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CLOTHES DRIER AUTOMATIC CONTROL CIRCUIT

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2 Sheets-Sheet 2

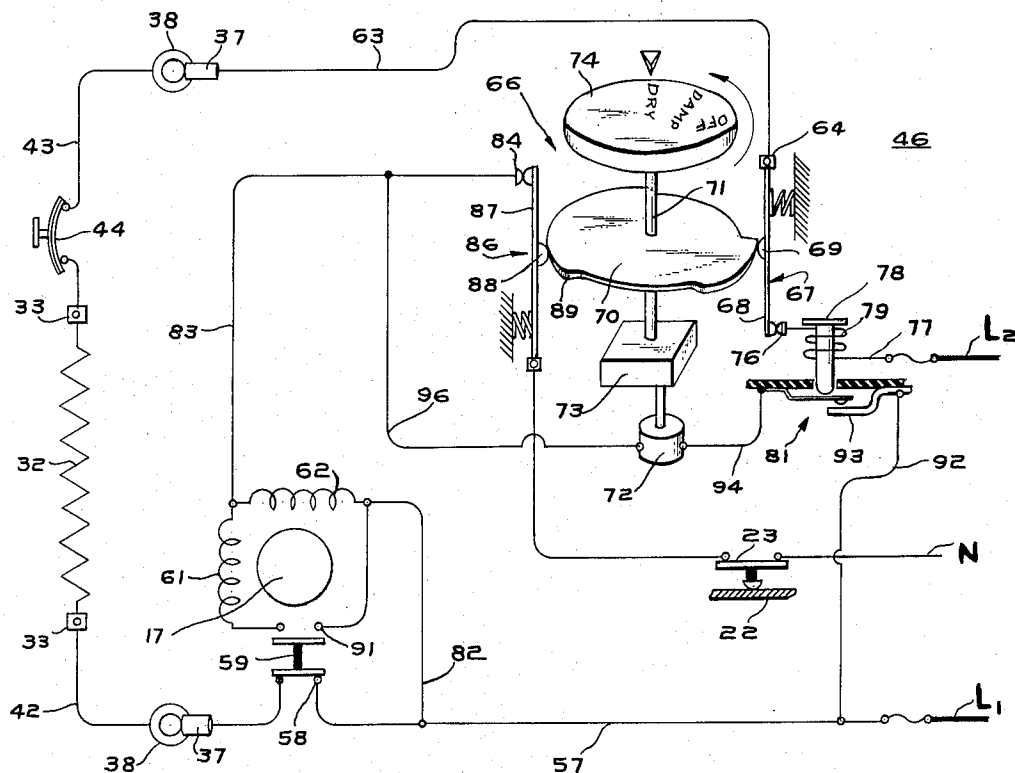


FIG. 3.

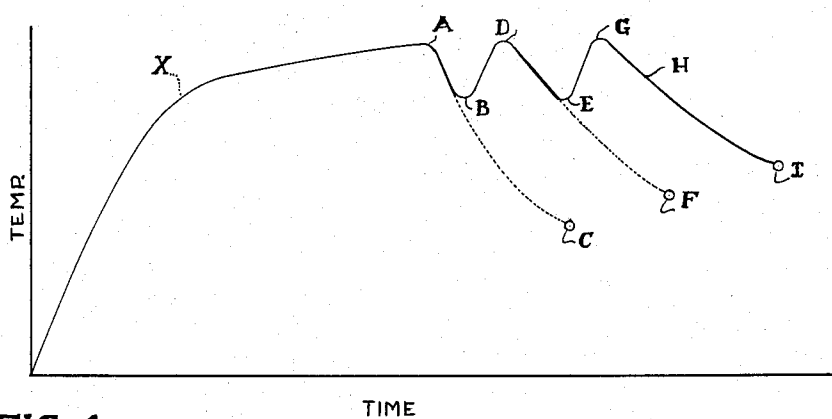


FIG. 4.

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## CLOTHES DRIER AUTOMATIC CONTROL CIRCUIT

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The invention relates to clothes driers and more particularly to control means for clothes driers to provide improved operation.

Driers used for removing moisture from clothing must be provided with control means of some type to terminate the heating period in order to prevent damage to the clothing, especially at the end of the drying operation.

In accordance with the invention, a tumbler type clothes drier is provided with means for heating the clothing to evaporate the moisture therein, a thermostat in the heating means circuit positioned so as to be responsive to the temperature within the drying chamber, an intermittently operated timing means for controlling the operation of the drying cycle and a relay responsive to deenergization of the heating element by the thermostat for energizing the timer to provide means for safely drying clothes without damage thereto.

During the initial portion of the drying operation the timer is maintained inactive until the drying chamber attains a predetermined temperature which corresponds to a condition wherein the major portion of the moisture has been removed from the clothing. As the drum temperature increases above this predetermined value, energization of the heating means is terminated by the thermostat and the timing means is energized until the heating element is again energized by the thermostat when the drum temperature again drops to a lower value. After one or more of such operations, the timing means actuates mechanism to permanently deenergize the heating means regardless of the demands of the thermostat but continues tumbling of the clothing to cool the same. After a predetermined time the timing means acts to deenergize the tumbling means and terminates the drying operation. By properly adjusting the timing means the finished condition of the individual batches of clothing may be varied from dry to moist.

Accordingly, it is one of the objects of the invention to provide a tumbler type clothes drier with a control means which may be selectively adjusted to vary the moisture content of individual batches of clothing at the end of the drying operation.

It is another object of the invention to provide a tumbler type clothes drier with control means which provides an automatic cooling period after the heating means has been deenergized.

It is still another object of the invention to provide a tumbler type clothes drier with a timer which is periodically operated by a relay responsive to energization of the heating means.

It is yet another object of the invention to provide a tumbler type clothes drier with a control means which utilizes the residual heat in the drying apparatus toward the end of the drying operation to conserve heat.

It is still another object of the invention to provide a tumbler type clothes drier with a control means which provides a definite limit on the temperature in the drum during the drying operation.

It is another object of the invention to provide a tumbler

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type clothes drier with control means which may be set to automatically dry various batches of clothing to a selected degree of retained moisture at the end of the drying operation.

It is another object of the invention to provide a tumbler type clothes drier with a simplified control means which employs but a single control knob.

Other objects, features, capabilities, and advantages are comprehended by the invention as will later appear and as are inherently possessed thereby.

Referring to the drawings:

Figure 1 is a diagrammatic partial front elevational view of a tumbler type clothes drier with portions in section to show details of construction to which the improved control means may be applied;

Figure 2 is a partial longitudinal sectional view of the clothes drier taken generally along the line 2-2 of Figure 1;

Figure 3 is a schematic wiring diagram of the improved control means for use in a clothes drier; and

Figure 4 is a graph showing the operating temperature in a clothes drier incorporating the improved control means.

Referring now more in detail to the drawings for one form of clothes drier embodying the control features of the present invention, there is shown an outer cabinet or casing 10 secured to a base frame construction 11 for completely enclosing the operating parts of the clothes drier. Projecting upwardly from the base 11 is a pair of spaced ribs 12 which provides a support for a hollow clothes receiving rotatable tumbler or drum 13, mounted for rotation about its horizontal axis within a cradle formed by four spaced flanged friction rollers 14 carried on opposite ends of parallel spaced shafts 16. The drum 13 may be rotated by means of a pivotally mounted electric motor 17 through suitable speed mechanism, such as, for example, a belt and pulley arrangement 18 which is operatively connected to one of the shafts and pair of the rollers 14. When the motor is energized, the driven pulley rotates one of the shafts and the friction between the engaging portions of the rollers and drum causes the same to rotate about its horizontal axis at a considerable speed reduction; i. e., between 35 and 50 R. P. M., while the opposite shaft carrying its pair of rollers merely acts as a rolling support.

The surrounding cabinet has an access opening 19 provided in its front wall 21 disposed about the horizontal axis of the drum 13 and a door or closure 22 adjacent the opening 19 is adapted to be opened or closed by the operator to gain access to the drum or to seal the opening. Also, when the door is moved from one position to the other, it is adapted to engage a door switch 23 for a purpose to be hereinafter described.

The horizontally mounted drum 13 within the casing and defining the drying chamber 24 is a unitary structure and includes an imperforate cylindrical wall 25, a front end wall 26, having a single centrally located access opening 27 facing the access opening 19 in the front wall of the cabinet, and an imperforate vertical rear end wall 28 spaced in parallel relation to the front wall. A plurality of parallel lifting ribs or vanes 29 are secured to the inner periphery of the cylindrical wall to tumble the clothes, and the end walls 26 and 28 are provided with circumferential flanges 31 which rest on the rollers 14 and constitute the sole support for the drum in its horizontal position.

In order to evaporate the moisture in the clothing within the drum 13, heat must be applied thereto. One such means for heating the drum is in the form of an electrical heating element 32 formed from a single, flat, long, thin and relatively wide strip of stainless steel, or other material having somewhat similar characteristics. This

particular type heating element is preferably tightly wound over a thin strip of electrical insulation to cover substantially the entire outer periphery of the imperforate cylindrical wall 25 of the drum, and its opposite ends are secured to suitable terminal posts 33 disposed within the recess provided by one of the elevating vanes 29. A heating element of this type uniformly heats the entire periphery of the drum which, of course, heats the clothing in the drying chamber to evaporate the moisture or a high percentage thereof, and the overall temperature of the entire heating element is reduced considerably. Also, to improve the overall efficiency of the drier, the outer surface of the drum may be enclosed by heat insulating material 34.

While various means may be employed for supplying energy to the heating element 32, there is diagrammatically disclosed a collector ring assembly 35 mounted on the back portion of the rear wall 28 at the approximate axis of rotation of the drum. This collector ring assembly includes a relatively stationary non-metallic support 36 carrying the usual carbon brushes 37 held in engagement with a pair of spaced concentric collector rings 38 mounted on the outer face of a generally disc-shaped rotatable insulating block 39 which is in turn anchored or secured to the rear wall 28 of the drum and, of course, rotates therewith. The stationary support 36 is held against rotational movement by means of a flexible holding arm 41 whose lower end is anchored to the base. Electrical conductors 42 and 43 extend from their respective collector rings radially outwardly along the back of the drum and are directly connected to the opposite ends of the heating element 32 at the terminal blocks 33 in any suitable manner. The conductor 43 is connected in series with a temperature responsive thermostat, or limit switch 44 which, in this instance, is secured to the rear wall 28 of the drum adjacent its outer periphery and it operates to deenergize the heating element 32 when the temperature within the drying chamber reaches or tends to exceed a predetermined safe value. Electrical energy is supplied to the heating element 32 from any suitable source of supply L<sub>1</sub> and L<sub>2</sub> under control of control mechanism generally referred to at 46 (Figure 3) to be hereinafter described.

Referring now more particularly to Figure 2, it can be seen that the front wall 26 on the drum is spaced from the front wall 21 of the cabinet 10 to provide room for an open-ended vertical fluid conducting rectangular duct or conduit 47. The upper open end of the duct is opened to the ambient atmosphere through a grilled opening 48 provided in the top wall 49 of the cabinet, and the lower open end is disposed adjacent the base 11 and in direct communication with the relatively cool air thereat. Intermediate the lower and upper ends of the vertical duct 47 and in alignment with the aligned access openings 19 and 27 in the cabinet and front wall of the drum, respectively, the duct is provided with a suitable horizontal cylindrical passage 51 of approximately the same size as the access openings in the drum. This passage permits access to the interior of the drum for inserting or removing the clothing.

In order to provide means for connecting the drying chamber 24 with the ambient atmosphere and to allow the vapor evaporated from the clothing to escape, the upper portion of the cylindrical passage 51 has a relatively large slot 52 directly communicating with the upper portion of the vertical duct. Also, the lower portion of the cylindrical passage 51 is provided with a series of relatively large openings or perforations 53 which directly communicate with the lower portion of the duct. While during the drying operation the major portion of the air entering the lower open end of the vertical duct flows upwardly through the perforations 53, they also provide the means for permitting heavy lint thrown through the opening and the vapor condensed in the duct to pass through and fall downward through its open end to be

collected in a spaced combination heavy lint and moisture collecting tray 54 disposed directly therebelow. While the heavy lint will fall downwardly into the collecting tray, the light airborne lint will travel with the vapor and heated air upwardly through the duct; therefore, a detachable airborne lint trap 56 is mounted in the upper portion of the vertical duct in any suitable manner to filter the vapor and heated air and trap the lint moving therewith.

Referring now to Figure 3 for a detailed description of the control means for controlling the operation of a clothes drier as described, there is shown a pair of conductors or leads L<sub>1</sub>-L<sub>2</sub> having a 230-volt potential across the two and a neutral N having a 115-volt potential between either one of the conductors L<sub>1</sub> or L<sub>2</sub>.

Energization of the heating element 32 is from the line L<sub>1</sub> through a conductor 57 connected to one of the brushes 37 on the drum and it is in series with a pair of back contacts 58 on a speed responsive or centrifugally operated switch 59 carried by the motor 17, having starting and running windings 61 and 62, respectively. As mentioned previously, the conductor 42 secured to one of the collector rings 37 and cooperating with its brush is connected to one terminal 33 of the heating element 32 which is wrapped about the outer periphery of the drum and the opposite terminal 33 has the conductor 43 leading therefrom to the other collector ring and brush. The temperature responsive thermostat 44 is mounted on the drum to rotate therewith and in the heating element circuit in series with the conductor 43.

From the last mentioned brush a conductor 63 leads to a terminal 64 provided by a timer mechanism 66 and this terminal is electrically connected to a first or heating element switch 67 having a movable contact 68. This movable contact is provided with a suitable abutment means or cam follower 69 for riding on a lobed timer cam means 70 secured to a timer shaft 71 rotated by a timer motor 72 through suitable speed reduction mechanism 73. Extending upwardly from the cam means and secured to the timer shaft 71 is a rotatable control knob 74 having indicia thereon which is adapted to be manually rotated by the operator independently of timer motor 72.

Adjacent the movable end of the movable contact 68 is a stationary contact 76 having a conductor 77 leading therefrom which is series wound about an armature 78 to provide a current coil 79 of holding relay 81 and its is connected to the line L<sub>2</sub> to complete the heating element circuit.

One side of the starting and running winding 61 and 62, respectively, of the drive motor 17 is energized through a conductor 82 leading from the line L<sub>1</sub> and the opposite side is connected to a conductor 83 terminating at a stationary contact 84 forming part of a second or motor switch 86 in the timer. The stationary contact is adapted to be engaged by a movable contact 87 having a cam follower or abutment 88 which is engaged by a lobe 89 formed on the rotatable cam 70 driven by the timer motor 72. The opposite end of the movable contact 87 is connected to the neutral N in series with the door switch 23 to complete the 110-volt motor circuit. The starting winding 61 is connected across the running winding 62 and is cut into or out of the motor circuit by means of the centrifugally operated switch 59 at the inner contacts 91.

Energization of the timer motor 72 is from the line L<sub>1</sub> through a conductor 92 to a low capacity third or relay operated timer motor switch 93 carried by the current responsive relay 81, and the opposite side of the switch is directly connected to one side of the timer motor 72 by a conductor 94. From the other side of the timer motor a conductor 96 is connected to the conductor 83 between the stationary contact 84 and the drive motor 17, and the timer motor circuit is completed to the neutral through the second switch 86 in the motor circuit. The neutral N

carries the door switch 23 operative whenever the door 22 is opened to deenergize the timer motor 72 and drive motor 17 which in turn deenergizes the heating element 32 at the contacts 58 when the drive motor reaches a predetermined low speed.

The operation of a clothes drier incorporating the above described improved control features is as follows:

The operator opens the door 22 and inserts the damp clothing to be dried through the aligned access openings 19 and 27 and then closes the same. This closes the door switch 23 and conditions the drive motor 17 and timer motor 72 for operation.

Next, the operator grasps the control knob 74 projecting from the cabinet and rotates the same in a clockwise direction for a part of a revolution, and assuming it is desired to have the clothing in a dried condition, the knob is rotated to the position shown in the drawings. As the knob is rotated the spaced lobes on the cam 70 shift their respective movable contacts 68 and 87 to engage their respective stationary contacts 76 and 84. This action energizes the drive motor 17 to start the same and rotates the drum 13 about its horizontal axis to tumble the clothing therein.

When the drive motor attains a predetermined speed, the centrifugal switch 59 is actuated to cut out the starting winding 61 at the contacts 91 and at the same time bridge the outer contacts 58 to energize the heating element 32. It is to be understood the thermostatic switch contacts 44 will be closed because of the low temperature prevailing in the drum at this time. As soon as the heating element 32 is energized, current flowing through the series winding 79 in the relay 81 which is in the heating element circuit, will elevate the armature 78 and the contacts of the relay switch 93 will be moved to their open position to open the timer circuit to the timer motor 72. The timer motor will remain deenergized as long as the heating element is energized; therefore, the cam means 70 holding the movable contacts 68 and 87 closed will remain stationary.

Should the drive motor 17 fail to attain its proper speed or fail to rotate, the heating element 32 will remain deenergized regardless of the position of the timer. Also, if the door 22 is opened during the drying operation, the drive motor will be automatically deenergized and the heating element 32 will be deenergized as previously mentioned.

Referring to Figure 4, there is shown a time-temperature diagram plotting a typical graph of the temperature within the drum 13 and it can be seen that as the heating element 32 is initially energized the temperature in the drum rises rapidly to the point marked "X" and thereafter the increase in temperature is relatively slight. It is in this latter period that the major portion of the moisture is evaporated from the clothing, and it is the rapid evaporation of moisture which restricts the drum to this slowly increasing rate. Since the time required to attain this condition is not dependent upon the timer, the length of this period is only dependent upon the heat input and quantity and type of clothing being dried. After a major portion of the moisture has been removed from the clothing, the drum temperature approaches a point "A" on the curve corresponding to the opening of the thermostat 44. As the thermostat opens the heating element circuit, the armature 78 in the relay 81 is released and it moves or drops to close the relay switch 93 to energize the timer motor 72.

Upon energization of the timer motor the cam means 79 is advanced slowly in a counter-clockwise direction, as viewed in the drawing. It is to be noted that, although the heating element circuit is opened, the drive motor circuit is closed and the drive motor 17 continues to tumble the clothing to absorb residual heat from the drum or drying medium. This continued tumbling results in cooling of the drum and when the drum temperature reaches

a predetermined low value corresponding to the point "B" on the graph, the thermostat 44 closes the heating element circuit to again energize the same. This action also energizes the current winding 79 in the holding relay to lift the armature 78 and open the timer motor circuit to stop the timer motor 72 and cam means. As the drum temperature again reaches the thermostat setting, the heating element circuit is again opened as at the point marked "D" and the timer circuit is closed to continue rotation as previously described. A control arrangement of this type utilizes a considerable amount of the residual heat in the drum for drying and at the same time puts a top limit on the drum temperature to prevent damage to the clothing being dried.

The number of cycles the thermostat 44 makes depends upon the material being dried and the original position of the control knob 74. After the timer motor has advanced the lobe controlling the heating element switch 67 to a point where it opens the cooperating contacts 68 and 76 on the timer, such as, for example, point "H," the timer continuously rotates the cam means 70 and the drive motor 17 tumbles the clothing for a predetermined length of time, which is until the lobe 89 on the timer cam 70 opens the switch 86 in the drive and timer circuits. This time is adjusted so that the tumbling action of the clothing will have reduced the temperature of the clothing and the temperature of the drum to approximately the point "I" on the graph. By reducing the temperature of the clothing, there is less danger of injuring or annoying the operator when the dried clothing is removed through the access openings.

Should the operator desire to remove the clothing from the drier before it is completely dry, the control knob 74 is only rotated to the "Damp" position. In this instance the circuits are all completed as previously described; however, the respective cams are rotated shorter distances, for example, the right hand portion of the heating element cam surface, as viewed in the drawings, will be located directly under or close to the abutment on the movable contact and the abutment on the switch 86 will be intermediate the ends of the lobe 89. Thus, when the temperature in the drum reaches the point "A" on the graph and the thermostat 44 opens the heating element circuit, the timer motor 72 will quickly open the heating element circuit at the first switch 67 and thereafter the drive motor 17 will be rotated for the regular predetermined cool down period.

Likewise, the operator may adjust the control knob to any of a number of positions between "Damp" and "Dry" by merely adjusting the knob to the desired intermediate position. Under these conditions the operation is identical with that previously described; however, energization of the heating element 32 will be terminated at the selected points such as, for example, at the point "E" on the graph. The cool down temperature would then take place generally along the line "E-F" as shown on the graph. It is to be understood that the heating element circuit may be opened by the switch 67 at any time after the thermostat 44 deenergizes the heating element 32 at A, D or G and need not be at the points B, E, or H.

From the foregoing it can be seen that an improved low cost relatively simple automatic control arrangement has been provided for a clothes drier in which the residual heat in the drum may be utilized, a definite upper temperature limit is placed on the drying medium, and that under all conditions of operation the drum is rotated for a predetermined length of time after the heating element has been deenergized to cool the same. Also, that the condition of dryness is not dependent upon time or the rate at which heat is supplied to the drum, but upon the selected condition of the clothing.

While I have herein described and upon the drawings shown an illustrative embodiment of the invention, it is to be understood that the invention is not

limited thereto but may comprehend other constructions, arrangements of parts, details and features without departing from the spirit of the invention.

It is claimed:

1. In a control mechanism for a drying apparatus, heating means, a first switch controlling said heating means, a drive motor, a timer control including a timer motor in parallel with said drive motor, a second switch controlling said drive and timer motors, said timer control having a single cam controlling said first and second switches, a normally open third switch in series with said timer motor, a relay coil in series with said heating means, said relay coil controlling said third switch, and means responsive to a predetermined high temperature for deenergizing said heating means and said relay to close said third switch and energize said timer motor.

2. In a control mechanism for a drying apparatus, heating means, a normally closed first switch controlling said heating means, a drive motor, a timer control including a timer motor in parallel with said drive motor, a second switch controlling said drive and timer motors,

said timer control having a single cam controlling said first and second switches, a third switch in series with said timer motor and in parallel with said drive motor, a relay coil in series with said heating means, said relay coil controlling said third switch, and means responsive to a predetermined temperature for deenergizing said relay and actuating said third switch and said timer motor to open said first switch and prevent energization of said heating means.

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