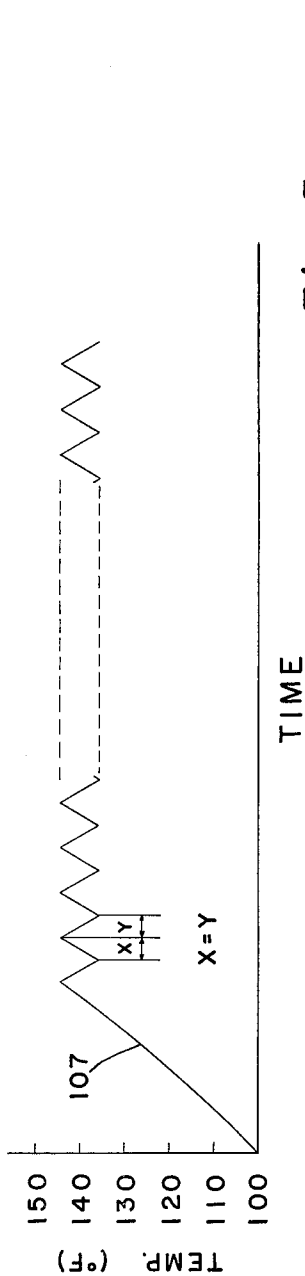
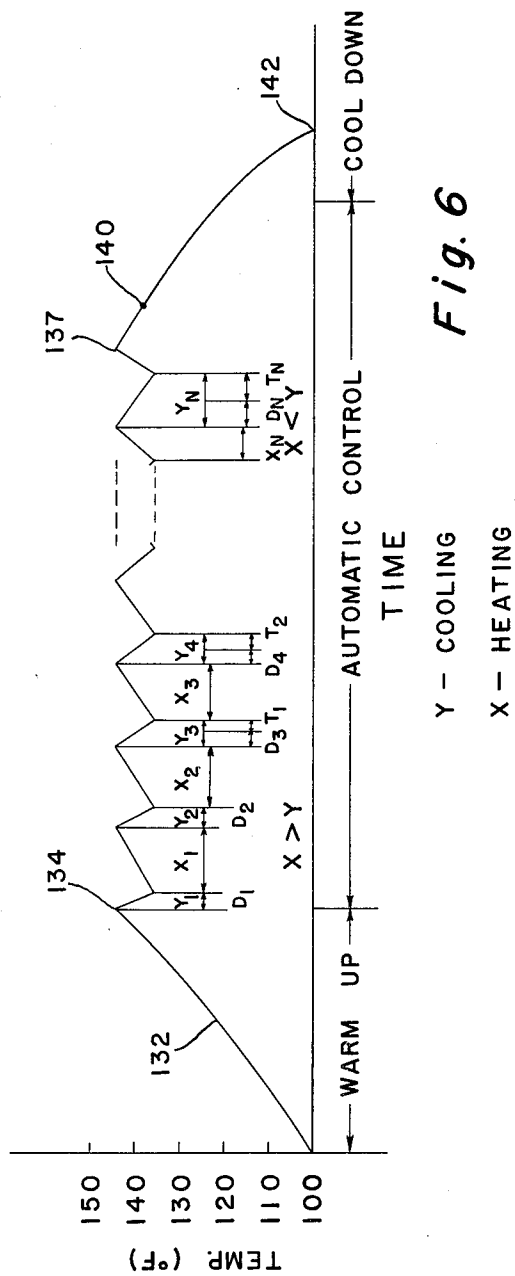
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CONTROL SYSTEM FOR CLOTHES DRYERS

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3 Sheets-Sheet 3



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## CONTROL SYSTEM FOR CLOTHES DRYERS

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11 Claims. (Cl. 34-45)

This invention relates to a domestic appliance and more particularly to an improved termination control for a clothes dryer having a periodically delayed timer advance.

All clothes dryers have their own particular characteristics which affect, more or less the rate of drying for a particular load. These inherent characteristics are generally insignificant where normal eight to ten pound loads are involved. But where small loads, such as below five pounds, are being dried, it is desirable to compensate for these dryer characteristics.

Accordingly, it is an object of this invention to provide an automatic dryer termination control which is equally effective to terminate the drying cycles for variously sized fabric loads.

A general object of this invention is the provision of an automatic clothes dryer timer which operates on the principle that a longer time is required for increasing temperature in a tumbling drum when the clothes are wet than for decreasing the temperature; but, as the clothes become dry, the reverse is true and a longer time is required for decreasing the temperature than for increasing the temperature.

More particularly, an object of this invention is the provision of a clothes dryer control wherein a timed cycle advancing motor and a heater are alternately, temperature responsively, energized, and wherein a delay period is incorporated into the advance of the timed cycle each time the timer motor is energized.

It is a further object of this invention to provide a control for a clothes dryer of the type wherein the heater and timer motor are alternately energizable, said control utilizing the rate of temperature increase and temperature decrease of the exhaust air in conjunction with a built-in delay in the timer motor operation to compensate for any dryer characteristic, thereby providing dryer termination based on a clothes load characteristic alone.

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

In the drawings:

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

FIGURE 2 is a schematic wiring diagram of this invention;

FIGURE 3 is a sectional view taken along line 3-3 in FIGURE 2;

FIGURE 4 is a timer cycle chart illustrative of the cam-actuated switch position in FIGURE 2 during a drying cycle;

FIGURE 5 is a graphic representation of temperature versus time in an empty clothes dryer; and

FIGURE 6 is a graphic representation of temperature versus time for a clothes load being dried in accordance with this invention.

In accordance with this invention and with reference to FIGURE 1, a clothes dryer 10 is illustrated having a front wall 12, a rear wall 14 and a top wall 16. These walls partially form a casing enclosing a tumbling drum 18 having a perforated rear wall 20 and a front access opening collar 22. The front wall 12 of the clothes dryer is recessed to form a clothes access opening 24 which is closable by a door 26. On the door 26 is a

lint collector housing 28 having a perforated rear wall 30 and a lint collector screen 32 which slidably removably nests snugly within the lint collector housing between the perforated wall 30 and an outlet 34. Interposed between the front wall 12 and the access opening 22 of the tumbling drum is a front port plate 36 which is fastened to the front wall of the dryer and serves to rotatably support the collar 22 and the front end of the tumbling drum. The port plate is perforated at 38 and leads thereby to a front duct 40 which is connected to the inlet 42 of a blower 44. The outlet 46 of the blower is connected to the atmosphere. The tumbling drum is supported at its rear wall on a bearing 50 in a rear bulkhead 52. Both the rear wall 14 of the dryer and the bulkhead are perforated as at 54 and 56 respectively to provide ingress of air across a heating element 58 in the annular space immediately adjacent the rear of the tumbling drum. Thus, when the motor 60 is energized, the tumbling drum 18 is rotated through a pulley and belt system 62 and the blower 44 is operated to draw air sequentially through the casing openings 54, the bulkhead opening 56, the heater 58, the perforated rear wall 20, across the clothes tumbling in the tumbling drum, through the perforated lint collector housing wall 30, the lint screen 32 and the front duct 40 to the blower inlet 42.

By way of control, a timer knob, which in this case is used for starting the automatic cycle, is shown at 66 on the console of the dryer. A high limit thermostat 68 is disposed in the heater chamber to the rear of the tumbling drum and a control thermostat 70 is positioned in the front duct 40 in a manner to place the thermostat in the path of air leaving the tumbling drum.

Turning now to FIGURE 2, the control circuit is shown to include a power source L<sub>1</sub>, L<sub>2</sub> and neutral N to provide a 115-230 volt source of power. A timer motor 74 is placed in the circuit and drivably connected to a power shaft 76 on a speed-reducing mechanism, shown generally at 78. Extending from the speed-reducing mechanism 78 is a timer shaft 80 which rotates a plurality of cams to actuate a cam-actuated switch 82 in the heater circuit, a cam-actuated switch 84 in the timer motor circuit and a cam-actuated switch 88 in the prime mover or main motor circuit. For convenience, an interior lamp 90 is included to illuminate the interior of the tumbling drum, and a door switch 92 is effective to terminate operation of the main motor 60 when the door is opened and to engage a contact 96 so that the lamp 90 may be energized.

The high limit thermostat 68 has a normal first position as shown (FIGURE 2) to condition the heater 58 for energization if the temperatures at the rear of the tumbling drum remain within acceptable limits, but the thermostat has a second position on a contact 98 to energize the timer motor 74 for running out the cycle if the temperatures exceed these acceptable limits.

Another safety feature in the heater circuit is a motor speed switch 100 which closes whenever the main motor 60 is energized and operative to rotate the tumbling drum.

In accordance with one aspect of this invention, a control thermostat 70 is provided and includes a switch blade 102 operating between a heater contact 104 and a timer motor contact 106. It should be understood that the thermostat 70 is accurately calibrated with an accurate differential. Although many differentials may be used if consistently and accurately maintained, for practical reasons an 8° F. differential has been found to be satisfactory, i.e., the switch blade 102 moves into engagement with the contact 104 when the temperature is below 136° F. and moves into engagement with the contact 106 when the temperature within the tumbling drum is above 144° F. The exact temperatures are not significant within the purview of this invention but it is important to

note that the temperature differential should be accurately and consistently maintained. Thus, it should be seen that the thermostat 70 is effective alternately to energize the heater circuit when the temperature within the tumbling drum is below a predetermined value and to energize the timer motor circuit to advance the timed cycle when the temperature within the tumbling drum is above a predetermined value.

The broad idea of alternately energizing the heater circuit and the timer motor circuit is taught in the prior art. However, the prior art arrangements do not compensate for such inherent dryer characteristics as the size of the heater and the c.f.m. circulated through the tumbling drum, both of which factors bear heavily on the rate at which the clothes are being dried. In general, compensation for dryer characteristics is needed only where small loads of clothes are being dried. This invention, therefore, is directed to an improvement for a drying cycle control of the alternating heater-timer motor type wherein a delay device is provided in the timer advance to compensate for these inherent dryer characteristics.

It is known that, under carefully controlled temperature conditions in an unloaded or empty electric clothes dryer, a temperature curve 107 of the outlet air would appear as shown in FIGURE 5. Note that the time X during which the air within the tumbling drum is heating from 136° F. to 144° F. is about the same as the time Y during which the air is cooling after the heater 58 has been deenergized. It is only after a clothes load is placed in the tumbling drum that the heat-up time X and the cool-off time Y start to vary. Using this fact, it was determined that the time factors X and Y could be truly indicative of the size clothes load being dried and the drying cycle therefor accurately terminated, if a time deduction or compensation could be made in the cycle duration for the inherent characteristics of each dryer.

As aforesaid, the shape of the temperature curve depends upon the size of the load placed within the dryer. The smallest modification of the unloaded dryer curve in FIGURE 5 occurs when a light load of clothes (five pounds or less) is being dried and this situation is shown graphically in FIGURE 6. Note that the first heat-up period  $X_1$  after warm-up of the dryer is longer relative to the cool-off period  $Y_1$  at the start of the cycle than the last heat-up  $X_n$  at the end of the cycle where the reverse is true, i.e., the cool-off period  $Y_n$  is greater than the heat-up period  $X_n$ . This is to be expected since the clothes are wet at the start of the cycle and, thus, retard the temperature increase. As the moisture is removed from the clothes, there is less resistance to temperature increase as is evidenced progressively along the curve in FIGURE 6.

Use is made of this heat-up, cool-off relationship in the termination device of this invention. A generally conventional timer is used in conjunction with a sensitive temperature control 70. The timer motor 74 will run only when the heater 58 is deenergized and vice versa. During the time that the timer motor 74 is deenergized, provision is made to reversely rotate the timer motor drive shaft 76 relative to the timer shaft 80 to subtract fifteen seconds from the programmed time-out period built into the timer mechanism. This time-out period has been found most effective when it is four minutes, i.e., in FIGURE 6  $T_1 + T_2 + \dots + T_n = 4$  minutes. The subtracting or delaying action thus compensates for the inherent dryer characteristics which particularly affect the control termination for small loads and the overall length of the drying cycle is lengthened accordingly. In general, then, the total duration of the drying cycle is equal to four minutes plus the sum of the progressive delays ( $D_1 + D_2 + \dots + D_n$ ) plus the time for warm-up (from start to that point 134 at which the timer motor 74 is first energized), plus the sum of the heating periods ( $X_1 + X_2 + \dots + X_n$ ).

To effect the foregoing concept, the speed-reducing mechanism 78 has a modified lost motion or delay gear 110 which is sufficiently close in the gear train to the motor drive shaft 76 to permit a spring-biased reversal of this motor drive shaft. The gear 110 is relatively rotatably positioned on a shaft 112 and provided with a fixed pin 114 on one side thereof. An arcuate slot 116 is adapted to receive a pawl 118 extending from and affixed to a gear 120 immediately below and in spaced parallel planar relationship to the free wheeling gear 110. A spring 122 is wrapped about the shaft 112 so that its terminal portions bias the pawl 118 and the fixed pin 114 in opposite directions. Thus, when the pinion 124 rotates as shown by the solid arrow, the lost motion gear 110 will rotate the length of the arcuate slot 116 against the bias of the spring 122 before the slot end 128 engages the pawl 118 to drive the gear 120. The length of the slot 116 has been determined in accordance with the speed of the motor 74 to provide a fifteen second delay between the start of the drive shaft 76 and the pick up of the gear 120. Each time that the thermostat switch 102 moves from the contact 106 to deenergize the timer motor 74, the gear 120 remains stationary while the spring 122 unwinds and biases the pin 114 and the lost motion gear 110 in the reverse direction so that, in effect, the timer motor must run for fifteen seconds the next time it is energized before the timer shaft 80 will be rotated. If we visualize the programmed cycle time devoted to automatic drying control in FIGURE 6 as four minutes and periodically delay the rotation of the timer shaft after the timer motor has been energized, we have, in effect, extended the total drying time by

$$D_1 + D_2 + D_3 + D_4 + \dots + D_n$$

plus the number of additional heat-up periods X resulting from the delays D—this extension depending upon the characteristic of the load being dried, i.e., the rates of heating and cooling being experienced as in FIGURE 6. The first few cooling times  $Y_1, Y_2$  may equal the delays  $D_1, D_2$ , if the heater 58 is reenergized before fifteen seconds elapse. However, assume that the cooling time  $Y_3$  is longer than the fifteen second delay, then the duration of  $Y_3$  is  $D_3$  (15 seconds) plus  $T_1$  (the first used portion of the predetermined four minute control cycle). The same may be said for  $Y_4$  where  $D_4$  is fifteen seconds and  $T_2$  is longer than  $T_1$ . Although the foregoing control has been described in connection with a modified timer for the delay, it should be understood that any device, such as a fast opening-delayed closing switch in the timer motor circuit, which is effective to vary the rate at which the automatic cycle is progressed by delay thereof is within the purview of this invention.

In operation and with reference to FIGURES 2 and 4, the drying cycle is initiated when the knob 66 is rotated to close the main line switch 130 and the cam-actuated switches 82 and 88 to close the contacts A and C. The main motor 60 is energized to rotate the tumbling drum and operate the fan; and the heater 58 is energized since the temperature within the tumbling drum at start-up is below the 136° F. figure at which the thermostat switch 102 engages the contact 104. Referring to FIGURE 6, the drying cycle commences along the curve portion 132 which is the WARM-UP portion of the drying cycle. At the point 134, the switch 102 moves to the contact 106 for the first time to deenergize the heater 58 and initiate the automatic CONTROL portion of the drying cycle. At the point 137 the last segment of the four minute CONTROL portion is initiated and a conventional fabric COOL-DOWN portion of the drying cycle starts as soon as the timer opens contact A and closes contacts B, say, for instance, at a point 140. The timer contact C continues closed as it was throughout the CONTROL portion of the cycle. When cam-actuated switches 84 and 88 open contacts B and C respectively and the main line switch 130 pops open, the complete cycle is finished.

By way of review and with reference to FIGURE 3,

the programmed four minute CONTROL cycle portion is used up incrementally and the spring 122 is loaded, when the pinion 124 is driving in the direction of the solid arrow and the pawl 118 is being driven by the end 128 of the slot 116. Conversely, when the timer motor is deenergized, the delay gear 110 is reversely rotated, as indicated by the dashed arrow, by the unwinding bias of the spring 122 on the gear pin 114. The timer shaft 80 remains stationary due to gear train friction while the timer motor shaft 76 is backed up. On the next succeeding energization of the timer motor 76, it can be seen that the motor will have to advance the delay gear an arcuate segment equal to the length of slot 116 before the timer shaft and the cams thereon will be rotated. This delay period uses up some of the cooling time (thermostat switch 102 on timer motor contact 106) before advancing the timer shaft 80 to progress the four minute CONTROL portion of the cycle. It is not until the cooling time exceeds the fifteen second delay that the timer shaft is advanced. Since each cooling time increases as the CONTROL portion of the cycle progresses, it should be understood that the timer shaft will be rotated each time a progressively longer interval once the cooling period exceeds the fifteen second delay.

It should now be seen that an improved automatic dryer control has been provided which compensates for dryer characteristics by introducing a time delay to vary the advance of the automatic drying cycle in accordance with the size of the load being dried.

While the embodiments of the present invention as herein disclosed constitute preferred forms, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. In combination with a clothes dryer having a casing, means for impelling air through said casing and means for heating said air, a control arrangement comprising, a power source, first circuit means connected to said power source and having a timer switch means and a thermostat in series with said timer switch means, said thermostat having a first contact, a second contact and a thermostat switch movable between said contacts in thermal response to air leaving said casing, said thermostat switch movable into engagement with said first contact when the temperature of air leaving said casing is below a predetermined value and movable into engagement with said second contact when the temperature of air leaving said casing is above a predetermined value, second circuit means connecting said first contact and said heating means, a timer motor, speed reduction means drivably connected to said timer motor, timer shaft means selectively drivably connected to said speed reduction means for sequentially closing said timer switch means to initiate a drying cycle of predetermined duration, third circuit means connecting said second contact and said timer motor, and means in said speed reduction means for delaying the drivable connection between said speed reduction means and said timer shaft means an amount predetermined in accordance with the inherent characteristics of said dryer and compensatory therefor each time said thermostat switch engages said second contact, thereby to extend said predetermined duration of said drying cycle by the length of the delays.

2. In combination with a clothes dryer having a casing, means for impelling air through said casing and means for heating said air, a control arrangement comprising, a power source, first circuit means connected to said power source and having a timer switch means and a thermostat in series with said timer switch means, said thermostat having a first contact, a second contact and a thermostat switch movable between said contacts in thermal response to air leaving said casing, said thermostat switch movable into engagement with said first contact when the temperature of air leaving said casing is below a predetermined value and movable into engagement with said second contact when the temperature of air leav-

ing said casing is above a predetermined value, second circuit means connecting said first contact and said heating means, a timer motor, speed reduction means drivably connected to said timer motor, timer shaft means selectively drivably connected to said speed reduction means for sequentially closing said timer switch means to initiate a drying cycle of a predetermined duration, third circuit means connecting said second contact and said timer motor, and means in said speed reduction means for delaying the drivable connection between said speed reduction means and said timer shaft means an amount predetermined in accordance with the inherent characteristics of said dryer and compensatory therefor each time said thermostat switch engages said second contact, thereby to extend said predetermined duration of said drying cycle by the length of the delays, said delaying means including a pinion drivably connected to said timer motor, a drive gear drivably connected to said timer shaft and having a pawl, an intermediate gear interposed in lost motion transfer relationship between said pinion and said drive gear and having an elongated slot for receiving said pawl, and means between said pawl and said intermediate gear for biasing said intermediate gear in a reverse direction each time said thermostat switch engages said second contact.

3. In combination with a dryer having a casing, means for impelling air through said casing and means for heating said air, a control arrangement comprising, a power source, a first circuit means connected to said power source and having a timer switch means and a thermostat in series with said timer switch means, said thermostat having a first contact, a second contact and a thermostat switch movable between said contacts in thermal response to air leaving said casing, said thermostat switch movable into engagement with said first contact when the temperature of air leaving said casing is below a predetermined value and movable into engagement with said second contact when the temperature of air leaving said casing is above a predetermined value, second circuit means connecting said first contact and said heating means, a timer motor, timer shaft means selectively drivably connected to said timer motor for sequentially closing said timer switch means to initiate a drying cycle of predetermined duration, third circuit means connecting said second contact and said timer motor, and means for delaying the drivable connection between said timer motor and said timer shaft means an amount predetermined in accordance with the inherent characteristics of said dryer and compensatory therefor each time said thermostat switch engages said second contact, thereby to extend said predetermined duration of said drying cycle by the length of the delays.

4. In combination with a dryer having a casing, means for impelling air through said casing and means for heating said air, a control arrangement comprising, a power source, first circuit means connected to said power source and having a timer switch means and a thermostat in series with said timer switch means, said thermostat having a first contact, a second contact and a thermostat switch movable between said contacts in thermal response to air leaving said casing, said thermostat switch movable into engagement with said first contact when the temperature of air leaving said casing is below a predetermined value and movable into engagement with said second contact when the temperature of air leaving said casing is above a predetermined value, second circuit means connecting said first contact and said heating means, a timer motor, timer shaft means selectively drivably connected to said timer motor for sequentially closing said timer switch means to initiate a drying cycle of predetermined duration, third circuit means connecting said second contact and said timer motor, and means for delaying the drivable connection between said timer motor and said timer shaft means an amount predetermined in accordance with the inherent characteristics of said dryer and compensatory therefor each time said thermostat switch engages said

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second contact, thereby to extend said predetermined duration of said drying cycle by the length of the delays, said delaying means including a lost motion connection between said timer motor and said timer shaft means.

5. In combination with a dryer having a casing, means for impelling air through said casing and means for heating said air, a control arrangement comprising, a power source, first circuit means connected to said power source and having a timer switch means and a thermostat in series with said timer switch means, said thermostat having a first contact, a second contact and a thermostat switch movable between said contacts in thermal response to air leaving said casing, said thermostat switch movable into engagement with said first contact when the temperature of air leaving said casing is below a predetermined value and movable into engagement with said second contact when the temperature of air leaving said casing is above a predetermined value, second circuit means connecting said first contact and said heating means, a timer motor, timer shaft means selectively drivably connected to said timer motor for sequentially closing said timer switch means to initiate a drying cycle of predetermined duration, third circuit means connecting said second contact and said timer motor, and means for delaying the drivable connection between said timer motor and said timer shaft means an amount predetermined in accordance with the inherent characteristics of said dryer and compensatory therefor each time said thermostat switch engages said second contact, thereby to extend said predetermined duration of said drying cycle by the length of the delays, said delaying means including a delayed closing switch in said third circuit between said second contact and said timer motor which is closable after a delay each time said thermostat switch engages said second contact.

6. In combination, means for impelling a gaseous medium into moisture absorbing contact with material to be dried, means for heating said gaseous medium, timing means for controlling said impelling means and said heating means in a drying cycle of predetermined duration, means at a location adapted to be thermally responsive to said gaseous medium downstream from said material and in selective power supply relationship with said heating means or said timing means, switch means in power supply relationship to said thermally responsive means and actuated by said timing means into a first position to initiate said drying cycle and into a second position to terminate said drying cycle, and means for delaying the actuation of said switch means into said second position an amount predetermined in accordance with the inherent characteristics of said impelling means and said heating means and compensatory therefor, thereby to extend said predetermined duration of said drying cycle.

7. In combination, means for conveying a gaseous medium into moisture absorbing contact with material to be dried, means for heating said gaseous medium, timing means for controlling said heating means in a drying cycle of predetermined duration, means at a location adapted to be thermally responsive to said gaseous medium downstream from said material and in selective power supply relationship with said heating means or said timing means, switch means in power supply relationship to said thermally responsive means and actuated by said timing means into a first position to initiate said drying cycle and into a second position to terminate said drying cycle, and means for delaying the actuation of said switch means into said second position an amount predetermined in accordance with the inherent characteristics of said conveying means and said heating means and compensatory therefor, thereby to extend said predetermined duration of said drying cycle.

8. The combination of claim 7 wherein said delaying means includes a lost motion connection means in said timing means actuatable each time said thermally responsive means is in power supply relationship with said timing means.

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9. In combination, means for conveying a gaseous medium into moisture absorbing contact with material to be dried, means for heating said gaseous medium, timing means for controlling said heating means in a drying cycle of predetermined duration and including a timer motor and timer shaft means selectively drivably connected to said timer motor, means at a location adapted to be thermally responsive to said gaseous medium downstream from said material and in selective power supply relationship with said heating means or said timer motor, timer switch means in power supply relationship to said thermally responsive means and actuated by said timer shaft means into a first position to initiate said drying cycle and into a second position to terminate said drying cycle, and means between said timer motor and said timer shaft means for delaying the actuation of said switch means into said second position an amount predetermined in accordance with the inherent characteristics of said conveying means and said heating means and compensatory therefor, thereby to extend said predetermined duration of said drying cycle.

10. In combination, means for conveying a gaseous medium into moisture absorbing contact with material to be dried, means for heating said gaseous medium, timing means for controlling said heating means in a drying cycle of predetermined duration and including a timer motor and timer shaft means selectively drivably connected to said timer motor, means at a location adapted to be differentially thermally responsive to said gaseous medium downstream from said material and in selective power supply relationship with said heating means or said timer motor, timer switch means in power supply relationship to said thermally responsive means and actuated by said timer shaft means into a first position to initiate said drying cycle and into a second position to terminate said drying cycle, and means between said timer motor and said timer shaft means for delaying the actuation of said switch means into said second position an amount predetermined in accordance with the inherent characteristics of said conveying means and said heating means and compensatory therefor, thereby to extend said predetermined duration of said drying cycle, said delaying means comprising a lost motion connection means actuatable each time said thermally responsive means is in power supply relationship with said timer motor.

11. In combination, means for impelling a gaseous medium into moisture absorbing contact with material to be dried, means for heating said gaseous medium, timing means for controlling said impelling means and said heating means in a drying cycle of predetermined duration, means at a location adapted to be thermally responsive to said gaseous medium downstream from said material and in selective power supply relationship with said heating means or said timing means, switch means in power supply relationship to said thermally responsive means and actuated by said timing means into a first position to initiate said drying cycle and into a second position to terminate said drying cycle, and means for repeatedly delaying the actuation of said switch means into said second position, each repeated delay being an amount predetermined in accordance with the inherent characteristics of said impelling means and said heating means and compensatory therefor, thereby to extend said predetermined duration of said drying cycle.

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