April 28, 1970 R. J. KOMBOL 3,508,340

LAUNDRY APPARATUS WITH DRYER HEAT CONTROL

Filed April 12, 1968 3 Sheets-Sheet 1

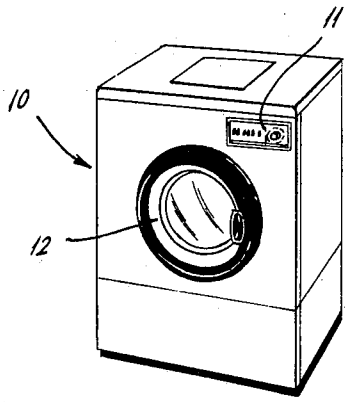


FIG. 1.

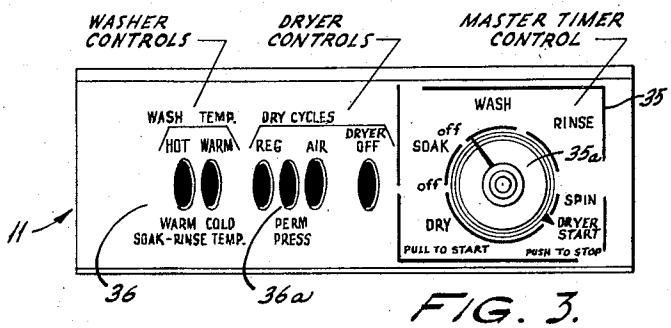


FIG. 3.

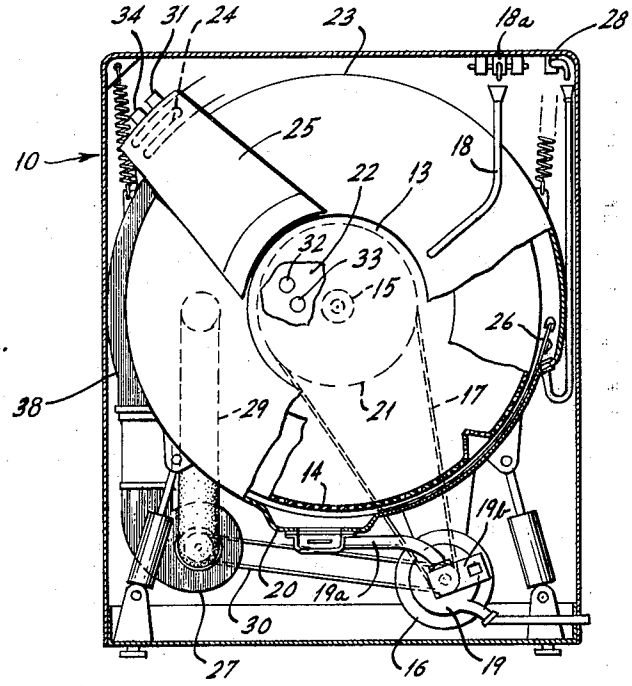


FIG. 2.

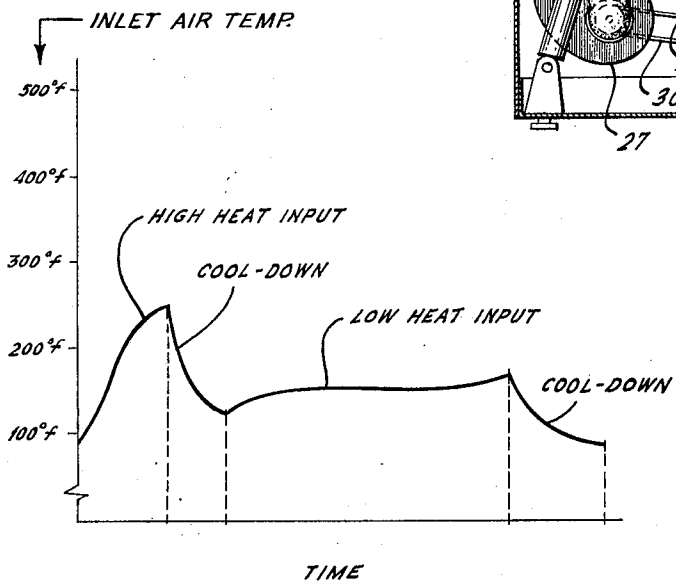


FIG. 7.

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LAUNDRY APPARATUS WITH DRYER HEAT CONTROL

Filed April 12, 1968 3 Sheets-Sheet 2

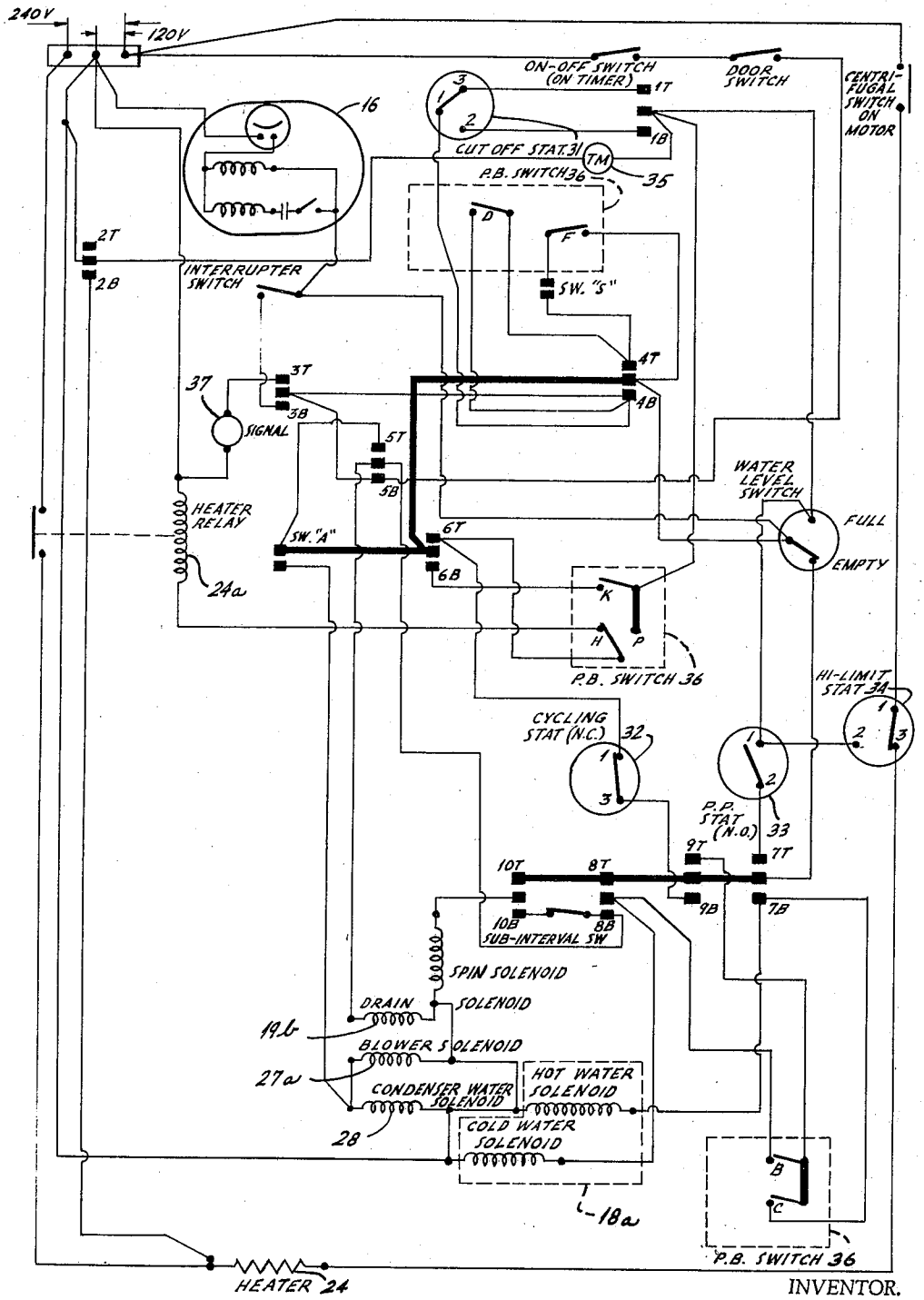


FIG. 4.

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LAUNDRY APPARATUS WITH DRYER HEAT CONTROL

Filed April 12, 1968 3 Sheets-Sheet 3

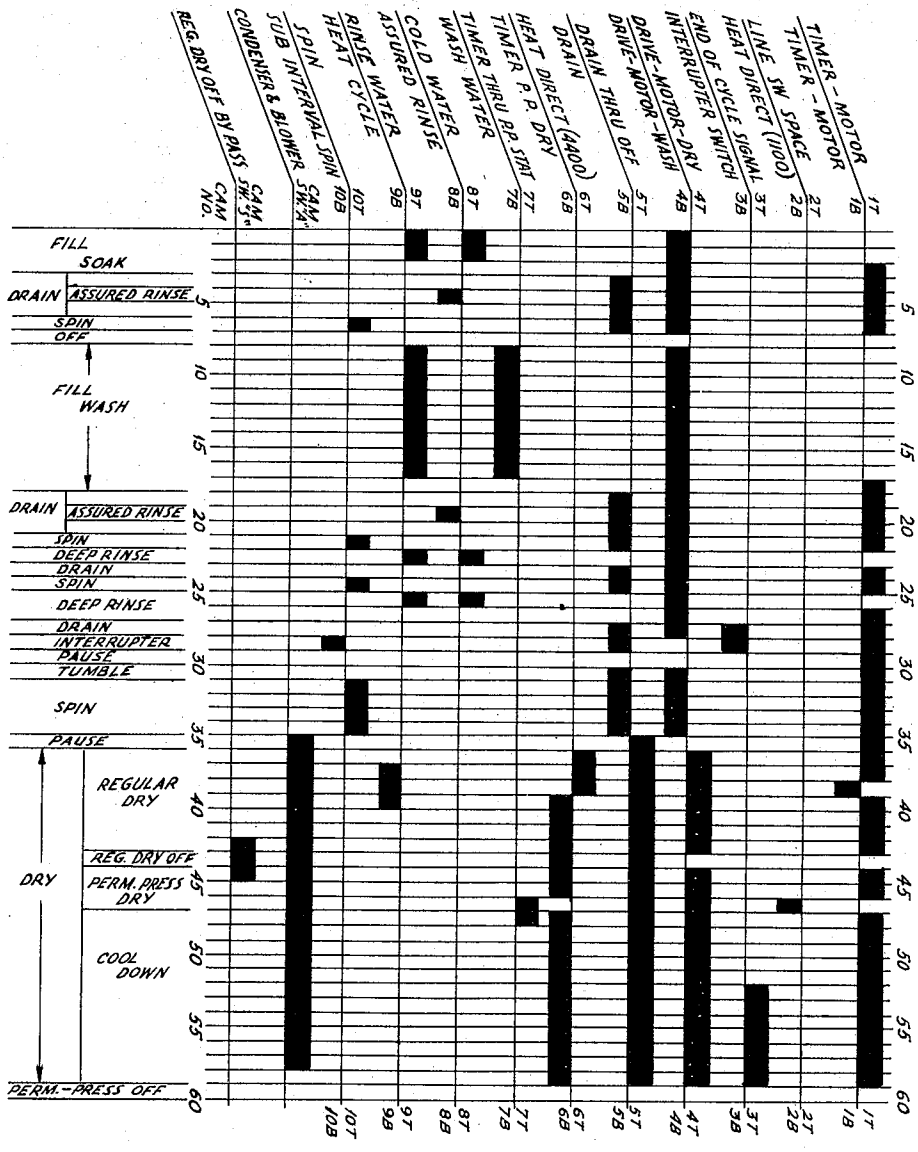


FIG. 5.

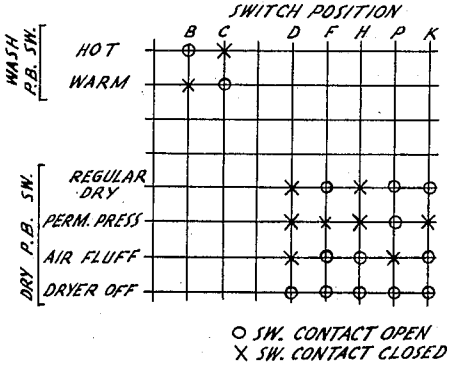


FIG. 6.

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LAUNDRY APPARATUS WITH DRYER HEAT CONTROL

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U.S. Cl. 34—48 7 Claims

ABSTRACT OF THE DISCLOSURE

An automatic clothes dryer providing a drying cycle for permanent press clothing. The dryer includes control circuitry providing an initial high heat input rate for a period of time terminated in response to attainment by a clothes temperature sensor of a temperature indicative of a dry-clothes condition. If the sensed temperature indicates that drying is not complete, the sensor is operable again to energize the heater, but at a lower heat input rate to preclude adverse effects of high temperatures on the clothing as it approaches a dry condition. Either program of heating is followed by a cool-down period, during which there is no input of heat.

BACKGROUND OF THE INVENTION

This invention relates to laundry apparatus, and more particularly to improved apparatus for drying fabrics.

One known type of such apparatus includes a perforate clothes container mounted within an enclosure, and means for heating air and for circulating it through the container to dry the clothes. In order to maintain the temperature of air in the container within predetermined limits safe for the clothes being dried, suitable thermostatic control means are provided in combination with the means for heating. In general, for the initial stages of drying when the moisture content of the clothes is relatively high, substantially elevated drying temperatures can be maintained safely due to the temperature stabilization effect derived from absorption of heat by excess moisture in the clothes at latent heat of vaporization. For the final stages of drying, when much of the moisture has been driven out, the rate of heat input is reduced to prevent the clothes from exceeding a safe temperature, preferably about 170° F. Advantageously, temperatures of permanent press fabrics can be closely controlled by this principle to prevent temperature extremes that might discolor or set stains in the fabrics. The initial high moisture content in such fabrics permits them to withstand the above described rapid heating at the beginning of a drying cycle.

The present invention recognizes that frequently, due to the relatively light thermal loading afforded by most articles of clothing and the like made from permanent press fabrics, such initial rapid heating as described above may be sufficient completely to dry the articles, without need for resorting to further heating at a lower input rate.

It is therefore a general objective of this invention to provide control circuit means for testing the dryness of such articles after an initial period of high heat input to determine whether additional heating at a lower temperature is necessary.

SUMMARY OF THE INVENTION

In achievement of the foregoing, as well as other general objectives, the invention contemplates provision, in an automatic clothes dryer, of means for achieving a drying cycle for clothing of the permanent press type. Such means includes control circuitry affording an initial high rate of heat input for a period of time followed by a period of heating at a lower heat input rate. Either period of heating is terminated in response to operation of a clothes temperature sensor. The invention recognizes that heating at the higher rate may be sufficient to complete the drying cycle for a particularly light clothes load. However, if drying is not complete, the clothes temperature sensor is operable again to energize the heater at its lower rate of heat input, to preclude adverse effects of high temperatures as the clothes approach a dry condition. The control circuitry provides a time-controlled cool-down period after drying is completed either as a result of heating at the high input rate, or as a result of heating at the combined higher and lower rates.

Preferred means for achieving the objectives and advantages of the invention are set out in the following description, taken in light of the accompanying drawing.

BRIEF DEECRIPTION OF THE DRAWING

FIGURE 1 is a perspective showing of laundry apparatus embodying the invention;

FIGURE 2 is an elevational showing on a larger scale, and with parts broken away, of the apparatus illustrated in FIGURE 1;

FIGURE 3 is a larger scale showing of control panel structure seen on the apparatus illustrated in FIGURE 1;

FIGURE 4 is a wiring diagram illustrating electrical control circuitry associated with the control panel illustrated in FIGURE 3, and effective to achieve the drying operation contemplated by the invention;

FIGURE 5 shows the sequence chart for the timer used in practice of this invention, and illustrated in FIGURES 3 and 4;

FIGURE 6 is a selector-switch chart showing the mechanical connections made through operation of the push buttons shown in FIGURES 3 and 4; and

FIGURE 7 is a graphic representation of some performance characteristics of apparatus embodying the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

With more detailed reference to the drawing, and first to FIGURES 1, 2 and 3, the invention is embodied in laundry apparatus that includes both a washing machine and a dryer in a single unit. It will be understood of course that the invention also is adapted for use in separately contained dryer units. The apparatus comprises cabinet structure **10** having mounted thereon a control panel **11** and a door **12** (FIGURE 1) that provides access to an opening **13** (FIGURE 2) communicating with the interior of a clothes drying chamber mounted within the cabinet structure. The clothes drying chamber comprises a horizontally extending perforate drum or cylindrical basket **14** which is mounted for rotating movement about a horizontally extending stub shaft **15** mounted in a bearing plate portion **22** of a tub **23** within which basket **14** is housed. A bearing plate construction particularly adapted for use in apparatus embodying the present invention is disclosed in U.S. Patent No. 3,038,324 assigned to the assignee of the present invention. Drive means for rotating drum **13** includes a motor **16** provided with a pulley (not shown) arranged to drive a belt **17**, the latter engaging a pulley **21** mounted on shaft **15**.

For washing and rinsing operations, water at the desired temperatures is introduced into tub **23** through a hose **18** fed by conventional, solenoid controlled valve means **18***a*. Spent wash water is withdrawn from the tub by means of an impeller-type drain pump **19** connected to the shaft of motor **16**. This pump communicates with a sump **20**, provided in a lower part of tub **23**, by means of a flexible hose **19***a*. Drainage of the water from the tub and basket is controlled by means of a solenoid actuated valve **19***b* associated with the drain pump.

As is well known in the art, in either the washing or the drying operation, basket **14** is rotated in order to tumble the clothes, and particularly during the drying operation uniformly to expose the fabrics or clothes being dried to circulating heated air, thereby facilitating the drying operation. While the ends of basket **14** are preferably imperforate, with the exception of the loading opening **13**, the cylindrical surface of the basket has perforations that permit passage of heated circulating air through the basket to dry clothes disposed therein.

Tub **23** is spaced from and encloses the basket **14**, and an electrical resistance heater **24** is disposed within an air duct **25** communicating with the tub in the region of its access opening. Means for cooling the circulated heated air includes a water vapor condenser **26** disposed within a wall of the tub and defined by a water distributing manifold that causes water to flow down inner surface portions of the tub. Preferably condensing water flows throughout the drying cycle, under the control of a solenoid valve **28**. Circulation of the air for drying is effected by a blower **27** that withdraws air from basket **14**, through perforations thereof into tub **23**, over the condensing water, and outwardly of the tub through rear bearing plate **22** and duct **29**. The blower redirects the dehumidified and cooled drying air through duct **38** that communicates with heater duct **25**, for flow back over heater **24** and into the tub and basket by way of their aligned access openings. Blower **27** preferably is of the rotary impeller type, and is driven by motor **16** through a pulley and belt arrangement **30**. The blower is driven only during the drying cycle, such selective drive being afforded by a clutch arrangement (not shown) associated with motor **16**, and under the control of a blower solenoid **27***a* (FIGURE 4). Under such arrangement energization of solenoid **27***a* causes the blower to be driven, and de-energization of solenoid **27***a* causes the blower to be stopped.

Means for sensing temperatures representative of heat conditions within the clothes drying chamber of basket **14** includes thermostats **31**, **32**, **33** and **34** positioned as shown in FIGURE 2, and each in heat exchange relation with various zones of the circulating air. More specifically, thermostats **31** and **34** are associated with duct **25**, in the region of heater **24** for subjection to the basket inlet air, and thermostats **32** and **33** are associated with the rear bearing plate for subjection to the basket exhaust air. Preferably, each thermostat is of the type having a bimetal disc which serves as a combined sensing element and circuit modifier in a manner to be hereinafter described.

With reference also to FIGURES 4, 5 and 6, the various phases of the washing and drying cycles of the total laundering operation are sequentially controlled by a master timer control **35**. The control circuitry associated with timer **35** is illustrated in detail in FIGURE 4, and is conditioned for multi-cycle operation by means of push-button control switch means **36** forming part of the control panel **11** on the front of the machine. The connections made by operation of the various push buttons are graphically shown in FIGURE 6. Since the present invention is not concerned with the wash cycle, which is conventional, only those details of this cycle which are necessary to understanding of the invention are described. It will be understood that both mechanical and circuit means for achieving any one of the washing or drying operations, including the permanent press cycle to which the invention is particularly directed, can be traced using the timer sequence chart (FIGURE 5) in conjunction with the wiring diagram (FIGURE 4). The timer actuated switch contacts and the function or component that each such contact controls (e.g., Heat cycle **9B** or Drive-motor-dry **4T**) are listed across the top of the timer chart of which FIGURE 5 is comprised. The phases of the complete cycles are listed down the left hand side

of the timer chart, and the timer increments are listed or numbered down the right and left hand sides of the chart. The solid vertical bars in the timer chart denote closed positions of the various timer switch contacts for each of the several cycles.

In order to trace the circuitry of FIGURE 4 using the timer sequence chart of FIGURE 5, one first locates the particular phase or step of the cycle on the sequence chart. From the chart it is determined which timer switch contacts are closed during the particular step or phase of the cycle, by noting positions of the solid vertical bars for that step. To aid in tracing the closed contacts, it is convenient to fill in the gaps of the respective closed contacts of FIGURE 4 with a dark pencil or the like. Similarly, it can be determined from FIGURE 6 which push-button switch contacts are closed. The circuitry for such particular step or phase of a cycle may then be readily traced on the wiring diagram.

Important to the invention is the fact that fabrics having substantial quantities of retained moisture at the start of the drying cycle can withstand substantial quantities of heat, since most of the initial drying energy is converted into latent heat of vaporization of the retained moisture. It is therefore possible, and desirable, to introduce a large quantity of heat during the initial stages of drying to remove this moisture as quickly as possible, to reduce the overall drying time. However, once this moisture is removed in substantial part, it becomes necessary to reduce the heat input to prevent the clothing from exceeding 170° F.

The above described principles are particularly useful in achievement of a drying cycle for so-called permanent-press clothing. According to the present invention, the permanent-press drying cycle is accomplished by a two-stage or two phase, heat input system. As is illustrated diagrammatically in FIGURE 7, the first phase of heating is at high heat input (e.g., 4400 watts) and the second phase of heating is carried out at low heat input (e.g., 1100 watts). Either phase of heating is followed by a cool-down period. Inasmuch as the illustrated dryer unit has a characteristically slow, condenser type drying system, the high heat input is used at the beginning of the drying cycle to cause rapid heating of the mass of the machine and the contained clothes to speed the drying cycle. The drying chamber inlet temperature during this first stage of heat input may reach temperatures as high as about 250° F. However, since the clothes are wet, the latent heat of vaporization of the large quantities of moisture in the clothes can maintain their temperature below about 170° F., the danger point for certain permanently pressed articles.

When the mass of the machine and clothes are heated sufficiently, but while the clothes are still damp, the high heat input is turned off. A cool-down period of about 7 minutes' duration follows. The low heat input is then initiated, and continues until such time as the exhaust temperature indicates that the clothes are dry. The low input heat is then discontinued followed by a cool-down period of about 12 minutes. During the last 7 minutes of the cool-down period an end-of-cycle signal **37** sounds, and the permanent press cycle is complete.

The permanent press cycle will now be described in more detail in terms of the operating circuitry for providing such cycle, and as illustrated further in FIGURES 4, 5, 6 and 7.

Assuming that the permanent press drying cycle is desired, push button **36***a* (FIGURE 3) is depressed, thereby closing switch contacts D, F, H and K as indicated in FIGURE 6. Circuitry associated with these contacts is illustrated in FIGURE 4. With push button **36***a* thus depressed, timer knob **35***a* is advanced automatically or manually to the "Dryer Start" position illustrated in FIGURE 3 (corresponding to the 37th increment in FIGURE 5), closing timer actuated switch contacts A, **6T**, **5T**, **4T** and **1T**. Closing of these contacts completes

a circuit from a 120 v. power source to the condenser water supply solenoid **28**, blower solenoid **27***a*, heater relay **24***a*, drain solenoid **19***b*, drive motor **16**, and timer motor **35**. Energization of heater relay **24***a* connects the heater **24** to a 240 v. power source.

The timer motor circuit is completed through a circuit including the illustrated normally closed **1–3** position of the cut-off thermostat **31** and timer switch contact **1T**. The timer then advances to its 38th increment, closing timer switch contact **9B**, completing an alternate circuit for heater relay **24***a* through the heater cycling thermostat **32**. Heater **24** receives its energy from the 240 v. power source. In the event that normally closed cycling thermostat **32** should cycle or open before completion of the high heat input period, direct heat will continue through timer switch contact **6T**. The purpose of direct heat through switch contact **6T** is to insure that normally closed cut-off thermostat **31** will open before the heat is turned off. At the 39th increment timer switch contact **1T** opens and contact **1B** closes breaking the circuit to timer motor **35**. However, cut-off thermostat **31** is still in its normally closed **1–3** position, whereby the timer is suspended in its 39th increment. The length of time that the timer remains suspended from operation varies with the clothes-load size, i.e., large, medium, or small. Timer **35** will remain suspended until normally closed contacts **1–3** of cut-off thermostat **31** open at about 170° F., thereby closing its contacts **1–2** to complete a circuit to the timer motor. Timer **35** then advances to the 40th increment, thereby opening switch contact **6T** and breaking one of the two possible current paths to heater relay **24***a*; the path through switch contact **9B** and the normally closed cycling thermostat **32** remain closed. Timer switch contacts **1T** and **6B** close at this time and **1B** opens. A bypass circuit is created through timer switch contact S and closed push-button switch contact F, thereby enabling drive motor **16** to continue to run through the regular cycle "off" perioid when the permanent-press drying cycle is selected. It is to be noted that both the regular and the permanent-press dry cycles share the same timer increments up to this point. Since the push-button switch contacts K are closed, timer **35** will continue to advance. The timer motor energizing circuit is completed through push-button switch contacts K, timer switch contacts **6B**, **4T**, push-button switch contacts D, timer switch contacts **4B** and **5B**, to the other side of the 120 v. source. Timer **35** then advances to the 41st increment and opens switch contact **9B**. Timer **35** continues through to the 47th increment to open switch contacts **6B** and **1T** and to close **7T** and **2B**. The closing of **2B** applies 120 volts across air heater **24** to lower its outputs to 1100 watts.

However, and in special accordance with the invention, it is at this stage of the permanent-press drying cycle that the normally open permanent-press thermostat **33** senses the dryness of the clothes indirectly to determine whether or not it is necessary to proceed with the second stage of drying at the low heat input rate of 1100 watts. Should the clothes be dry after the first stage of drying at the high heat input rate of 4400 watts, the temperature in the vicinity of the permanent-press thermostat **33** will not have been lowered sufficiently to cause its switch contacts to open. Since thermostat **33** and the contact **7T** are closed, timer **35** has a circuit to drive it directly into cool down.

If, on the other hand, switch contacts of permanent-press thermostat **33** are open, indicating the need for further drying, timer **35** will remain supended in its 47th increment until permanent-press thermostat **33** reaches about 140° F. and closes, completing the timer motor circuit through switch contact **7T** and advancing the timer to the 48th increment. Timer switch contact **2B** opens at this time, and the 1100 watt heater circuit is broken. This is accompanied by the closing of switch contact **6B**, completing the timer motor circuit which then remains closed for the rest of the cool-down period. In the 53rd increment of timer operation, switch contact **3T** closes completing the circuit to the end-of-cycle signal, characterized by the sounding of a bell every 6 to 7 seconds for the last 7 minutes of the cool-down period. The permanent-press cycle is then completed.

It will be appreciated that the invention provides improved apparatus for drying clothes and other articles of the permanent press type. Moreover there is provided an improved clothes dryer of the non-vented, condenser type in which the time required for drying permanent-press clothing is materially reduced through a novel two-stage heating arrangement.

I claim:

1. In laundry apparatus: means defining an enclosure for fabrics to be dried; means for moving air through said enclosure to dry such fabrics; means for heating said air sequentially at a higher heat input rate and at a lower heat input rate; means for sensing the degree of dryness of said fabrics at the termination of said higher heat input rate; and means operable in response to the sensed degree of dryness either to initiate heating at said lower heat input rate, if the fabrics are not substantially dry, or to terminate heating, if the fabrics are substantially dry.

2. In laundry apparatus: means defining an enclosure for fabrics to be dried; means for moving air through said enclosure to dry such fabrics; means for heating said air sequentially at a higher heat input rate and at a lower heat input rate, including a heater of the electrical resistance type selectively energizable at either a higher or a lower energy output rate; a higher voltage source and a lower voltage source; and control means operable to establish a period of operation of said heater by said higher voltage source in achievement of the recited higher heat input rate, and to sense the degree of dryness of said fabrics upon termination of said higher heat input rate, said control means being further operable in accordance with the sensed degree of dryness either to establish a period of operation of said heater by said lower voltage source in achievement of the recited lower heat output rate, or to terminate heating.

3. In laundry apparatus: means defining an enclosure for fabrics to be dried; means for moving air through said enclosure to dry such fabrics; means for heating said air sequentially at a higher heat input rate and at a lower heat input rate, including a heater of the electrical resistance type selectively energizable at either a higher or a lower energy output rate; a higher voltage source and a lower voltage source; and control means operable to establish a period of operation of said heater by said higher voltage source in achievement of the recited higher heat input rate, and to sense the degree of dryness of said fabrics upon termination of said higher heat input rate, said control means being further operable in accordance with the sensed degree of dryness either to establish a period of operation of said heater by said lower voltage source in achievement of the recited lower heat output rate, or to terminate heating, said control means also being operable to provide a cool-down period following heating of said fabrics to dry the same.

4. In laundry apparatus: means defining an enclosure for fabrics to be dried; means for moving air through said enclosure to dry such fabrics, including an air impeller and conduit means arranged to provide a closed, recirculating air flow path; water vapor condensing means in said air flow path; means for heating said air sequentially at a higher heat input rate and at a lower heat input rate; and control means for sensing the degree of dryness of said fabrics at the termination of said higher heat input rate, said control means being operable in accordance with the sensed degree of dryness either to initiate heating at said lower heat input rate or to terminate heating.

5. Apparatus according to claim **4**, and further characterized in that said means for heating air is operable

continuously in provision of its higher and lower heat input rates.

6. Apparatus according to claim 5 and further characterized in that said control means is operable to provide a cool-down period following either period of heating.

7. In laundry apparatus of the type having means for tumbling clothes in an enclosure and moving heated air through said enclosure to dry fabrics contained therein, control means adapting such apparatus for use in drying so-called permanently pressed clothing, said control means comprising: means for tumbling the clothes and for establishing a flow of air over such permanently pressed clothes while the latter are in a relatively wet state and with the air heated to a temperature substantially above the temperature acceptable for contact with such clothes when they are in a drier state; means for terminating heating of the air while continuing tumbling of the clothes to establish a cool-down period during which the clothes continue drying; means for sensing the degree of dryness

of said clothes during the latter part of said cool-down period; and means selectively operable in response to the condition of clothes dryness either to provide for termination of operation of said apparatus, if the clothes are substantially completely dry, or to continue tumbling and drying with the air heated to a lower temperature acceptable for drying such clothes when in said drier state.

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JOHN J. CAMBY, Primary Examiner

U.S. Cl. X.R.

34—53