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DRYER AND METHOD OF OPERATION

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2 Sheets-Sheet 1

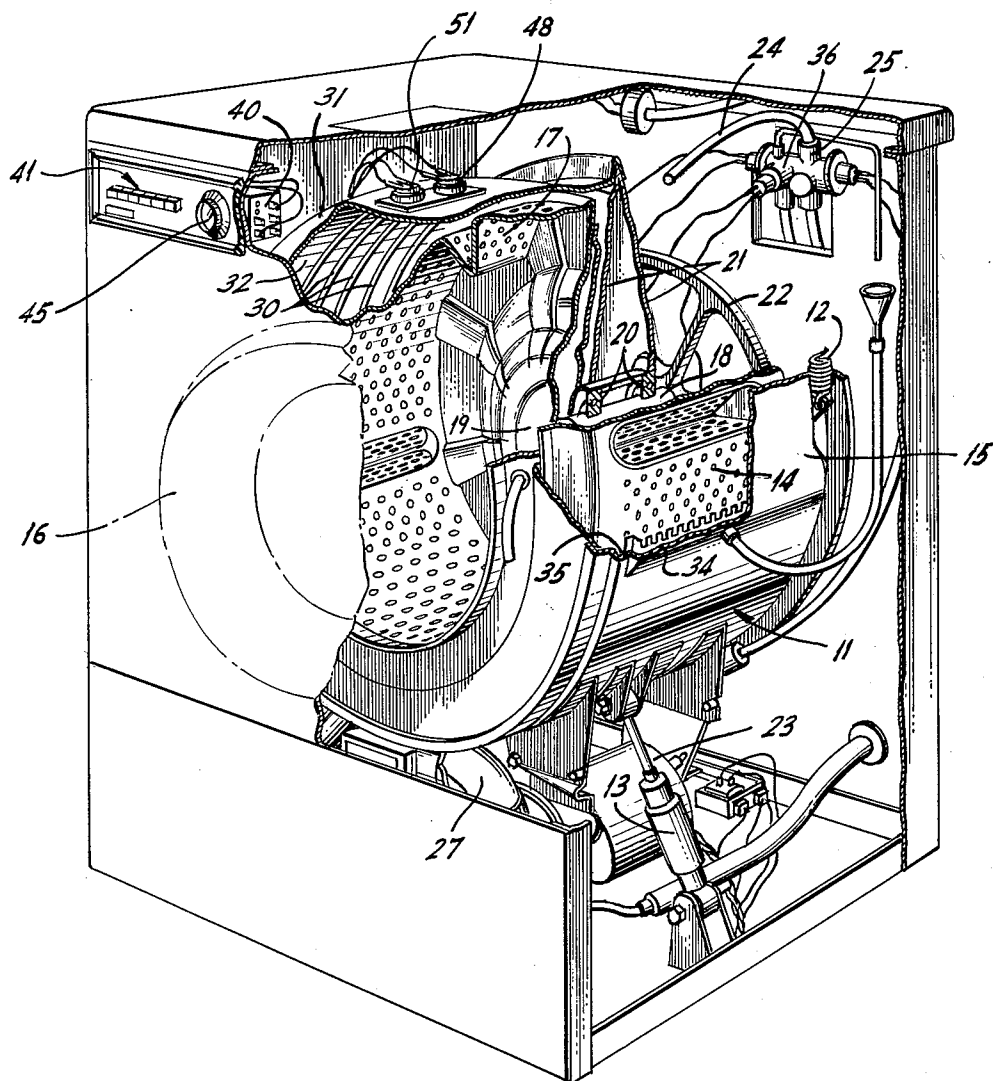


FIG. 1.

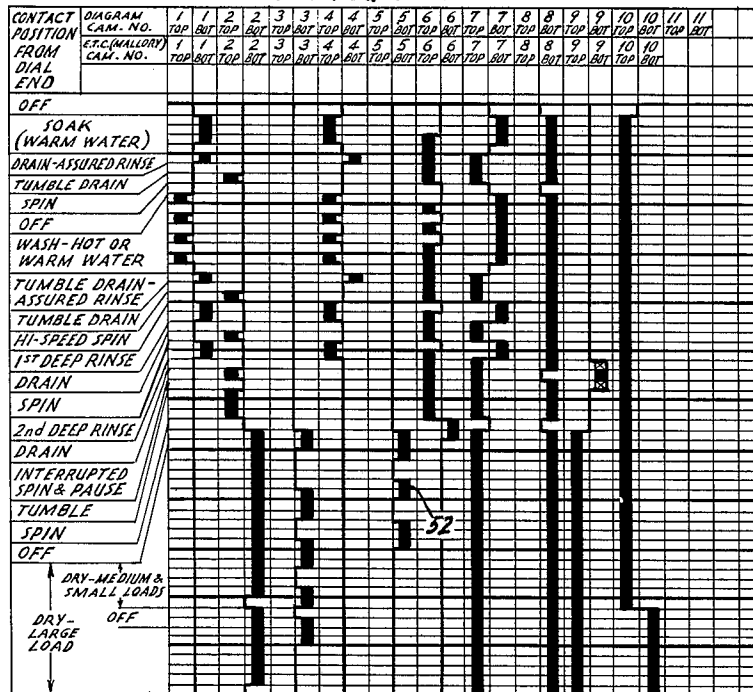
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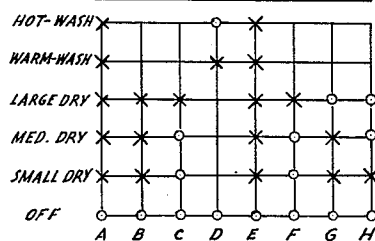
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TIMER SEQUENCE CHART



The diagram is a detailed electrical schematic for a timing circuit. It shows a power supply line (E) connected to a series of components. A large capacitor (46) is connected to a timer (40) and a 23 ohm resistor. The timer is connected to a 36 ohm resistor and a 46 ohm resistor. The circuit is divided into sections for 'EMPTY' and 'FULL' water levels. The 'EMPTY' section includes a 10B capacitor, a 10T capacitor, and a 27 ohm resistor. The 'FULL' section includes a 2B capacitor, a 1B capacitor, a 1T capacitor, a 4T capacitor, a 4B capacitor, a 7T capacitor, a 7B capacitor, a 6T capacitor, a 6B capacitor, an 8B capacitor, a 7B capacitor, a 9T capacitor, a 30 ohm resistor, a 31 ohm resistor, a 3B capacitor, and a 5B capacitor. The circuit is labeled with various components and their values, including '10B', '10T', '27', '2B', '1B', '1T', '4T', '4B', '7T', '7B', '6T', '6B', '8B', '7B', '9T', '30', '31', '3B', '5B', '190°', 'EMPTY', 'FULL', 'A', 'B', 'C', 'D', 'F', 'G', 'H', 'E', '36', '46', '40', '23', '10B', '10T', '27', '2B', '1B', '1T', '4T', '4B', '7T', '7B', '6T', '6B', '8B', '7B', '9T', '30', '31', '3B', '5B', '190°', 'EMPTY', 'FULL', 'A', 'B', 'C', 'D', 'F', 'G', 'H', 'E', '36', '46', '40', '23'.

PUSH BUTTON SWITCHING CHART



○ - OPEN
 X - CLOSED

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DRYER AND METHOD OF OPERATION

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This invention relates generally to laundering apparatus and more particularly to an improved method and means for drying.

It is a primary object of this invention to provide a simplified method for minimizing the time required to dry a predetermined load of fabrics or the like given a specific drying enclosure and a fixed power input.

It is a further object of this invention to provide an automatic control for clothes dryers of the domestic type insuring a drying run approximating the empirically determined optimum for such dryer.

It is a still further object of this invention to provide a novel technique for automatically programming the drying operation of a domestic washing machine which technique is both reliable and inexpensive.

These, and other objectives and features of the present invention will be apparent from a consideration of the following detailed description taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a sectionalized perspective view showing a combination washer-dryer embodying features of the present invention;

FIGURE 2 shows a sequence chart of a timer used in the practice of this invention;

FIGURE 3 is a wiring diagram showing one form of auxiliary control circuit designed to implement timer control of the drying cycle; and

FIGURE 4 is a selector switch chart showing the mechanical connections effected through push button operation.

In broad general terms the accomplishment of the above mentioned general objectives is achieved by empirically determining the optimum drying run for the drying apparatus under consideration and then automatically duplicating this run or series of runs through timer controlled programming of the dryer heaters.

More specifically this novel method of drying comprises empirically determining the energy requirements for the drying system, during the period from the point of substantial conversion of input energy into sensible heat to the end of the drying run, necessary to produce the desired degree of dryness in optimum time using minimal energy and then duplicating those energy requirements through timer controlled, intermittent operation of the heat source. By this technique there has been devised a simplified and accurate method for producing an optimum drying run for varying wash loads which is custom tailored to the design parameters and operating characteristics of the individual machine.

Referring to FIGURE 1, the invention is depicted, for exemplary purposes as being embodied in laundry equipment of the washer-dryer type. It should be understood, however, that while the aforementioned apparatus embodies in a single unit a washer and dryer, the present invention is equally well adapted for use in a separately contained dryer. The illustrated machine includes a cabinet structure in which a drum and tub assembly 11 is suspended by means of springs 12 and shock absorbers 13 in the manner set forth in the U.S. patent to Oeler et al. No. 2,642,996 issued June 23, 1943 and assigned to the assignee of the present invention.

The tub assembly 11 comprises a perforated cylindrical

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drum 14 adapted to rotate about a substantially horizontal axis within a cylindrical liquid-retaining tub 15. The front wall portions of the drum and tub are each provided with concentrically aligned openings adapted to register with an access door 16, shown in phantom for simplicity of illustration. To insure tumbling of the clothes within the drum during its rotation the drum is provided with inwardly presented vanes or ribs 17.

A stub shaft 18 is affixed to the rear wall 19 of the drum 14 and extends axially thereof through bearings 20 housed in rear wall portions 21 of the tub 15. A pulley 22 is carried on the outer end of the shaft 18 and is belt driven through a multispeed transmission by the synchronous motor 23.

For washing and rinsing operations water is introduced into the tub 15 through a hose 24 which receives water from the outlet side of a solenoid valve 25 of conventional construction. The water is withdrawn from the tub by means of an impeller type, solenoid actuated drain pump, not shown, connected directly to the shaft of motor 23. This pump communicates with a sump provided in the lower part of the tub 15 by means of a flexible hose 27. Drainage of the water from the drum is controlled by means of a solenoid actuated valve, not shown, located in the inlet port of the water pump.

For the drying cycle the machine is provided with a heating section comprising a bank of resistance heaters 30 disposed in a cove 31 provided in the wall of tub 15. To improve thermal efficiency the heating elements are backed by a reflector plate 32. Diametrically opposite this heating section is a water condensing zone fed by a water distributing manifold 34 having a serrated weir over which water is caused to flow down inner wall surface portions 35 of the tub 15. The condensing water runs throughout the drying operation and flow thereof is initiated by activation of the condenser solenoid 36.

The various phases of the washing and drying cycles of the total laundering operation are sequentially controlled by a common timer 40. The control circuitry associated with this timer, shown in FIGURE 3, is conditioned for multicycle operation by means of a six push button control switch center 41 seen in the upper lefthand portion of the machine in FIGURE 1. The connections made by operation of the various push buttons is graphically shown in FIGURE 4. The two buttons on the extreme left offer a selection of hot or warm wash water and the button on the extreme right permits the user to start and stop the machine in any phase of the wash or dry cycle.

The remaining three push buttons control the programming of the various drying cycles hereinafter discussed in detail. The wash cycle per se forms no part of the present invention and since its operation is in accordance with conventional practice only those details of its functioning which are necessary to an adequate understanding of the invention are described.

The push button selector switch is a mechanical contrivance by which electrical current is directed from one circuit to another through a multiple switching arrangement. The switching chart, shown in FIGURE 4, in conjunction with the wiring diagram of FIGURE 3 and the sequence chart of FIGURE 2, will be used in describing the detailed operation of one form of drying system incorporating this invention.

Important to the operation of this invention is the fact that fabrics having a substantial quantity of retained moisture at the start of the drying cycle can withstand substantial thermal gradients since most of the initial drying energy is converted into latent heat of vaporization. Consequently, it is both feasible and desirable to employ a large quantity of heat during initial stages of

drying to remove this moisture as quickly as possible to reduce overall drying time. Once this moisture is removed in substantial part, however, it becomes necessary to reduce the heat input to prevent scorching. It is to this later phase of the drying cycle to which the invention is primarily directed, namely to that period of the cycle between the time when a substantial transfer of energy into sensible heat occurs and the end of the drying run. Basically the invention consists of providing a minimal drying time for this phase of the cycle through timer-controlled programming of the heat source initiated by a thermostatic element strategically positioned to monitor the temperature of the drying air. The heat source is thereby operated in accordance with an empirically determined program designed to closely approximate the optimum drying time for that particular load in that particular machine.

In the embodiment chosen for illustration the clothes begin the drying cycle as they come from the centrifuge drying phase of the wash cycle. Clothes at this stage of the operation contain moisture equal to about 85% of their dry weight. In the initial stages of drying, as has been noted, this large percentage of retained moisture permits a considerable quantity of heat to be pumped into the drying chamber without appreciable rise in temperature. By using a large quantity of heat during the early stages of drying the overall drying time for any particular wash load can be materially shortened.

For any particular dryer and type and weight of load there is a point in the drying cycle at which the temperature of the drying air undergoes a marked increase indicating an appreciable reduction in the moisture content of the fabrics being dried and a substantial conversion of energy into sensible heat. This point is dependent on the size of the drying chamber, the energy input into the system and other characteristics of the machine. This point, however, can be readily determined by empirical means for any given dryer and load. Control of the drying cycle is not inaugurated until the point of sensible heat transfer is reached at which time there is a rapid rise in temperature. As indicated, this temperature surge will occur for a predetermined system and loading at a time when the fabric has a predictable quantity of retained water. Once this point is empirically determined for any given dryer and in particular accordance with the present invention, this operational characteristic is used to initiate timer control of the heaters in the manner hereinafter described in detail. By timer modulating the heater operation, controlled amounts of heat can be injected into the system to closely approximate the optimum drying run for that machine and to produce the desired terminal water retention for the fabrics being dried.

In the embodiment chosen for illustration the drying chamber 14 has a volume of approximately 5 cubic feet, the drum having a diameter of 29 inches and a depth of 13.5 inches. A condenser type dryer is shown, employing a single 3600 watt, 220 volt air heating unit 30. It should be understood, however, that the invention is equally applicable to systems using forced air ventilation. In the apparatus of the present embodiment, the container is rotated at 56 r.p.m. so that the clothes are gently tumbled through the heated air stream throughout the drying cycle. With this set of parameters it was found that loads of from 2 to 8 lbs. exhibited a peaking temperature of about 190° F. when their retained water was reduced to approximately 30%.

In particular accordance with the invention the terminal water retention level may be brought to any desired level using this temperature indication as the point at which programmed control of the drying cycle is initiated through timer operation of the heater 30. In the illustrated embodiment this parameter for any particular range of loading is fixed during the design of the machine. This feature however could readily be made subject to

control by the operator by simply providing a selection of heating runs.

To illustrate the application of this inventive method to laundering apparatus having the specifications outlined above, assume for example that a load of fabrics weighing from 4 to 8 pounds is to be dried having an average moisture content of about 85%. To condition the machine for the drying of this size load the push button marked "Large" is depressed and the wash timer knob 45 manually advanced into the dry position to preset the cam switches. Operation of the push button marked "Large" presets a bank of switches as indicated in FIGURE 4, closing switches A, B, C, E, and F and opening switches G and H if they have previously been closed. This action, referring to FIGURES 2 and 3, results in initiating the following series of events: current being directed to the condenser solenoid 36 beginning flow of condensing water to the water distributing manifold 34; rotation of drum 14 by actuation of motor 23; opening of the drain solenoid 46; and energization of air heater 30. In the initial phases of drying, the timer motor 40 is left unenergized until the amount of water retained in the fabrics is brought to a predetermined low level as sensed by the delay thermostat 48. As discussed above, the temperature at which timer control of heater 30 is initiated for this machine is around 190° F. On closure of the delay thermostat 48, switch A directs current to the timer motor 40 through closed cam switch 9T. This places the air heater 30 under the control of timer cam 3B which is designed to cycle the heater in an empirically predetermined manner. In the illustrated case the timer is designed to produce a drying run of minimal time in which fabrics have a terminal water retention of approximately 10%. After two increments of timer controlled operation, each increment taking one and a half minutes of running time, the heater is turned off for four increments of time followed by three increments of on time, two off, three on, two off, two on, one off, three on, terminated by a cool down period of four increments. Timer control is imposed for a total of about 40 minutes when working with a large load. By this means drying of a 4-8 lb. load is accomplished in optimum time utilizing a single, fixed energy heat source. Moreover, this mode of operation affords precise control of the input energy to produce a substantially uniform degree of dryness in successive drying runs. The condenser water is shut off by contact 2B one increment before the end of the drying cycle. An additional thermostat 51 is interposed in series circuit with the heater 30 and serves in the dual capacity of a safety thermostat and as a cycling thermostat in the event temperatures exceed 200° F., the switch being set to open at 200, and close at 190° F. Under normal operation, however, the thermostat 51 serves only in the capacity of a safety switch.

In the event a medium load of from 2 to 4 pounds is to be dried the push button marked "Medium" is depressed. Virtually the same mode of operation results as previously discussed with the exception that the heaters are placed under the control of timer contact 5B. The surface of the cam which actuates this contact is cut to produce intermittent operation of the heater 30 in a manner accommodating this lighter load. As seen in FIGURE 2 the heater is on for a substantially shorter period of time. In this drying run the heater is off for the last 9 minutes of operation to provide an extended cooling period to prevent wrinkling of the clothes load. Reference to the sequence chart of FIGURE 2 will show that there is an extra increment of heating time introduced at the beginning of the timer controlled portion of the drying cycle. The purpose of this extra increment is to compensate for any miscalculation by the operator insofar as laundry load size is concerned. If the operator has mistaken the load size and thought that it was larger than it really was the extra increment of time will cause the

safety thermostat 51 to open. This protects against over-drying in this critical phase of the drying cycle. Protection results from the fact that the safety thermostat 51 will require about 6 or 7 minutes to close. The timer's continued advance during this period will thus reduce the heat input by by-passing the middle segment 52 of the heater control cam 5B resulting in continued inactivation of heater 30.

In the event a small load is to be dried the "Small-Dry" button is depressed, which closes switches A, B, E, G and H, by-passing the delay thermostat 48. Accordingly for small loads the heater is timer controlled from start to finish. The sequencing of the heater is again controlled by cam switch 5 the cycling being equivalent to that used in the medium load drying cycle just described without any initial preheat period.

In summation we have discovered a novel method and means for optimizing the drying run of any given dryer by timer programming heater operation throughout the critical period of the drying cycle, namely, that period which is normally measured from the time that a notable change in the ambient drying temperatures is sensed until the desired degree of dryness is obtained. This technique affords positive and undeviating control of the drying operation to produce a consistently uniform drying run of optimum efficiency.

Although the invention has been described with particular reference to specific practice and embodiments, it will be understood by those skilled in the art that the apparatus of the invention may be changed and modified without departing from the essential scope of the invention in either its method or apparatus aspects.

We claim:

1. In laundering apparatus the combination comprising: a rotatable, perforate container for receiving material to be dried; air heating means associated with said container; means for rotating said container to tumble material therein; means for causing translation of air heated by said heating means through said container and into contact with materials therein; a timer adapted to provide programmed, intermittent operation of said heating means in accordance with a predetermined operating pattern designed to optimize the drying run for said material; and means responsive to a temperature of the drying air for placing said timer in control of said heating means.

2. In laundering apparatus including a dryer of the type having a single fixed energy heat source, the combination comprising: a rotatable container for receiving material to be dried; means for rotating said container to tumble material being dried therein; means for causing movement of air heated by said heat source into contact with material within said container; timer mechanism for controlling phases of the laundering operation; and thermostatic means responsive to a temperature of the drying air indicative of a substantial conversion of the input energy into sensible heat for placing said timer mechanism in control of said heat source, and said mechanism including cam means constructed and arranged to produce intermittent operation of said heat source in accordance with a predetermined operating program.

3. In laundering apparatus, the combination comprising:

ing: a timer mechanism for sequentially controlling phases of the laundering operation; and thermostatic means responsive to a temperature of the drying air, indicative of a substantial conversion of the input energy into sensible heat, for operatively connecting said timer mechanism and heating means, said mechanism including cam and associated switch means constructed and arranged to produce intermittent operation of said heating means in accordance with a predetermined operating program designed to optimize the drying run.

4. In laundering apparatus embodying both a washer and a dryer having a common timer, the combination comprising: a rotatable container for receiving material to be dried; air heating means of the type having a single fixed energy heat source; means for rotating said container to tumble material being dried therein; means for causing movement of drying air into contact with material within said container; thermostatic means for placing said timer in control of said heating means when the drying air reaches a predetermined temperature; and means operable by said timer to provide intermittent operation of said heating means in accordance with a predetermined operating pattern effective to produce the desired degree of dryness in optimum time with minimal consumption of energy.

5. In drying apparatus of the type in which heated air is brought into contact with wet materials being tumbled in a perforate container, the method of drying which comprises: heating said materials to remove a major portion of their retained liquid; thermostatically sensing the rise in temperature of the drying air to detect the substantial conversion of input energy into sensible heat; and utilizing said thermostatically sensed temperature to initiate timer-controlled, intermittent operation of the air-heating means in accordance with a predetermined program designed to produce requisite drying in optimum time with minimal energy.

6. In drying apparatus of the type described, the method of drying which comprises: initially heating material being dried to remove a major portion of its retained moisture; utilizing a rise in temperature, indicative of a conversion of a substantial portion of the input energy into sensible heat, to initiate timer controlled operation of the air heating means; and thereafter intermittently operating said heating means by said timer in accordance with a predetermined operating program.

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