May 1, 1956 T. R. SMITH 2,743,533

AUTOMATIC CONTROL FOR CLOTHES DRIERS

Filed May 1, 1953 2 Sheets-Sheet 1

Fig. 1.

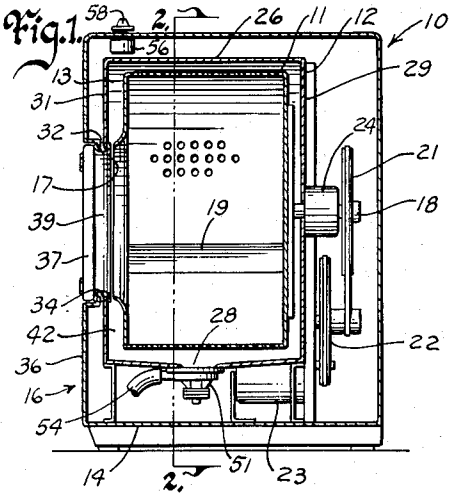
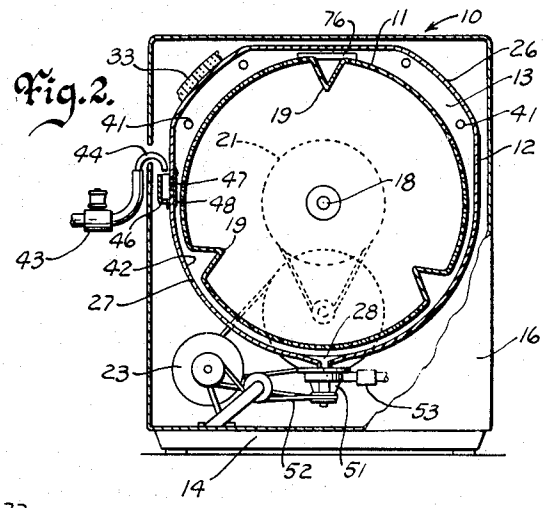


Fig. 2.



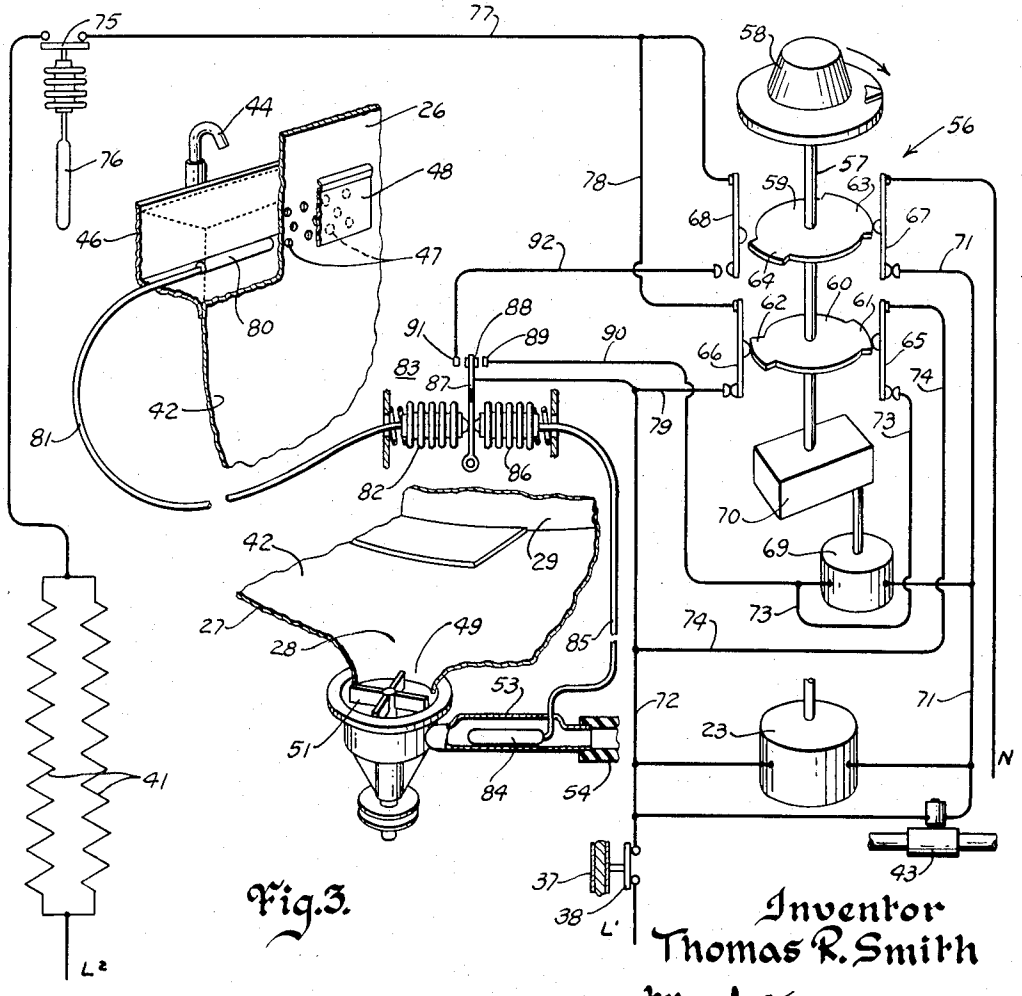


Fig. 3.

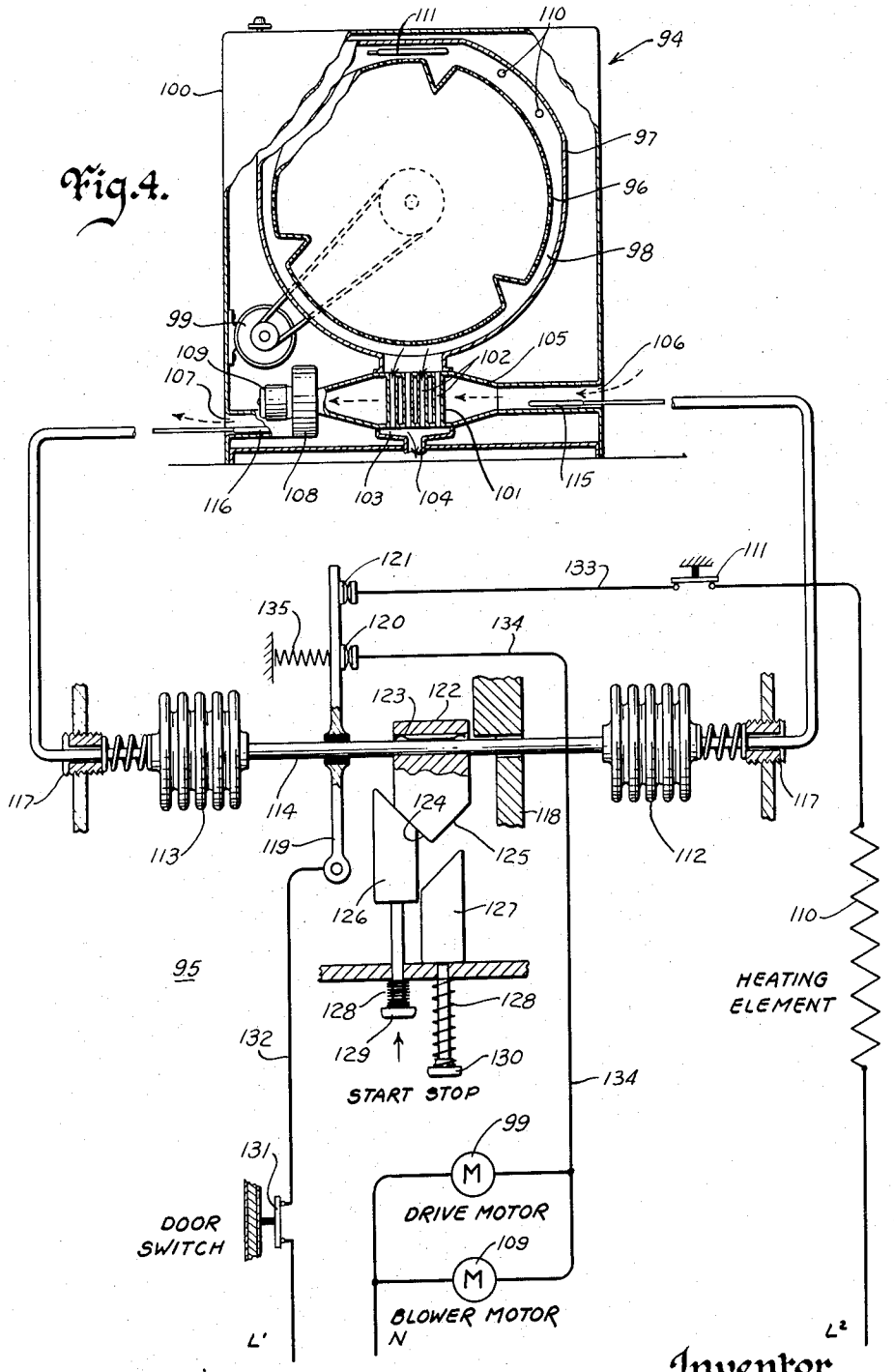
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May 1, 1956 T. R. SMITH 2,743,533

AUTOMATIC CONTROL FOR CLOTHES DRIERS

Filed May 1, 1953 2 Sheets-Sheet 2

Fig.4.



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AUTOMATIC CONTROL FOR CLOTHES DRIERS

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Application May 1, 1953, Serial No. 352,443

13 Claims. (Cl. 34—45)

The invention relates to control apparatus and more particularly to control apparatus for clothes driers of the cold wall or vapor condensing type.

It is one of the objects of the invention to provide a vapor condensing type clothes drier with control apparatus which is responsive to the difference in temperature of the condensing medium at its inlet and outlet for controlling the drying operation.

In accordance with the invention, a clothes drier of the vapor condensing type is provided with a substantially sealed casing. A condensing medium is supplied to the drier through an inlet and it flows over a surface associated with the casing and out of an outlet. Under drying conditions, after the drier has been put into operation for a predetermined length of time to initiate the drying operation, the vapor evaporated from the clothing contacts the surface cooled by the condensing medium and is condensed, with the result that the temperature of the condensing medium is increased as it flows to the outlet. A differential control mechanism responsive to the temperature of the condensing medium entering and leaving the drier is provided and this difference in temperature is reflected upon switch means which, when the temperature difference is relatively high, maintains the heating element circuit closed. Toward the end of the drying operation when the major portion of the vapor is evaporated from the clothes, the rate of heat absorption by the condensing medium decreases. Thus the difference in temperature of the condensing medium at the inlet and outlet tends to become more nearly equal and this is reflected on the control mechanism to open the heating element circuit to thereby terminate the heating operation, after which the clothes may be tumbled for a predetermined length of time to cool the clothing to a lower temperature for comfortable handling. In still another form, control apparatus is provided which eliminates the tumbling of the clothing after the heating operation is terminated.

Accordingly, it is another object of the invention to provide a vapor condensing type clothes drier with control apparatus which is responsive to the temperature difference between the condensing medium at its inlet and outlet to terminate the application of heat to the drier.

It is yet another object of the invention to provide a vapor condensing type clothes drier with a simplified control apparatus which maintains the energization of the heating means regardless of the load in the drier until the temperature difference between the condensing medium at its inlet and outlet decreases to a predetermined value.

It is another object of the invention to provide a vapor condensing type clothes drier with control apparatus which initiates the drying operation for a predetermined length of time after which a temperature differential responsive switch controls the duration of the drying operation.

It is still another object of the invention to provide a

vapor condensing type clothes drier with control apparatus which is simple in construction, positive in operation and will consistently terminate the drying operation when the clothing has been dried to the proper degree regardless of the inlet temperature of the condensing medium.

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 vertical longitudinal sectional view of a vapor condensing type clothes drier to which the improved control apparatus may be applied;

Figure 2 is a vertical transverse sectional view taken generally along the line 2—2 of Figure 1;

Figure 3 is a diagrammatic wiring diagram and arrangement for a vapor condensing type clothes drier incorporating the improved temperature differential control features, and

Figure 4 is a diagrammatic wiring diagram and arrangement for a slightly modified differential control applied to a vapor condensing clothes drier of a different type.

Referring now more in detail to Figures 1 to 3 of the drawings for an embodiment of a clothes drier selected to illustrate an embodiment of the improved control apparatus, there is shown a tumbler type clothes drier 10 having a horizontally mounted rotatable perforate drum 11 enveloped or encompassed by a substantially imperforate stationary sheet metal casing or container 12 providing a drying chamber 13 in which the drum 11 rotates. The container or casing 12 is suitably supported on a base frame 14 and the entire assembly is surrounded by a cabinet construction 16 to provide a pleasing appearance.

The drum 11 has a centrally located access opening 17 in its forward wall through which the clothing to be dried is inserted and removed, and is supported for rotation from its rear wall by means of the forward end of a horizontal supporting or drum shaft 18 concentric to the drum axis. Elevating or agitating vanes 19 are spaced within the drum to provide the means for agitating the clothing in a tumbling manner when the drum is rotated.

From the rear wall of the drum the drum shaft 18 extends axially rearwardly through the container 12 and its outer end has a driven pulley 21 of any suitable type secured thereto. This pulley may be driven at a reduced speed by means of a speed reduction pulley and belt arrangement 22 connected to a driving means or motor 23 mounted on the base frame construction 14. In addition, the drum shaft is suitably journaled in a housing construction 24 which in turn is rigidly secured to the base 14 in any suitable manner.

The container or casing 12 surrounding the drum 11 includes a substantially imperforate longitudinally extending wall 26, whose lower sector 27 is generally cylindrical in transverse section and axially recessed at its lowermost portion for substantially its entire length to provide a water collecting trap or sump 28, a rear wall 29 and a front wall 31 having an access opening 32 aligned with the access opening 17 in the drum. All of these elements are secured together at their marginal edges in any suitable manner to provide a unitary rigid structure. On addition, the outer surface of the container 12 is preferably provided with suitable heat insulating material 33 to improve the overall efficiency of the drier.

The cabinet 16 which completely encloses the container 12, base frame construction 14, drive mechanism 23 and other auxiliary equipment, has an access opening 34 in its front wall 36 in alignment with the access openings

32 and 17 in the casing and drum, respectively, and the cabinet opening 34 is provided with a hinged insulated door or closure 37. Covering or encompassing the aligned access openings is a resilient combination gasket and seal 39 for engaging the inner surface of the door 37 to seal about the openings and to provide a static seal between the adjacent portions of the cabinet and casing. A door switch 38 is automatically operated by movement of the door in a manner to be hereinafter described.

In order to evaporate the moisture in the clothing, heat from a suitable source must be supplied to the drying chamber 13. In the modification shown, there is disclosed, by way of example, a pair of standard sheathed electric heating elements 41 which are mounted within the drying chamber 13 in oppositely disposed recessed portions at the upper section of the casing beyond the outer periphery of the drum 11.

Since the stationary container 12 is not provided with an air inlet or outlet, means must be provided to dispose of the vapor evaporated from the moist clothing being dried. In the preferred form, the vapor is condensed by having it directly contact a zone or area 42 on one side of the lower cylindrical wall portion 27 of the container 12 which is directly cooled by a stream or thin film of cool water flowing over its inner surface or periphery. The cooling or condensing water may be supplied from any suitable source of supply under the control of a solenoid operated water control valve 43 and it is discharged from the downwardly directed end of a conduit 44 into a distribution box or receptacle 46. The inner wall of the receptacle is formed as part of the wall 26 of the casing and defines the upper end of the condensing section or zone 42. In addition, the portion of the casing 12 defining the inner wall of the water distributing receptacle is provided with a plurality of parallel and horizontally spaced small orifices or openings 47 through which the water flows by gravity during the drying operation.

Covering these openings within the casing is a curtain type flap or check valve 48 having its upper end anchored to the casing and its lower end free. In this manner, the escape of vapor through the openings 47 into the interior of the cabinet 17 is obviated, while at the same time the condensing water flows through some of the distributing openings 47, passes the lower edge of the check valve and flows downwardly over the condensing zone 42 in relatively thin film.

The lower end of the condensing zone 42 is recessed as previously mentioned to provide the trap or sump 28 for collecting the condensing water, condensed vapor and lint, and this sump has a centrally located drain outlet 49 which also provides the inlet to a centrifugal pump 51 mounted directly therebelow at the lowermost portion of the casing. The pump may be rotated by the drive motor 23 through suitable drive or belt mechanism 52 and the discharge end of the pump is connected to an enlarged space 53 open to a conduit 54 which leads to a suitable drain.

Referring now more particularly to Figure 3 for a detailed description of the improved control apparatus for a vapor condensing clothes drier, there is shown a timer 56 having a shaft 57 extending upwardly through the top wall of the cabinet 16 on which is mounted a control knob or dial 58 adapted to be grasped by the operator and turned in a clockwise direction, as viewed in the drawings, to initiate the drying operation. As shown, the timer knob 58 has been manipulated to start the drying operation.

Rigidly secured to the shaft 57 are switch actuating cam means 59 and 60 each having spaced lobes or abutments 61 and 62 and 63 and 64, respectively, which are adapted to engage and actuate suitable switches 65, 66, 67 and 68, respectively, in a manner to be hereinafter described. In addition to the control knob 58, the timer shaft 57 is adapted to be slowly advanced or rotated in one direction by means of a low capacity constant speed motor 69 through suitable speed reduction or escapement mechanism 70. The timer motor 69 is connected, along with the condensing water control valve 43 and the drum drive motor 23, to the neutral line N through a common conductor 71 and the switch 67 which is actuated by the lobe 63 on the cam 59 as soon as the timer shaft 57 is shifted or rotated. The opposite side of the valve and the drive motor are connected in parallel to a conductor 72 in series with the door switch 38 leading to the line L_1. Thus, as soon as the knob 58 is turned, the drive motor 23 is energized to rotate the drum 11 about its horizontal axis, the valve 43 is opened to supply condensing water to the receptacle 46 to flow the same over the condensing area 42 to the sump 28, and to energize the timer motor 69 to advance the cams in a positive manner. The opposite side of the timer motor is initially energized from a conductor 73 leading to the cam operated switch 65 and from the opposite side of the switch to a conductor 74 connected to the conductor 72 leading to the line L_1.

Initial energization of the heating elements 41 is from the line L_2 and from the opposite side of the heating elements to a thermostat actuated switch 75 which has its temperature responsive bulb 76 mounted within the drying chamber 13 to provide an upper limit on the temperature therein. From the opposite side of the thermostat switch 75 conductors 77 and 78 lead to the switch 66 actuated by the lobe 62 on the cam 60 and the heating element circuit is completed by means of conductor 79 connected to the conductor 72 leading to the line L_1.

Disposed within the liquid distribution receptacle 46 is a temperature responsive bulb 80 which reflects the inlet temperature of the condensing water discharged from the conduit 44 through a tube 81 directly to an expansible member or sylphon bellows 82 which forms part of a differential temperature responsive switch 83. A second temperature responsive bulb 84 placed in the chamber 53 at the discharge side of the centrifugal pump 51, or any other suitable location, is responsive to the temperature of the condensing water as it leaves the drying chamber 13 to transfer a force through a tube 85 to a second expansible member or sylphon bellows 86 mounted in opposition to the first mentioned one. These bellows may be adjustably mounted to provide the required balance of forces and act in opposition on opposite sides of a suitable pivoted arm or contact carrying member 87 which, in this instance, carries a contact 88 directly connected to the line L_1 through the conductor 72.

The contact 88 on the movable arm 87 is double acting and when the difference in temperature of the condensing water at the inlet and outlet is the same or relatively slight, the contact 88 engages a contact 89 which is connected to a conductor 90 leading to the timer motor 69. Under these conditions the timer motor is energized to advance the cams 59 and 60. However, when the drier is in operation and vapor is being condensed, the temperature of the condensing water is increased in so doing; therefore, with the inlet water temperature remaining substantially constant the temperature of the condensing water leaving the drying chamber 13 will be increased by an amount equal to the latent heat of vaporization, the sensible heat in the condensate and the heat naturally absorbed in passing through the heated drying chamber 13. This temperature difference is reflected on the bellows 86 which counteracts the force of the opposing bellows 82 and shifts the movable contact 88 in the direction to engage a heating element contact 91 which in turn is connected to a conductor 92 leading to the cam operated switch 68 on the timer. This switch is also connected to the conductor 77 and completes the heating element circuit from the lines L_2 and L_2.

As long as vapor is being generated by the heating elements 41, this temperature difference will exist or prevail and after the initial timed operation has transpired and the switches 65 and 66 on the timer cam 60 are opened,

energy will be continuously supplied to the heating elements, assuming, of course, that the temperature responsive switch **75** remains closed. Toward the end of the drying period, the quantity of vapor in the chamber **13** decreases; therefore, less vapor is condensed, with the result that the outlet temperature of the condensing water starts to drop. When the outlet water temperature approaches the inlet water temperature the movable contact **88** is moved away from the heating element contact **91** by the balancing forces of the bellows **82** and **86** and opens the heating element circuit. At the same time, this action closes the timer circuit at the contact **89** and the timer motor **69** is energized to again advance the cams. After a predetermined length of time, from five to ten minutes, the timer motor advances the cams to a point where they open the switches **67** and **68** to thereby open the circuits to the heating elements **41**, drive and timer motors **23** and **69**, respectively, and the water control valve **43**. At this point the drying operation is completed because the switches **65** and **66** were opened at the end of the initial timed starting portion of the cycle. The switch **68** is primarily provided to maintain the heating element circuit open at the end of the drying operation.

In the operation of a clothes drier of the type disclosed, the operator opens the door **37** and inserts the damp clothing to be dried into the rotatable drum **11** through the aligned access openings, after which the door is closed and latched against the door gasket **39** to seal the interior of the container **12** at this point and such action closes the door switch **38**.

Next the operator adjusts or manipulates the control knob **58** to its starting position. This action closes the switches **65**, **66** and **67** in the timer to energize the timer and drive motors, **69** and **23**, respectively, open the condensing water control valve **43** and energize the heating elements **41**. At the start of the drying operation, the bellows **82** and **86** are substantially in equilibrium because there is no or very little temperature difference between the two and the movable contact **88** engaging contact **89** is in the position to energize the timer motor **69** in parallel with the closed switch **65**. Since the switch **68** and the contacts **88** and **91** are open, energization of the heating elements **41** is effected through the closed switch **66** to supply heat to the drying chamber **13** to evaporate the moisture in the clothing, while they are tumbled at approximately 45 R. P. M. within the drum **11** by the drive motor **23**. As the water control valve **43** opens, water flows throughr the conduit **44** into the water distribution receptacle **46** at the upper portion of the condensing area **42**. This water then flows through the small openings **47** to provide a relatively wide and thin stream or sheet of water which passes from beneath the lower edge of the check valve **88** and flows uniformly downwardly by gravity over the condensing area. As the cooling or condensing water reaches the bottom of the casing, it is collected in the sump **28**, flows to the outlet opening **49** providing the inlet to the centrifugal pump **51** and is discharged therefrom through the chamber **53** and conduit **61** to drain. Since the bulb **80** is in the distribution receptacle **46** and the other bulb **84** is in the chamber **53** at the discharge side of the pump, they directly reflect their respective water temperatures on the bellows **82** and **86** forming the differential temperature responsive switch **83**.

During the initial timed operation, the timer motor **69** slowly advances the cams **59** and **60**. As the heat builds up in the drying chamber **13** the moisture in the clothing is evaporated therefrom. With the drum **11** being rotated in a counterclockwise direction, as viewed in Figure 2, the vapor is circulated around the inner periphery of the stationary container **12** and in so doing a portion of the vapor directly contacts the cold water flowing over the condensing area or zone **42** and is condensed. This results in a flow of vapor in the direction of the cold surface where it is condensed. As the condensing water and condensate reach the bottom of the chamber, it flows into the sump **28** and is discharged as previously mentioned.

Upon condensation of the vapor, heat is absorbed by the condensing water which, of course, raises the temperature of the same. As the heated condensing water passes over the bulb **84** in the chamber **53** and heats the same, the bellows **86** is expanded by the increased temperature, reacts against the opposing bellows **82** and compresses the same. In so doing the movable contact **88** is shifted to the left, as viewed in the drawings, to engage the heating element contact **91** to condition this side of the line for operation. At the end of the timed interval, for example, ten minutes, sufficient to start the drying operation and raise the temperature of the discharge water, the switches **65** and **66** on the timer are opened by the cam **60** and the switch **68** is closed by the lobe **67** on the cam **59**. This action continues energization of the heating elements **41** through the switches **83** and **68** and places the heating elements under the direct control of the differential temperature responsive switch. At the same time, the opened switch **65** deenergizes the timer motor to arrest the timer operation, while the drive motor **23** and valve **43** remain energized by the closed switch **67** at this point.

As long as vapor is evaporated from the clothing, this temperature difference of the water at the inlet and outlet will be maintained regardless of the initial temperature of the water at the inlet. It may be mentioned that the inlet water temperature may vary widely from a low temperature up to well over 100° F. and still provide for efficient operation.

When the major portion of the vapor is evaporated from the clothing, the rate of heat absorption of the condensing water decreases or declines with the result that the temperature of the water as it leaves the drying chamber is more nearly that of the inlet temperature. As the temperature at the discharge reaches a relatively low value, the bellows **86** responding to the bulb **84** is contracted and the other bellows **82** acts to shift the movable contact **88** in the direction to open the heating element circuit and terminate the application of heat to the drying chamber **13**. As the movable contact opens the heating element circuit, it closes the timer circuit through the conductor **90**, and energizes the timer motor which again begins to advance the timer cams.

This interval represents the cool-down period in which the clothes are tumbled within the chamber without the application of heat while the condensing water acts to absorb a portion of the residual heat to reduce the clothes to a temperature for comfortable handling. After a predetermined length of time, for example, five to ten minutes, the timer motor will move the cam **59** to open the remaining closed switches **67** and **68**. This final movement opens the heating element circuit to prevent reenergization, and that portion of the control circuit in series with the timer and driving motors and valve. At this time, the operator need but open the door and remove the clothing which has been properly dried and cooled for safe handling.

By way of example, assuming the bulbs **80** and **84** are at room temperature of approximately 70° F. the opposing forces on the bellows will be substantially equalized. As water is discharged through the conduit **44**, the temperature of the bulb **80** will be reduced to approximately 50° F. and initially, before the temperature within the chamber is elevated by the heating element, the water discharge from the pump **51** over the bulb **84** will be approximately the same temperature; therefore, the forces of the bellows will likewise remain substantially equalized.

After the drying operation starts the temperature of the water discharged over the bulb **84** will increase, due to the absorption of the latent heat of vaporization of the vapor and the sensible heat of the condensate, to approximately 100° F. This increase in temperature is

reflected on the bellows 86 and moves the arm 87 in opposition to the bellows 82 to maintain the contacts 88 and 91 engaged. This temperature difference will remain substantially constant throughout the drying operation and will be maintained within relatively narrow limits regardless of the temperature of the inlet water.

As the heat absorption of the condensing water decreases toward the end of the drying operation because of decreased vaporization of moisture from the clothes, the temperature of the water discharged over the bulb 84 begins to decrease. When the temperature decreases approximately 15 to 20 degrees the arm 87 is moved by the contracting bellows 86 and the bellows 82 in the opposite direction away from the heating element contact 91 to engage the timer contact 89 in the manner previously described.

Referring now to Figure 4 there is shown a modified type of vapor condensing clothes drier 94 and a modified differential temperature responsive control arrangement 95 in which the timing means has been eliminated. This drier includes a rotatable drum 96 encompassed by a substantially imperforate casing 97 to provide a drying chamber 98. A drive motor 99 is adapted to rotate the drum about its horizontal axis through suitable speed reduction mechanism in the usual manner and the entire mechanism is preferably closed by a cabinet 100 to provide a pleasing appearance.

Extending downwardly from the lower portion of the casing is a heat exchanger 101 comprising a plurality of vertically extending tubular members 102 whose upper open ends communicate directly with the drying chamber 98 and whose lower open ends communicate with a lower header 103 in which the condensed vapor is collected prior to being discharged through a conduit 104 in any suitable manner to drain. Surrounding the heat exchanger is a generally horizontally arranged duct 105 having an inlet 106 and an outlet 107 with a fan or blower 108 driven by a motor 109 disposed in the duct at one side of the heat exchanger 101. This blower is adapted to draw condensing air through the inlet 106 from the ambient atmosphere, circulate the same about the tubular condensing members 102 to condense the vapor within the tubes by removing the latent heat of vaporization and some of the sensible heat from the liquid, after which it is discharged through the outlet opening 107 back into the ambient atmosphere at the opposite side of the cabinet.

Disposed within the drying chamber 98 adjacent its upper sector is a heating element 110 of any suitable type and a temperature responsive switch 111 which provides an upper limit on the temperature therein.

The operation of the drier is adapted to be manually initiated after which it is under the control of the differential control means 95. This control means includes a pair of sylphon bellows 112 and 113 mounted in opposition to each other through a bar or member 114. The one bellows 112 is made responsive to the temperature of the inlet air by means of a bulb 115 carried at the inlet side 106 of the heat exchanger 101 while the other bellows 113 is made responsive to the air on the discharge side of the heat exchanger by directly connecting it to a bulb 116 suitably positioned adjacent the outlet 107 of the duct 105. Each bellows is properly proportioned for the operating conditions and adjusting means 117 may be provided to modify within limits the movement of the bellows.

Between the sylphon bellows and loosely encompassing the bar 114 there is provided a stationary abutment or stop member 118 and a pivotal or movable arm 119 carrying a pair of movable contacts 120 and 121 thereon which are adapted to engage mating stationary contacts to energize a pair of electrical circuits. These two elements are longitudinally spaced from each other a suitable distance to provide room for a slidable contact moving member or abutment 122 therebetween. This member has a passage therethrough encompassing the bar 114 and is frictionally held in position thereon by a spring member 123 or any other suitable gripping device. The movable abutment 122 is further provided with a pair of oppositely sloping cam surfaces 124 and 125 facing in the direction of a pair of independently movable cams 126 and 127 which are each normally biased in a direction away from the movable abutment by means of independent compression springs 128. The outer end of cam 126 has a "start" push button 129 thereon which, when depressed the full limit, engages the mating cam surface 124 with the result that the abutment 122 is shifted to the right, as viewed in the drawings, regardless of the relative position of the bellows with respect to the stationary abutment 118. The other cam 127 has an "off" push button 130 which, when depressed the full limit, engages the opposite cam surface 125 on the movable abutment and shifts the same to the left along the bar 114 to engage and move the arm 119 carrying the contacts 120 and 121 in such direction as to open the electrical circuits.

The electrical circuits involved are the heating means and drive and blower motor circuits. In this instance, the heating means circuit extends from the line L_1 through the door switch 131 and a conductor 132 to the movable arm 119 carrying the contacts 120 and 121. A conductor 133 connects the upper contact 121 in series with the thermostat 111 and heating element 110, and the opposite end of the heating element is connected to the line L_2 to provide a 230 volt circuit. The lower contact 120 on the movable arm is connected to a conductor 134 leading to one side of the drive and blower motors 99 and 109, respectively, and the other side of the motors is connected to the neutral N to complete the circuit therethrough and provide a 115 volt circuit.

Thus it can be seen that when the movable contacts are moved to the right by the spring 135 they engage their respective contacts and both circuits are simultaneously energized; likewise, when moved to the left by the movable abutment 122, the circuits are opened and the drying operation is terminated. Also, note that the movable abutment's position may be changed relative to the movable arm 119 by means of the differential force of the opposing bellows in either direction. When moved to the right the movable abutment's relative position is changed when the same contacts the stationary member 118 and when moved to the left, by the differential forces of the bellows or cam 127, the circuits are opened when it engages and moves the arm 119.

In operation the operator follows the same procedure as previously outlined. At the start the movable abutment 122 will be positioned to the left and is holding the contacts 120 and 121 open against the force of the spring 135, and both sylphon bellows 112 and 113 will be substantially balanced because the temperature of the controlling bulbs 115 and 116 are approximately equal. The operator next momentarily presses the "start" button 129 for its full length which causes contact with the cam surface 124 and such action shifts the movable abutment 122 along the bar 114 to the right. This action moves the abutment away from the movable arm 119 and the spring force moves the arm so that the contacts 120 and 121 carried thereby engage the stationary contacts and closes both the heating element and the motor circuits. Upon energization of the circuits the drive motor 99 causes tumbling of the clothes by rotating the drum 96 and the blower motor 109 draws air from the ambient atmosphere through the inlet 106, circulates the same about the heat exchanger 101 and discharges it into the ambient atmosphere through the outlet 107. At the same time the heating element 110 supplies heat to the chamber 98 to evaporate the moisture from the tumbling clothing. The moisture leaving the clothing in the form of vapor moves toward the heat

exchanger, releases its latent heat of vaporization to the air circulating about the tubes **102** and is condensed. The condensate passes to the header **103** and out of the opening **104** for discharge to drain.

As the vapor is condensed the temperature of the air is increased by an amount equal to the latent heat of vaporization plus some of the sensible heat in the condensate. This increased temperature is detected by the bulb **116** at the discharge side of the duct and is reflexed on the bellows **113** which expand against the force of the other bellows **112** responding to the inlet temperature. Since the temperature at the inlet is relatively constant the force of the bellows responding thereto will remain substantially constant. Thus the increased expansion of the bellows **113** compresses the other and moves the bar **114** to the right carrying with it the abutment **122**. Prior to attaining the upper limit of the temperature difference, the abutment **122** engages the stationary member **118** and any further movement of the bar **114** to the right merely shifts the relative position of the abutment and bar.

Toward the end of the drying operation the rate of vaporization decreases with the result that the rate of heat absorption of the air decreases, thus the bulb **116** permits the bellows **113** to contract with the result that the bar **114** carrying the abutment **122** begins to move to the left and approach the movable arm **119**. As the temperature of the inlet and outlet air approaches equilibrium the contracting bellows **113** moves the abutment into engagement with the arm **119** and moves the same against the spring force to open the contacts **120** and **121**. This action opens both circuits to deenergize the heating element **110** and stop the drive and blower motors **99** and **109**, respectively, and the drying operation has been completed, after which the clothes may be removed as previously described.

If at any time the operator wishes to terminate the operation of the drier, the "off" button **130** is momentarily depressed and the mating cam surfaces force the movable abutment **122** to the left to engage the arm **119** to open the contacts.

In the above disclosed arrangement the timer for initiating and terminating the drying operation has been eliminated. However, it is to be understood that either control arrangement may be applied equally as well to either of the drier modifications shown, and that other modifications of vapor condensing type driers may be provided utilizing controls as outlined above.

From the foregoing, it can be seen that control apparatus for a vapor condensing type clothes drier has been provided which is responsive to the difference in temperature of the condensing medium entering the inlet and leaving the outlet of the drier casing to control the duration of the drying operation. Also, that a simplified drier control has been provided which is only dependent upon the quantity and condition of the materials being treated to determine the duration of the drying cycle and is independent of outside extraneous conditions for proper operation.

While I have herein described and upon the drawings shown illustrative embodiments of the invention, it is to be understood that the invention is not limited thereto, but may comprehend other constructions, arrangement of parts, details and features without departing from the spirit of the invention.

It is claimed:

1. In control apparatus for a vapor condensing type clothes drier, the combination of means for agitating the clothes, a casing surrounding said means to provide a drying chamber, means for heating the clothes in said chamber to evaporate the moisture therefrom, condenser means for receiving a cooling medium for condensing the vapor evaporated from the clothing by absorbing the heat from said vapor, an inlet and an outlet for said cooling medium, a timer for initiating the drying operation, circuit means responsive to a difference in temperature of the cooling medium between said inlet and said outlet, a first switch controlled by said timer for conditioning said circuit means for control over said heating means, a second switch controlled by said timer for de-energizing said timer to transfer control of said heating means from said timer to said circuit means, said circuit means operative to transfer control of said heating means back to said timer upon a decrease in the rate of heat absorbed by said cooling medium.

2. A drier for damp clothing, comprising means for agitating the clothes, a casing defining a drying chamber enclosing said means, means for heating said chamber to evaporate the moisture in the clothing, means for conducting a cooling medium over a surface associated with said casing to condense the vapor evaporated from the clothing by absorbing the latent heat of vaporization therefrom, said last named means including an inlet and an outlet, means for initiating the drying operation and controlling said heating means, a first switch responsive to differences in temperature of said cooling medium at said inlet and said outlet, means controlled by said initiating means for conditioning said first switch for control of said heating means, switch means controlled by said initiating means for transferring control of said heating means to said first switch, said circuit means being operable to return control of said heating means to said initiating means upon a decrease in the rate of heat absorption by said cooling medium.

3. A drier for damp clothing, comprising means for agitating the clothes, a casing defining a drying chamber enclosing said means, means for heating said chamber to evaporate the moisture in the clothing, means for conducting cooling air over a surface associated with said casing to condense the vapor evaporated from the clothing by absorbing its latent heat of vaporization, said means including an air inlet and an air outlet, manually operable means for initiating the operation of said drier, and means including a switch responsive to differences in temperature of the cooling air between said inlet and outlet for maintaining said heating means operative as the outlet temperature of the cooling air increases during the drying operation, and responsive when the difference in air temperature therebetween decreases to terminate the operation of said drier.

4. A drier for damp clothing, comprising means for agitating the clothing, a casing defining a drying chamber enclosing said means, means for heating said chamber to evaporate the moisture in the clothing, a heat exchanger having a portion in direct communication with said chamber, a duct having an inlet and an outlet communicating with the ambient atmosphere surrounding said heat exchanger, means for conducting air through said duct to condense in said heat exchanger the vapor generated in said casing by absorbing its latent heat of vaporization, a switch for controlling the operation of the drier, means for manually initiating the operation of said drier, and differential temperature responsive means responsive to a decrease in the temperature difference of the air on opposite sides of said heat exchanger during the drying operation for terminating the operation of the drier by opening said switch.

5. A clothes drier for drying damp clothing comprising a casing defining a drying chamber for said clothing, means for heating said chamber to evaporate moisture in said clothing, condenser means associated with said casing to condense said evaporated moisture, said condenser means being provided with an inlet and an outlet for movement of a cooling medium therebetween, manually operable means for controlling said heating means, circuit means responsive to differences of the temperatures at said inlet and said outlet for assuming control of said heating means from said manually operable means and maintaining said heating means operative while said evaporated moisture is condensed by

said condenser means, said manually operable means operable to condition said heating means for control by said circuit means, said circuit means being operable to render said heating means inoperative upon a substantial decrease in the rate of condensation of the evaporated moisture.

6. A clothes drier for drying damp clothing comprising a casing defining a drying chamber for said clothing, means for heating said chamber to evaporate moisture in said clothing, condenser means associated with said casing to condense said evaporated moisture, said condenser means being provided with an inlet and an outlet for movement of a cooling medium therebetween, a first cam operated switch for controlling said heating means, circuit means responsive to differences of the temperatures at said inlet and said outlet for assuming control of said heating means from said first cam operated switch and maintaining said heating means operative while said evaporated moisture is condensed by said condenser means, a second cam operated switch operable to condition said heating means for control by said circuit means, said circuit means being operable to render said heating means inoperative when the condensation of said evaporated moisture is substantially terminated.

7. A clothes drier for drying damp clothing comprising a casing defining a drying chamber for said clothing, means for heating said chamber to evaporate moisture in said clothing, condenser means associated with said casing to condense said evaporated moisture, said condenser means being provided with an inlet and an outlet for movement of a cooling medium therebetween, a timer, circuit means including a set of contacts, said circuit means being responsive to differences of the temperatures at said inlet and said outlet, a switch, said timer being operable to control said heating means during a first interval and operable to actuate said switch to condition said heating means for operation through said set of contacts during a second interval, said circuit means being operable to render said heating means inoperative at the termination of said second interval upon a substantial decrease in the rate of vapor condensation by said condenser means.

8. A clothes drier for drying damp clothing comprising a casing defining a drying chamber for said clothing, means for heating said chamber to evaporate moisture in said clothing, condenser means associated with said casing to condense said evaporated moisture, said condenser means being provided with an inlet and an outlet for movement of a cooling medium therebetween, a timer, circuit means including a set of contacts, said circuit means being responsive to differences of the temperatures at said inlet and said outlet, a switch, said timer being operable to control said heating means during a first vapor condensing interval and operable to condition said switch for operation through said set of contacts during a second vapor condensing interval, said circuit means being operable to render said heating means inoperative responsive to a decrease in the rate of heat absorption by said cooling medium.

9. A clothes drier for drying damp clothing comprising a casing defining a drying chamber for said clothing, means for heating said chamber to evaporate moisture in said clothing, condenser means associated with said casing to condense said evaporated moisture, said condenser means being provided with an inlet and an outlet for movement of a cooling medium therebetween, a timer, a switch, circuit means responsive to thermal differentials between said inlet and said outlet, said timer controlling said heating means during the first interval and conditioning said switch for operation, said circuit means being operable to assume control of said heating means from said timer after said switch has been conditioned for operation, said circuit means being further operable to relinquish control of said heating means to said timer responsive to a decrease in the rate of heat absorption by said cooling medium as the rate of moisture vaporization decreases substantially.

10. A clothes drier for drying damp clothing comprising a casing defining a drying chamber for said clothing, means for heating said chamber to evaporate moisture in said clothing, condenser means associated with said casing to condense said evaporated moisture, said condenser means being provided with an inlet and an outlet for movement of a cooling medium therebetween, a timer, a switch, cooling medium thermal sensing devices near said inlet and said outlet, circuit means responsive to said thermal sensing devices, said timer controlling said heating means during a first interval and operable to actuate said switch to condition said circuit means for deenergizing said timer and assuming control of said heating means from said timer, a second switch, said circuit means operable to deenergize said heating means and energize said timer upon a substantial decrease in the rate of vapor condensation by said condenser means, said timer being operable to deenergize itself after a timer interval.

11. A clothes drier for drying damp clothing comprising a casing defining a drying chamber for said clothing, an agitator for tumbling said clothing, power means for said agitator, heating means for evaporating moisture in said clothing, condenser means associated with said casing to condense said evaporated moisture, said condenser means being provided with an inlet and an outlet for movement of a cooling medium therebetween, a control for regulating the movement of said cooling medium, a timer, first and second switches, cooling medium thermal sensing devices near said inlet and said outlet, circuit means responsive to said thermal devices, said timer controlling said heating means during a first interval through said first switch and operable to actuate said second switch to condition said circuit means for deenergizing said timer and for assuming control of said heating means from said timer, said circuit means being operable to render said heating means inoperative and energize said timer upon a substantial decrease in the rate of vapor condensation by said condenser means.

12. In a clothes drier for dry damp clothing comprising a drying chamber for said clothing, heating means for evaporating moisture in said clothing, condenser means associated with said drying chamber to condense said evaporated moisture, said condenser means being provided with an inlet and an outlet for providing a cooling medium, the automatic control which comprises a first timer switch connected in a circuit for energizing said heating means, a second timer switch, a temperature responsive switch connected in series with said second timer switch, said temperature responsive switch and said second timer switch connected in parallel with said first timer switch, a first timer means for closing said first timer switch to energize said heating means for a first timer interval, a second timer means for closing said second timer switch prior to the end of said first timer interval to energize said heating means through said temperature responsive switch upon the termination of said first timer interval.

13. In a clothes drier for drying damp clothing comprising a drying chamber for said clothing, heating means for evaporating moisture in said clothing, condenser means associated with said drying chamber to condense said evaporated moisture, said condenser means being provided with an inlet and an outlet for providing a cooling medium, the automatic control which comprises a first timer switch connected in a circuit for energizing said heating means, a second timer switch, a temperature responsive switch connected in series with said second timer switch, said temperature responsive switch and said second timer switch connected in parallel with said first timer switch, a first timer cam for closing said first timer switch to energize said heating means for a first timer interval, and a second timer cam for closing said second timer switch prior to the end of said first timer interval

to energize said heating means through said temperature responsive switch upon the termination of said first timer interval, means for actuating said first and second timer cams, a third timer switch for energizing said latter means, and manual means for closing said first and third timer switches at the beginning of the timing cycle.

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