Nov. 26, 1963 A. M. STONE 3,112,187

CONTROL SYSTEM FOR CLOTHES DRYERS

Filed Aug. 4, 1960 3 Sheets-Sheet 1

FIG. 4

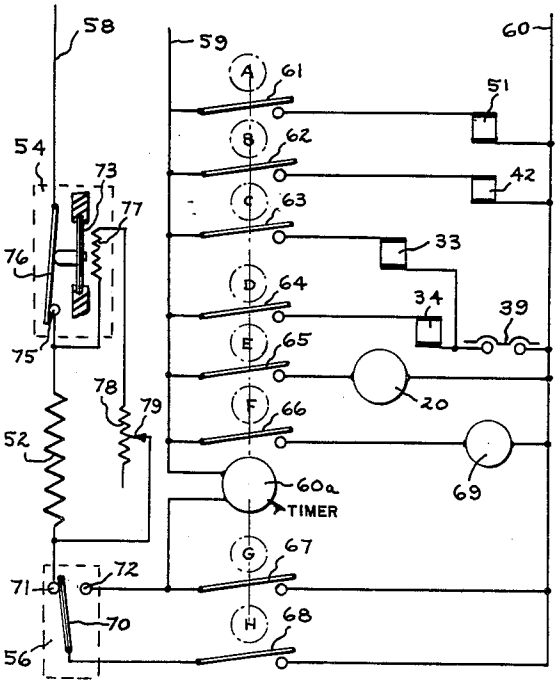


FIG. 6

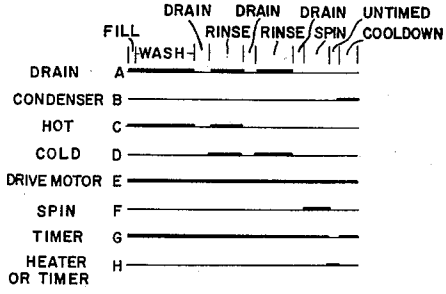


FIG. 1

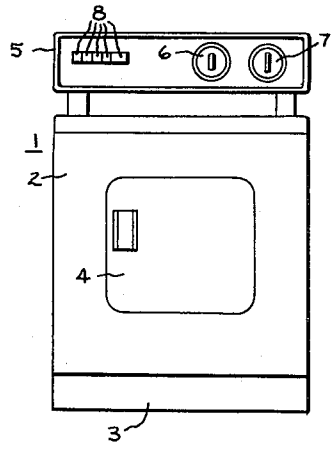


FIG. 5

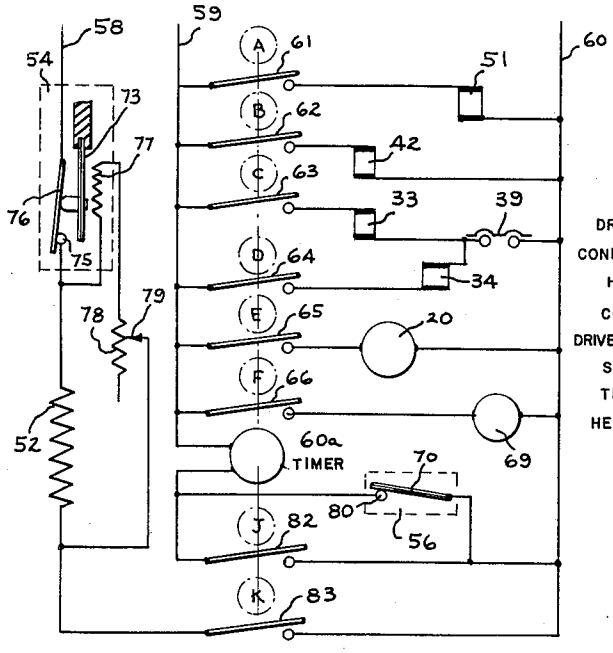
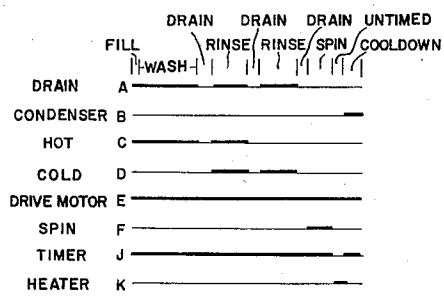


FIG. 7



INVENTOR.
AIDAN M. STONE
BY Dean P Lawrence
HIS ATTORNEY

Nov. 26, 1963 A. M. STONE 3,112,187

CONTROL SYSTEM FOR CLOTHES DRYERS

Filed Aug. 4, 1960 3 Sheets-Sheet 2

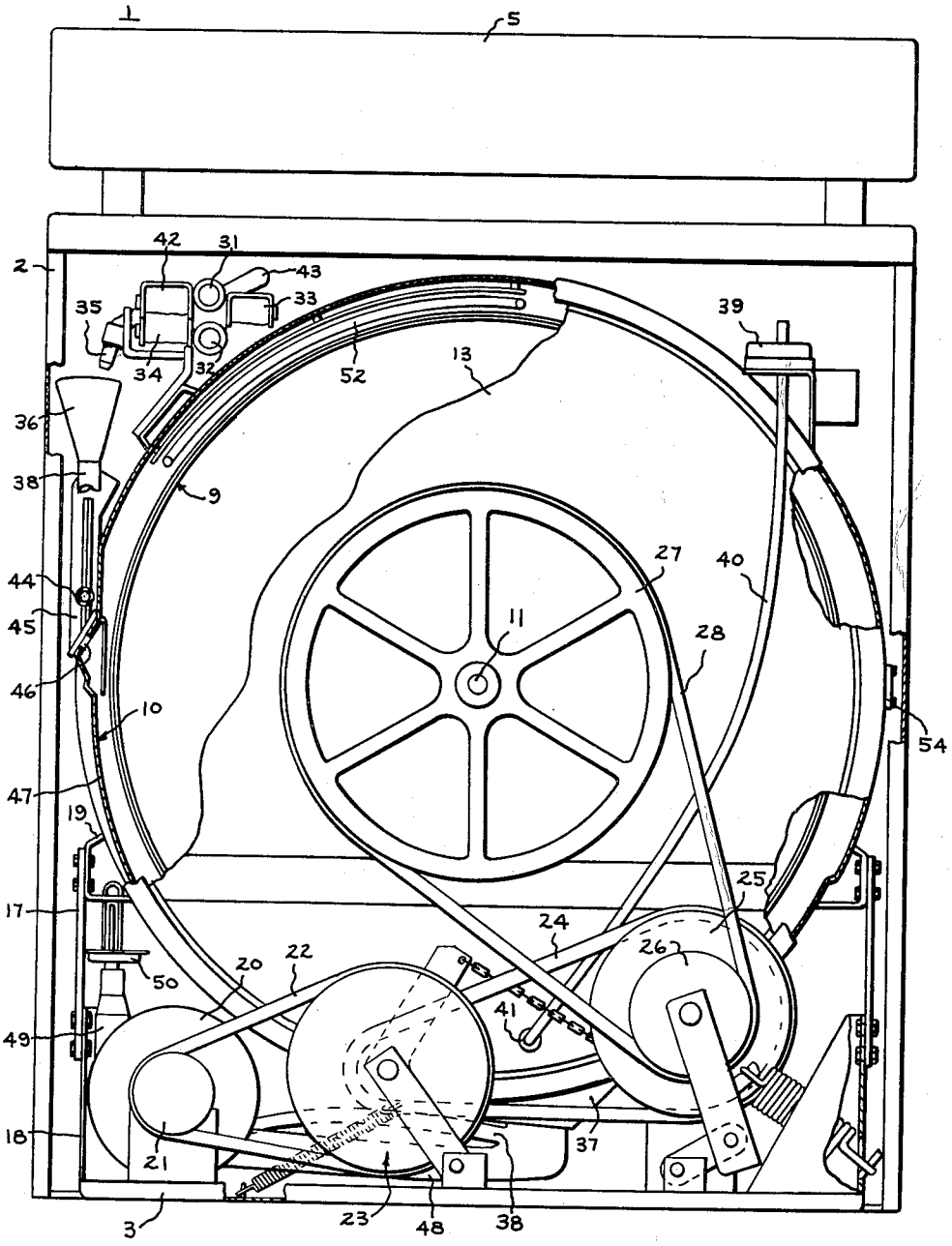


FIG. 2

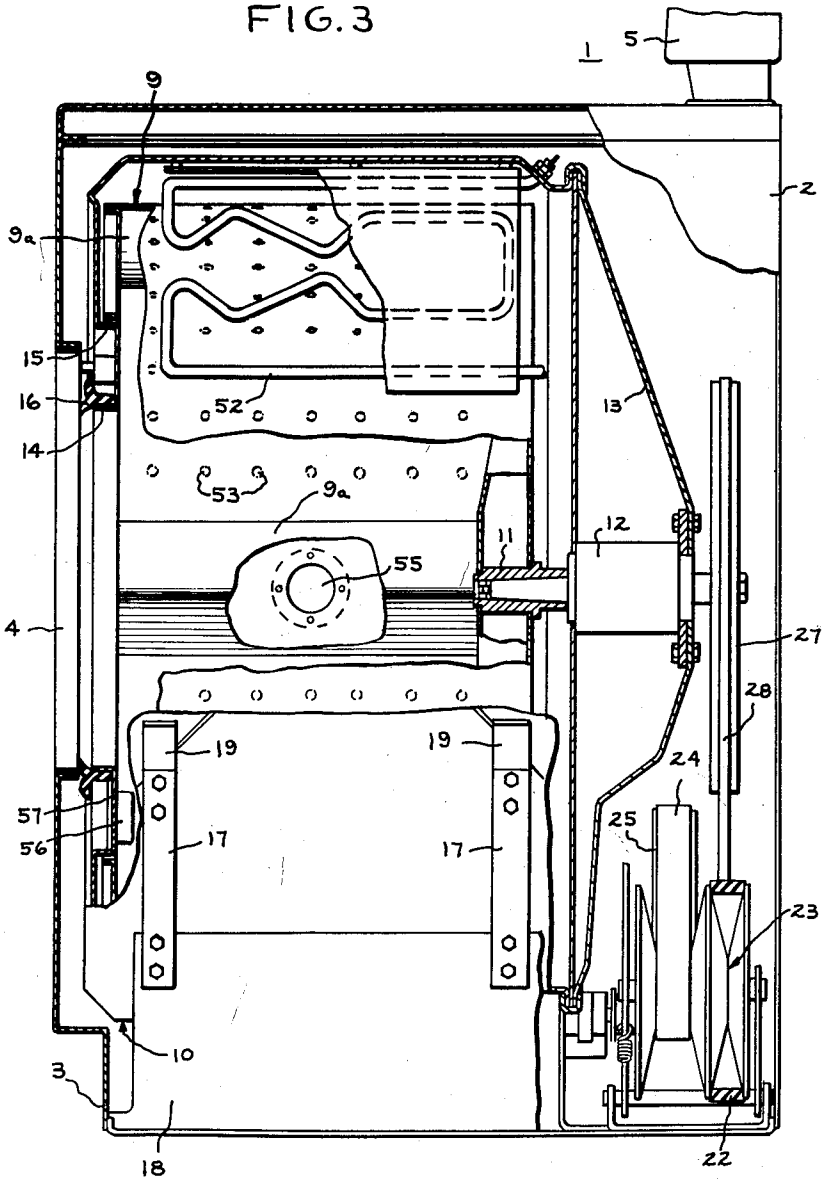
INVENTOR.
AIDAN M. STONE
BY Derek P Lawrence
HIS ATTORNEY

Nov. 26, 1963 A. M. STONE 3,112,187

CONTROL SYSTEM FOR CLOTHES DRYERS

Filed Aug. 4, 1960 3 Sheets-Sheet 3

FIG. 3



INVENTOR.
AIDAN M. STONE
BY Derek P Lawrence
HIS ATTORNEY

United States Patent Office 3,112,187 Patented Nov. 26, 1963

3,112,187

CONTROL SYSTEM FOR CLOTHES DRYERS

Aidan M. Stone, Louisville, Ky., assignor to General Electric Company, a corporation of New York

Filed Aug. 4, 1960, Ser. No. 47,478
11 Claims. (Cl. 34—45)

This invention relates to clothes dryers, and more particularly it relates to a control system for automatically controlling such machines during the drying operation. While the invention has general application to such machines, it is particularly useful in dryers and combination washer-dryers which provide a closed-cycle type of drying in which the same air is retained within the clothes receptacle, and is both heated and the moisture therein condensed while in or adjacent the receptacle.

It is highly desirable, in the art of clothes drying, to provide an automatic cycle which is dependent purely upon the condition of the clothes for termination of the cycle. "Automatic cycle" is used, in this context, to signify the type of cycle which is automatically terminated when the clothes indicate a substantial condition of dryness, as opposed to the more primitive type of cycle wherein the operator merely presets a predetermined length of time for the operation thereby guessing at the time it will take to effect drying of the clothes. In the type of automatic cycle used heretofore, it has been found very difficult to achieve an entirely temperature-responsive arrangement (it being understood that clothes temperature in a dryer may be used as a reflection of the dryness of the clothes) wherein the cost of the structure is suitable for a highly competitive mass production type market and the response of the structure is substantially accurate so as to provide desirable results under virtually any circumstances.

It is therefore, an object of my invention to provide a dryer control arrangement wherein an automatic cycle is provided in its entirety by temperature responsive means.

A further more specific object of my invention is to achieve such a cycle by the provision of two thermostats, one of which causes the heat to be cycled in response to the temperature in the clothes receptacle while the other is arranged to be responsive to the clothes temperature and to stop the operation when the clothes temperature indicates dryness, it being understood, as stated above, that there is a direct correlation between the clothes temperature and the dryness of the clothes.

Yet a further and more specific object of my invention is to achieve such a two-thermostat control arrangement wherein the cycling thermostat is provided with a biasing heater which heats it only during operation of the clothes heating means, with the result that each "on-off" cycle of the clothes heating means is substantially shorter than it would be without the presence of the biasing means and therefore a substantially greater number of "on-off" cycles are provided in the course of any drying operation.

In carrying out my invention in one form thereof, I provide clothes drying apparatus in which there is provided, in the conventional manner, a clothes receptacle and means for tumbling clothes in the receptacle together with means for heating clothes in the receptacle to effect drying. A first thermostatic means has a low temperature normal position and a high temperature tripped position and is positioned so as to sense the air temperature within the clothes receptacle. Adjacent the first thermostatic means, I provide auxiliary heating means which is arranged so as to heat it, that is, to have a biasing effect thereon. When the first thermostatic means is in its normal position it enables operation of both the clothes heating means and the auxiliary heating means; when it trips because of a temperature rise, it prevents operation of both heating means.

In addition, I provide a second thermostatic means which has a low temperature normal position and a high temperature tripped position; this second means is positioned so as to sense the temperature of the clothes in the receptacle and is calibrated so as to move to tripped position at a temperature which indicates dryness of the clothes. In the normal position of the second thermostatic means it enables operation of the clothes heating means, while in its tripped position it prevents operation of the clothes heating means and, in addition, terminates operation of the apparatus, either directly or, preferably, after a suitable cool-down period.

The result of the foregoing structure is that, because of the biasing effect of the auxiliary heater, the first thermostatic means will rapidly cycle the clothes heater on and off, the "off" periods becoming longer toward the end of the drying operation because as the clothes dry the recooling of the first thermostatic means is slowed down. When the clothes are dry, the second thermostatic means, which I prefer to position so that it actually contacts the clothes, trips thereby finishing operation of the heaters. Because of the rapid "on-off" action resulting from the biasing heater, a substantial number of "on-off" cycles of the clothes heater is provided, even for relatively delicate fabrics which require only a short drying time. There is an inherent advantage in a large number of short drying cycles of this type: a substantial number of cycles permits a gradual increase in the "off" time of the cycles, as opposed to the type of drying machine which has only two or three "on-off" cycles and in which, therefore, there can be relatively little difference in the power input per unit time for different cycles without the addition of relatively expensive modifications such as additional heaters which may be shut off in sequence, and the like.

The subject matter which forms my invention is particularly pointed out and distinctly claimed in the concluding portion of this specification. The invention itself, however, both as to organization and method of operation, together with further objects and advantages, may best be understood by reference to the following description taken in conjunction with the accompanying drawings.

In the drawings,

FIGURE 1 is a front elevational view of a domestic laundry machine, specifically a combination washer-dryer, which may advantageously incorporate my improved dryer control system;

FIGURE 2 is a rear view of the machine of FIGURE 1 with the rear panel removed to illustrate details;

FIGURE 3 is a side elevational view of the machine of FIGURE 1 with the side panel removed, the view being partially in section and having certain surfaces broken away in order to illustrate details;

FIGURE 4 is a schematic electrical diagram illustrating a first embodiment of my improved dryer control;

FIGURE 5 is a schematic electrical diagram illustrating a second embodiment of my invention;

FIGURE 6 is a development of the surfaces of the cams shown in FIGURE 4 illustrating a conventional washing sequence and the sequence of cam operation for my improved drying operation; and

FIGURE 7 is a development of the surfaces of the cams shown in FIGURE 5 illustrating a conventional washing sequence and the sequence of cam operation for my improved dryer operation.

Referring now to FIGURES 1, 2 and 3 I have shown my invention in one form applied to a domestic laundry machine 1 comprising a combination washer and dryer. The machine 1 includes a cabinet 2 which is mounted on a supporting structure 3. Access to the machine for loading and unloading of the clothes is provided by a hinged door 4 disposed in the front wall of the cabinet.

A backsplasher 5 mounted at the top of the cabinet serves as a mounting means for suitable operator controls for the machine. These controls may, for example, comprise the rotatable dials 6 and 7 and the pushbuttons 8.

The machine 1 is of the type which includes a clothes basket rotatable about a nonvertical axis; specifically, referring to FIGURES 2 and 3, it includes a perforated basket 9 disposed for rotation about a generally horizontal axis and provided with a number of inwardly extending vanes 9*a* which help to tumble the clothes in the basket and also to circulate air during drying. Basket 9 is mounted within an imperforate tub structure 10 which encloses it on all sides. The basket is rotatably supported from the tub structure by a horizontally extending shaft 11 which is mounted in an elongated bearing 12 hung from the rear wall 13 of the tub structure. The shaft 11, as well as supporting the basket, also serves as the means for turning it during operation of the machine. The tub and basket are provided, respectively, with openings 14 and 15 in the front walls thereof, with the openings being aligned with the door opening in the front wall of the cabinet 2 so that clothes may be placed into or removed from the basket. The door 4 seals against a gasket 16 around the tub opening 14 to close off the tub completely during operation of the machine.

Tub 10 is supported from base 3 by means of a plurality of brackets or arms 17 which are mounted on an upstanding plate 18 fixedly attached to the base 3. Four of these arms 17 are provided, two of them being secured to each side of the tub. Although the arms 17 can be secured directly to the wall of the tub 10, I prefer to attach them, as shown, by means of suitable brackets 19. With tub 10 supported in the manner shown, it vibrates sideways in a plane parallel to the front of the machine if the basket 9 should be unbalanced during high speed rotation thereof; however, for vibrations in the front-to-rear directions and in the vertical direction the arms 17 are not at all flexible and they prevent substantially any vibration in those directions.

Referring now particularly to FIGURE 2, during operation of the machine the basket 9 is driven from an electric motor 20. The drive from the motor to the basket includes a pulley 21 which is secured to the motor shaft so as to rotate therewith, and over which passes a belt 22. Belt 22 drives an adjustable sheave assembly 23 of the type which is well known for use in achieving variable output speeds from a constant input speed source. The adjustable sheave assembly in turn operates belt 24 to cause rotation of pulleys 25 and 26. The rotation of pulley 26 is passed on to a pulley 27 by a belt 28, pulley 27 being rigidly secured on basket shaft 11. In this manner, the motor 20 may be driven at a constant speed, and, through the adjustable sheave assembly 23, the speed imparted to pulley 27 and basket 9 may be varied so as to provide an appropriate range of speed for the basket. For instance, for tumbling purposes during the cleansing and rinsing operation, and also during the heat drying operation, a speed of approximately forty-seven r.p.m. may be provided to the basket 9, while a centrifuging speed of several hundred r.p.m. may be provided to the basket for effecting centrifugal extraction of liquid from the clothes prior to the heat drying operation.

The operation of the variable speed drive briefly described above does not form any part of the present invention, and is set forth merely to provide a substantially complete description of an operative machine. A complete detailed description of such a drive is provided, for instance, in application Serial Number 731,362, filed on April 28, 1958, by John Bochan, now Patent No. 2,950,613, and assigned to the General Electric Company, assignee of the present invention.

In order to admit water to the machine, connections 31 and 32 are provided through which hot and cold water may be supplied to the machine 1 for the washing operation. A valve controlled by a solenoid 33 admits hot water to the machine and a valve controlled by an opposed solenoid 34 admits cold water to the machine. The hot and cold water valves under the control of the solenoids 33 and 34 discharge through a common outlet conduit 35, through a suitable air gap, and into a funnel 36 which leads to a sump 37 formed at the bottom of tub 10. The connection may be made through a suitable conduit 38, part of which is shown leading from the funnel 36 and part of which is shown extending from the sump 37. The air gap provided by the funnel 36 makes it impossible, as is well known, for the water to be siphoned from the machine and thereby contaminate the incoming water supply line. A pressure actuated sensing device or water level control 39 may be provided to control both solenoids 33 and 34 so as to provide the proper water level in the machine during the washing operation. Sensing device 39 may be connected to the interior of tub 10 by a suitable conduit 40 which connects with the tub adjacent the bottom thereof at 41 as shown.

The illustrated machine is of the type which uses cold water during the drying cycle for condensing the moisture extracted from the clothes. The condenser water is admitted to the machine through an additional solenoid actuated valve controlled by a solenoid 42 which is energized during the drying operation so that the valve passes water at a suitable rate sufficient to condense from the air the moisture vaporized from the clothes. As shown, the condenser water valve discharges into a conduit 43 which leads, through an appropriate air gap (not shown), to the inlet of a vent trap 45 which is of the type commonly provided in connection with machines of this type in order to seal off the tub and basket from atmosphere during heat drying of the clothes while leaving the tub vented to atmosphere at other times. An appropriate construction for vent trap 45 is, for instance, fully described and claimed in Patent 2,800,008—Raczysnki, issued on July 23, 1957, and assigned to the General Electric Company, owner of the present invention. From the vent trap 45, the condenser water flows into the tub 10 through an opening 46 and then flows in a thin sheet down the lower left wall 47 of the tub so as to cool a substantial portion of the area of the side wall and provide a large cool surface for condensing the moisture extracted from the clothes.

The wash and rinse water used during the washing portion of the operation, and the condenser water and the moisture extracted from the clothes during the heat drying operation, are discharged from the machine through the sump 37 formed at the bottom of the tub. A suitable discharge hose 48 leads from the sump to a pump (not shown) which may be attached directly to the motor 20 so as to be continuously driven thereby and which in turn discharges through a conduit 49 to a valve 50 which is suitably controlled by a solenoid (schematically shown at 51 in FIGURE 4) so that when the solenoid is energized the valve 50 is closed and when the solenoid is not energized the valve 50 is open. In other words, for water to be retained in the tub 10 the solenoid must be energized to close the valve 50 so that the continuous operation of the pump will not be effective to drain the tub. It will be understood that from valve 50 a connection is made to a suitable drain (not shown).

To heat the clothes during the heat drying portion of the cycle, there is provided in the machine a suitable heater assembly preferably comprised in the present case of a single electric heater 52. When the heater is energized during the drying cycle it operates to heat the basket 10 which, through its rotation, then contacts the clothes to transfer its heat to the clothes. In addition, since the outer cylindrical wall of the basket is perforated by a great many small spaced openings 53, the heating element also heats the clothes directly by radiation and convection. The heat thus transferred to the clothes causes vapor migration out of the clothes so as to effect drying thereof.

A thermostat **54** is secured to the tub **10** with a temperature sensing surface **55** positioned so as to sense the temperature of the air within the tub **10**. In addition, a second thermostat **56** is provided; thermostat **56** is positioned to sense rises in the temperature of clothes in the basket. In this connection, I prefer to cause thermostat **56** to contact the clothes and, accordingly, have provided it extending to the rotating basket through stationary wall **57** forming a part of the front of tub **10**. With this arrangement of the thermostat **56**, that is, stationary and relatively near the bottom of the tub **10**, the clothes within the basket **9**, as they tumble, will virtually continuously contact the thermostat **56** thereby providing the thermostat **56** with an accurate indication of the temperature of the clothes. In effect, this will be a wet bulb temperature when the clothes are wet, slowly changing to a dry bulb temperature as the clothes become dry. It will be recognized that the method of ascertaining the approximate temperature at which clothes are dry under any particular circumstances is well known in the art, and that therefore the trip temperature of the thermostatic switch **56** may be preset so that it coincides substantially with the dry temperature at which clothes contained within basket **9** have become dry.

Referring now to the schematic circuit diagram or FIGURE 4, there is shown a simplified control arrangement for the machine **1** which includes my improved control arrangement utilizing the thermostats **54** and **56** in the control of heater element **52**. The electrical system of the machine **1** is energized across a suitable source of power through conductors **58**, **59** and **60**. Generally, in commerical practice, 220 volts are impressed across conductors **58** and **60**, with 110 volts appearing between each of them and the neutral conductor **59**.

Directly connected to neutral line **59** is a timer motor **60***a* of any conventional well known type. Timer motor **60***a* forms a part of a conventional sequence control assembly wherein a number of cams A, B, C, D, E, F, G, and H control a number of switches such as those indicated by the numerals **61** through **68**. When the timer motor **60** is energized, cams A through H are rotated and cause the switches **61–68** to open and close in a suitable sequence so as to effect the desired operations within the machine. In addition it will be understood that in the conventional manner one of the dials, for instance dial **6**, on the backsplasher of the machine may be used manually to control the position of the switches **61–68** and to advance them from an "off" position which they normally attain at the end of a cycle to a "start" position when another cycle of operation is desired. Generally, when this is done, the switch **67** closes so as to complete an energizing circuit for the timer motor **60***a* across conductors **59** and **60**. Thus, when the dial is released after having been put in the start position, the operation of the timer motor will cause the switches which it controls to open and close in the suitable sequence.

For illustrative purposes, the switches have been shown as controlling various components of the machine. Thus, switch **61** controls the drain valve solenoid **51**, switch **62** controls the condenser valve solenoid **42**, switch **63** controls the hot water solenoid **33**, switch **64** controls the cold water solenoid **34**, switch **65** controls the drive motor **20**, and switch **66** controls the operation of a small gear motor assembly **69** which is generally provided to control the position of the adjustable sheave assembly **23**, it being understood that in this type of structure energization of the gear motor **69** causes adjustment of the transmission to provide high speed basket rotation while de-energization of gear motor **69** causes a low basket speed. The switch **67**, as has been mentioned, controls the operation of timer motor **60***a*. The last timer switch **68** may control the energization of either the heater **52** or of the timer motor **60***a* depending upon whether bimetal elements **70** of thermostat **56** (the bimetal element constituting the temperature-sensitive portion of the thermostat) is in the position shown in engagement with contact **71** (its normal position) or is in its tripped position in engagement with contact **72**.

The thermostat **54** also includes temperature-sensitive means in the form of a bimetal element **73** which has a normal position and will snap, when its temperature rises a predetermined amount, to a tripped position. In its normal position, the bimetal element **73** allows engagement of contact **75** and contact arm **76**. However, when it moves to its tripped position, the bimetallic element pushes on contact arm **76** to separate the two contacts. Contacts **76** and **75** are in series with the heater **52**, as is also true of contact **71** and switch arm **70**. An auxiliary resistance heater **77** is connected in parallel with the main clothes heater **52** and in series with the contacts **76** and **75** on the one hand and contact **71** on the other hand. In this way, opening of the contacts in either of the thermostats **54** and **56** causes de-energization of both heaters **52** and **77**, while closing of both thermostat contacts at the same time as the closing of the switch **68** causes energization of both heaters.

The heater **77** is an exceedingly low-power heater and is physically positioned so as to have a heating effect on the bimetal element **73**. As an example of the relative power consumptions of the heaters, heater **52** may be provided with a resistance of fourteen ohms while heater **77** has a resistance of three thousand ohms, it being understood that power consumption is inversely proportional to resistance. In series with heater **77** there may be positioned a resistance **78** so that the total amount of current through resistance **77** is variable by varying the position of a movable contact **79** on resistance **78**. The position of contact **79** on resistance **78** may be varied by any suitable manual means such as, for instance, rotation of the dial **7** in FIGURE 1.

When the dial **6** is rotated into cycle starting position, as shown in FIGURE 6, timer motor **60***a* causes switches **62**, **63**, **64**, **65** and **66** to open and close in a suitable sequence to provide a washing operation. For purposes of brevity, a particular sequence in which the switches are opened and closed will not be fully described, such sequences being relatively conventional features and susceptible of many modifications; however, for illustrative purposes one such sequence is fully shown in FIGURE 6. In general, water is introduced into the machine with the drain valve closed for a washing step, then the water is drained out, then several rinses are provided with warm, hot, or cold water, each rinse being followed by draining, and a high speed spin is provided thereafter in order to remove as much liquid as possible by centrifuging.

At the end of the high speed spin, timer motor **60***a* closes switch **68** to start a heat drying operation. This then completes a circuit which, starting at line **58**, passes through contact arm **76**, contact **75**, heater **52**, contact **71**, bimetallic element **70**, and switch **68** to conductor **60**, thereby completing a 220 volt circuit for both parallel connected heaters **52** and **77**. Shortly after switch **68** is closed, switch **67** is opened so as to de-energize the timer motor. At this point the drying operation is proceeding without any timing occurring, and with the heaters **52** and **77** energized.

Because the auxiliary heater **77** is physically adjacent the bimetallic element **73** which, as stated in connection with FIGURE 3, is positioned to sense air temperatures within the tub **10**, the bimetallic element is being acted upon by both the air temperature and the heater **77**. When the trip temperature of bimetal **73** is reached, it snaps to a position wherein contacts **76** and **75** are separated. This de-energizes both heaters **52** and **77**. With the heater **52** de-energized, the clothes mass and the air in the basket start to cool down. In addition, with the heater **77** de-energized there is a very rapid heat decrease in the immediate area of the bimetal **73** so that the reset temperature of the bimetal element **73** is rapidly reached. This is particularly true if the clothes are still quite wet in which case, because of the energy absorbed by evapora-

tion, the cooling effect in the basket and tub will be faster.

Thus the presence of heater **77** acts to effect a substantial increase in the rate at which the bimetal **73** resets itself after tripping. This action continues as long as the bimetal element **70** remains in engagement with contact **71**. It will be apparent that because the concurrent energization and de-energization of the two heaters **52** and **77** cuts short the time required for bimetal **73** to reset, a substantial number of "on-off" cycles is provided for virtually any clothes drying operation. Of course, the more rapid the "on-off" cycling within reasonable limits the greater the sensitivity of the dryer control system to different types of clothing. In this connection, it will be apparent that if a large normal load of clothes requires ten "on-off" cycles, then the availability of 9, 8, 7, etc. cycles for other different types of clothes loads affords far more sensitivity in the machine than if a large normal clothes load only had three "on-off" cycles. Such an arrangement only leaves a very limited different number of "on-off" cycles which may be provided for drying sequences involving other types of clothing.

As previously stated, the bimetal **70** is part of a thermostat **56** which in my preferred construction actually projects into the basket **9** so as to contact the clothing tumbling therein. The main purpose of the thermostat **56** is to sense the clothing temperature, and while this may be done in a more remote location if so desired, it is desirable to have actual contact of the thermostat by the clothing as shown since this, in effect, affords a wet bulb temperature as long as the clothing is wet changing to a dry bulb temperature as the clothing is dried.

With this arrangement, then, the thermostat **56** reflects quite accurately the temperature of the clothing and the temperature of the clothing in turn, as is well known, reflects quite accurately the degree of dryness which it achieves. This is basically a result of the fact that when the rate at which moisture is evaporated from the clothing rises substantially to the rate at which energy is being put into the clothing in the form of heat, there is a plateau in the curve of temperature with respect to time, and it is only after a very substantial part of the moisture has been removed that the temperature will again begin to increase because all of the energy being put into the clothing is not being absorbed for evaporation purposes. Thus, when the end of the plateau is reached and a fairly sharp temperature rise is provided, this indicates that dryness of the clothes has been achieved. While this is true in all machines provided relatively constant external air temperature conditions exist, the concept provides its most accurate dryness measurement in a clothes system such as that described in connection with machine **1** wherein the same air is retained within the basket **9** throughout the drying operation, being dried by the condensing system and then heated by heater **52**.

When the temperature sensed by thermostat **56** represents the dry temperature of the clothes, the bimetal element **70** trips from contact **71** over into engagement with contact **72**. This has the dual effect of de-energizing both heaters **52** and **77** and of re-energizing timer motor **60***a* through a circuit which starts at conductor **59** and then proceeds through the time motor itself, contact **72**, bimetal element **70**, switch **68** and conductor **60**. After a brief period of operation of the timer motor, the switch **67** is closed to continue the timer motor energization and the switch **68** is opened to insure that there will be no further heating in the machine regardless of the position of bimetal element **70**. The timer motor then, preferably, provides a suitable period of tumbling by the energization of motor **20** without any heating effect so as to cool the clothes down, and then opens all circuits so as to de-energize all components of the machine.

Included among the advantages in my improved type of circuit, it inherently provides the important function of decreasing the power input to the clothes as the drying cycle progresses. While a substantial amount of power is required to evaporate the moisture in the clothing when the clothing is thoroughly wet all the way through, a lesser amount is desirable as the clothing dries, partly because there is less moisture altogether, and partly because the moisture cannot be evaporated until it reaches the surface of the clothing and as the clothing dries the moisture comes to the surface more slowly. I achieve the desired result of decreasing the power input toward the end of the cycle as a result of the fact that, despite the rapid reset characteristic achieved by de-energization of my heater **77**, the clothes when they are partly dry provide a heat reservoir which slows up the lowering of the temperature in the basket so that as the cycle progresses the "off" time becomes substantially greater compared to the "on" time. At the same time, the "on" time actually becomes shorter because there is not so much moisture to absorb energy and the temperature is inclined to rise more rapidly in the basket; this effect is very pronounced, substantially more so even than the lengthening of the "off" time. Thus, an inherent result of my structure is, in addition to the quick "on-off" cycling and the sensitivity resulting therefrom, a decrease in the amount of power input to the clothes as the cycle progresses, the power input being greatest at the beginning when it is so important that there be a high power input and decreasing to a minimum at the end of the cycle.

It will be observed that both thermostats **54** and **56** are of the bimetal type. This is particularly significant in the case of thermostat **54**. Without the biasing effect of heater **77**, the response of the bimetal elements presently commerically available is substantially slower than bulb and bellows type thermostats as an inherent result of their construction. However, by the use of my biasing heater **77** I raise the sensitivity of the bimetal type thermostat **54** to that normally provided only by bulb and bellows type thermostats. Thus, my improved control circuit is particularly significant in permitting replacement of bulb and bellows type thermostats with bimetal type thermostats, inasmuch as the cost of the latter is very substantially less than that of the former.

However, it will be readily recognized that the performance of a bulb and bellows type thermostat will also be improved by the presence of the biasing heater when provided in my improved dryer arrangement. Therefore, in the broadest aspect of my invention all types of thermostats are included, but in the narrower aspect the beneficial effect obtained in making relatively cheap bimetal thermostats usable in my improved circuit makes my circuit with bimetal elements the preferred construction.

Referring now to FIGURE 5 there is shown a second embodiment of my invention where like parts are shown by like numerals. In the embodiment of FIGURE 5, the relationship of the thermostat **54**, including the bimetal element **73** and the biasing heater **77**, to the clothes heater **52** is precisely the same as before, and the other components provided for obtaining a washing operation in the machine are also the same as before; also, the sequence of operation of these components may be the same as before as shown in FIGURE 7. However, instead of having the thermostat **56** connected so that the bimetal element **70** is in series with either the heater or the timer, the bimetal element **70** is positioned so as either to engage a contact **80** or to be disengaged therefrom.

When the bimetal element **70** engages contact **80**, a circuit is completed for the timer motor **60***a* to conductor **60**. In addition, in parallel with the bimetal element **70** is another timer switch **82** which, when closed completes the timer motor circuit independently of the bimetal element **70**, and in order to provide energization of the heater **52**, a timer switch **83** is provided. The "on-off" cycling operation of the structure of FIGURE 5 is identical to that of FIGURE 4, it being understood that, during the drying operation, switch **83** is closed and switch **82** is open, just as for switches **67** and **68** in the previous embodiments; this will be seen from the similarity of the operation of

cams G and H in FIGURE 6 and cams J and K in FIGURE 7. When the clothes temperature rises sufficiently to cause bimetal element 70 to snap to its closed position it energizes the timer motor which then, after a brief period of time, closes the switch 82 and opens the switch 83. This provides for continued energization of the timer motor and insures de-energization of the heater 52, thereby providing a cool-down similar to that provided in connection with the structure of FIGURE 4.

It will be observed that, in the FIGURE 5 embodiment, the thermostat 56 is not actually in the heater circuit; rather it is in a 110 volt circuit, and this requires a somewhat simpler and less expensive construction than where the thermostat has to accept the 220 volt potential of the heater circuit.

While in accordance with the patent statutes I have described what at present are considered to be the preferred embodiments of my invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and I therefore aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. Clothes drying apparatus comprising: a clothes receptacle; means for tumbling clothes in said receptacle; clothes heating means; first thermostatic means having a low-temperature normal position and a high-temperature tripped position, said first thermostatic means being positioned to sense temperatures within said receptacle; auxiliary heating means positioned in heating relation to said first thermostatic means, said first thermostatic means being arranged to enable operation of both said heating means in said normal position and to prevent operation of both said heating means in response to movement to said tripped position; second thermostatic means having a low-temperature normal position and a high-temperature tripped position, said second thermostatic means being positioned to sense rises in the temperature of clothes in said receptacle and being calibrated to move from its normal position to its tripped position at a temperature indicating dryness of the clothes, said second thermostatic means being arranged to enable operation of said clothes heating means in its normal position and to prevent operation of said clothes heating means in response to movement to its tripped position; and means for terminating operation of said apparatus in response to movement of said second thermostatic means to its tripped position.

2. The apparatus defined in claim 1 wherein said first thermostatic means includes a bimetallic element positioned to sense temperatures within said receptacle.

3. The apparatus defined in claim 1 wherein both said thermostatic means include bimetallic elements for temperature sensing purposes.

4. The apparatus defined in claim 1 wherein said second thermostatic means is positioned so as to contact clothes tumbling within said receptacle.

5. Clothes drying apparatus comprising: a clothes receptacle; means for tumbling clothes in said receptacle; an electric clothes heater; a first thermostatic switch having a low-temperature normal position and a high-temperature tripped position, said first thermostatic switch including temperature sensitive means positioned to sense temperatures within said receptacle; an auxiliary electric heater positioned in heating relation to said first thermostatic switch temperature sensitive means, said first thermostatic switch being connected to enable energization of both said heaters in its normal position and to cause de-energization of both said heaters in response to movement to said tripped position; a second thermostatic switch having a lower-temperature normal position and a high-temperature tripped position, said second thermostatic switch including temperature sensitive means positioned to sense rises in the temperature of clothes in said receptacle and being calibrated to move from its normal position to its tripped position at a temperature indicating dryness of the clothes, said second thermostatic switch being connected to enable operation of said clothes heater in its normal position and to prevent operation of said clothes heater in response to movement to its tripped position; and timing means for terminating operation of said apparatus a predetermined length of time after movement of said second thermostatic switch to its tripped position.

6. The apparatus defined in claim 5 wherein said clothes receptacle is substantially sealed from atmosphere during the drying of clothes, and means are provided adjacent said receptacle to dehumidify the sealed-in air after it has picked up moisture from the heated clothes.

7. The apparatus defined in claim 6 wherein said means for tumbling clothes in said receptacle comprises means for rotating said receptacle on a non-vertical axis, and the rotation of said receptacle provides entirely the circulation of air therein.

8. The apparatus defined in claim 5 wherein an adjustable resistor is provided in series with said auxiliary heater and in parallel with said clothes heater thereby to vary the heating effect of said auxiliary heater on said first thermostatic switch.

9. Clothes drying apparatus comprising: a clothes receptacle; means for tumbling clothes in said receptacle; an electric clothes heater; first thermostatically operated switch means having a low-temperature normal position and a high-temperature tripped position, said first thermostatically operated switch means including temperature-sensitive means positioned to sense temperatures within said receptacle; an auxiliary electric heater positioned in heating relation to said first thermostatic switch means temperature sensitive means and connected in parallel with said clothes heater, said first thermostatic switch means being connected in series with both said heaters in its normal position thereby to enable operation of said heaters and disconnecting both said heaters in its tripped position; second thermostatic switch means having a low-temperature normal position and a high-temperature tripped position, said second thermostatic switch means including temperature sensitive means positioned to sense rises in the temperature of clothes in said receptacle and being calibrated to move from its normal position to its tripped position at a temperature indicating dryness of the clothes, said second thermostatic switch means being connected in series with both said heaters in its normal position and disconnecting said heaters when it moves to its tripped position; and means for terminating operation of said apparatus in response to movement of said second thermostatic switch means to its tripped position.

10. The apparatus defined in claim 9 wherein said means for terminating the operation of said apparatus includes a timer motor, said second thermostatic switch means completing a timer motor energizing circuit in its tripped position, and switch means in energization controlling relation to said heaters controlled by said timer motor and opened thereby in response to operation of said timer motor subsequent to movement of said second thermostatic switch means to its tripped position.

11. Clothes drying apparatus comprising: a clothes receptacle; means for tumbling clothes in said receptacle; an electric clothes heater; first thermostatic switch means having a low-temperature normal position and a high-temperature tripped position, said first thermostatic switch means including temperature-sensitive means positioned to sense temperatures within said receptacle; an auxiliary electric heater positioned in heating relation to said first thermostatic switch means temperature-sensitive means, said first thermostatic switch means being connected in series with both said heaters in its normal position and disconnecting both said heaters in its tripped position; second thermostatic switch means having a low-temperature normal position and a high-temperature tripped position, said second thermostatic switch means including

temperature sensitive means positioned to sense rises in the temperature of clothes in said receptacle and being calibrated to move from its normal position to a tripped position at a temperature indicating dryness of the clothes; means including a timer motor for terminating operation of said apparatus in response to tripping of said second thermostatic switch means, said second thermostatic switch means being connected in series with said timer motor and completing an energizing circuit therefor in its tripped position and opening said energizing circuit therefor in its normal position; and a second energizing circuit for said timer motor including a timer operated switch, said timer motor closing said timer operated switch in response to operation thereof subsequent to tripping of said second thermostatic switch means; and a second timer operated switch in series with said heaters, said timer motor

opening said second timer operated switch shortly after it starts operation in response to tripping of said second thermostatic switch means.

References Cited in the file of this patent

UNITED STATES PATENTS

2,654,961	Manecke	Oct. 13, 1953
2,743,532	Steward	May 1, 1956
2,820,304	Horecky	Jan. 21, 1958
2,851,790	Worst	Sept. 16, 1958
2,878,579	Fuchs	Mar. 24, 1959
2,882,610	Hughes	Apr. 21, 1959
2,885,789	Conkling et al.	May 12, 1959
2,895,230	Reiley	July 21, 1959
3,028,680	Conlee	Apr. 10, 1962