Sept. 16, 1958 R. L. DUNKELMAN 2,851,789

CONTROL SYSTEM FOR CLOTHES DRYERS

Filed March 13, 1956 2 Sheets-Sheet 1

FIG. 1

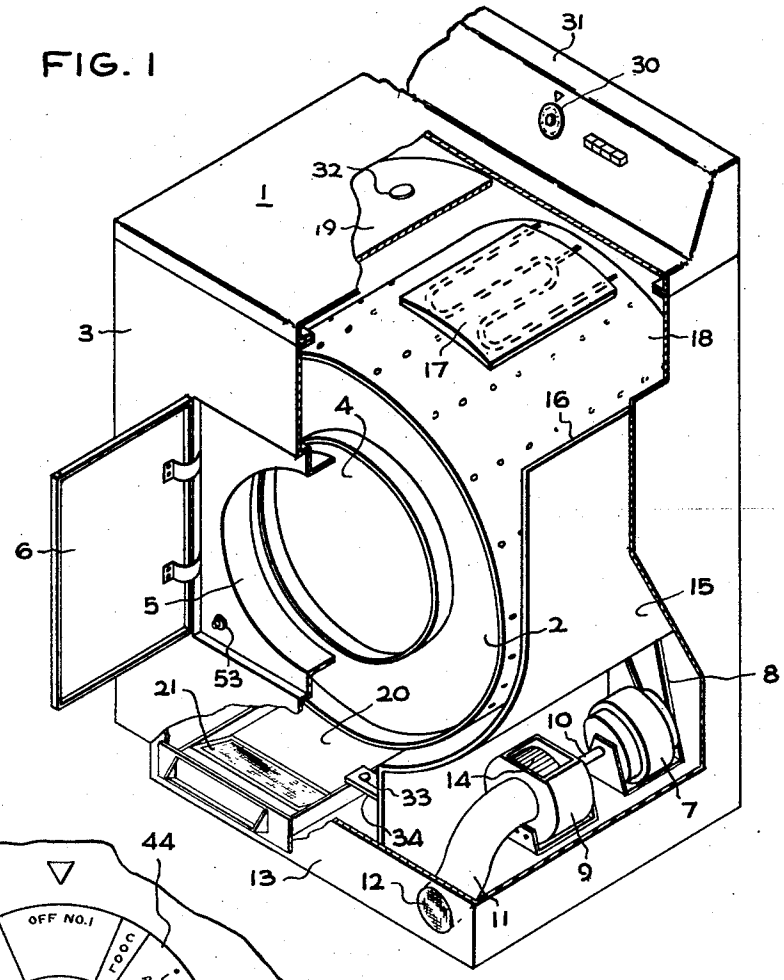

FIG. 3

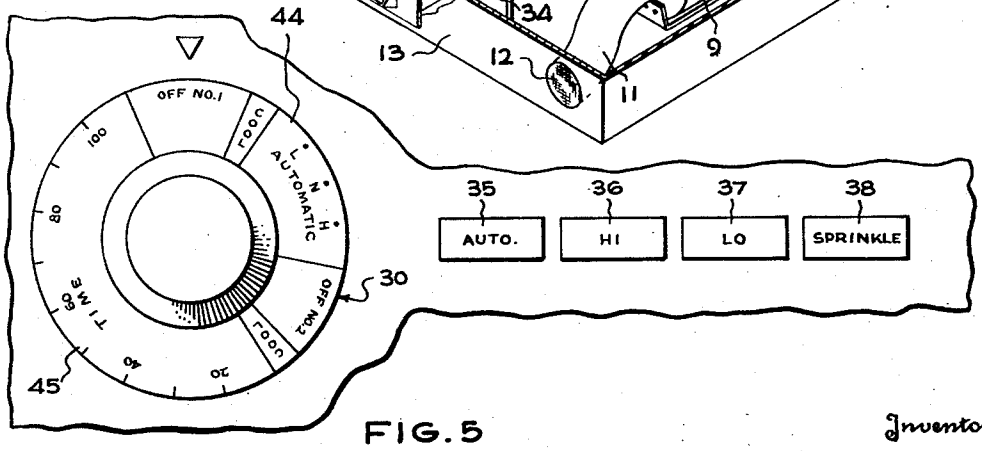

FIG. 5

	35 AUTOMATIC	36 HI	37 LO	38 SPRINKLE
39		X	X	X
40	X			
41		X	X	X
42	X	X		
43			X	

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His Attorney

Sept. 16, 1958 R. L. DUNKELMAN 2,851,789

CONTROL SYSTEM FOR CLOTHES DRYERS

Filed March 13, 1956 2 Sheets-Sheet 2

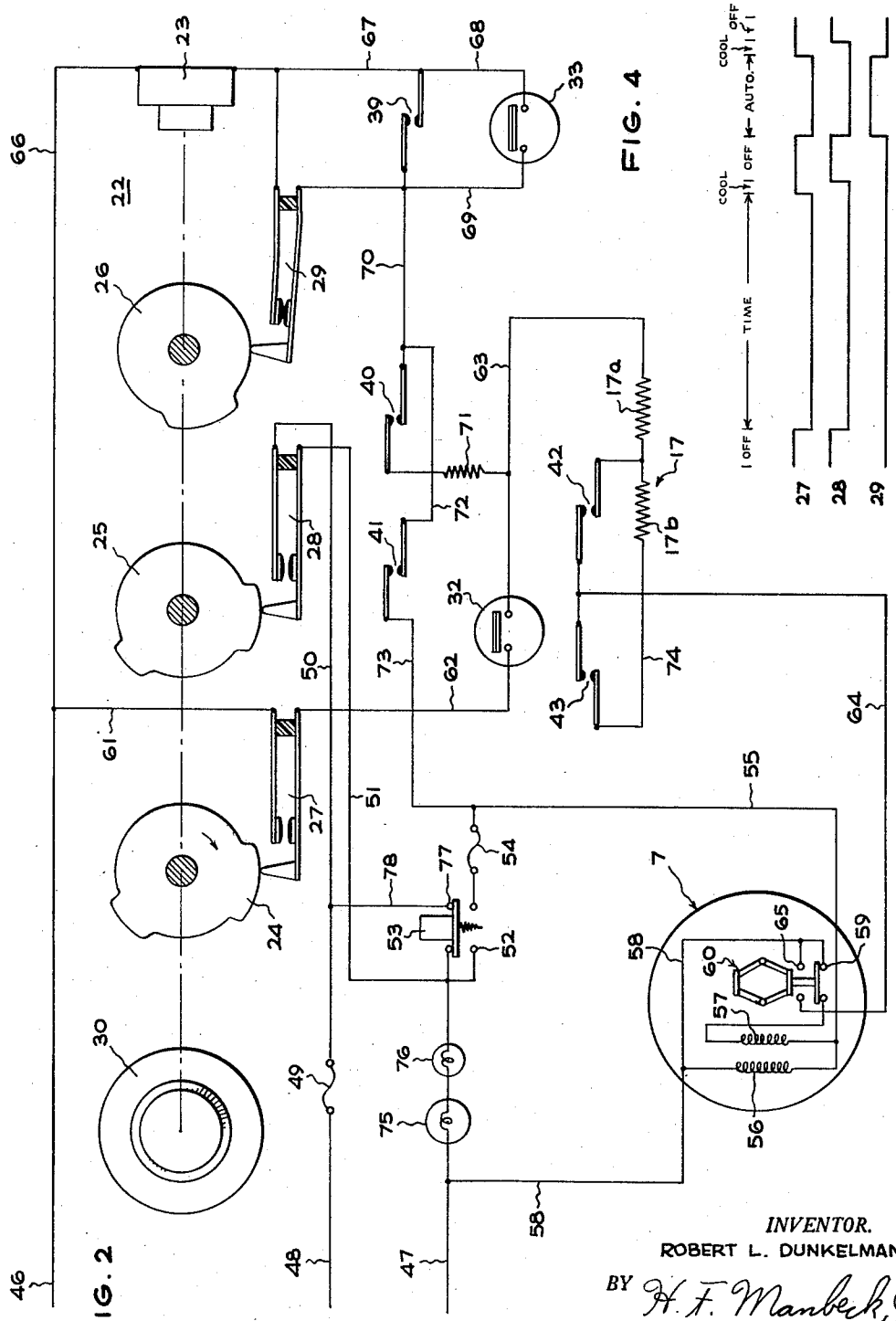

FIG. 2

FIG. 4

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CONTROL SYSTEM FOR CLOTHES DRYERS

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Application March 13, 1956, Serial No. 571,181

12 Claims. (Cl. 34—45)

My invention relates to clothes dryers and more particularly to the electrical control systems used in such dryers.

It is an object of my invention to provide a new and improved control system for clothes dryers.

It is another object of my invention to provide an improved control system for clothes dryers, by which the drying operation may be controlled in accordance with the temperatures of both the inlet air entering the clothes tumbling means and the exhaust air leaving the tumbling means, thereby automatically to terminate the dryer operation when the clothes have dried.

A further object of my invention is to provide a clothes dryer control system which is effective selectively to produce at least two different drying operations including the above mentioned automatic temperature controlled drying operation and also a second drying operation of timed length.

Another object of my invention is to provide a clothes dryer control system which is effective to produce three different clothes treating operations comprising the automatic temperature controlled drying operation, the drying operation of timed length, and a clothes tumbling operation without heat also of timed length.

Still another object of my invention is to provide a control system of this latter type in which the dryer heater may be selectively energized at a plurality of different levels during the timed drying operation. It is an additional object of my invention to provide a control system of that type, which may be adjusted simply and easily between its various operations by means of a single rotatable control dial and a plurality of push buttons.

Still a further object of my invention is to provide an improved clothes dryer control system having a motor driven centrifugal safety switch in the heater circuit, which switch is also utilized to open the timer motor circuit when the drive motor stops at the end of one of the drying operations of the system.

In carrying out my invention in one form thereof, I provide a clothes dryer including clothes tumbling means and a drive motor for driving the tumbling means. A heater is provided within the machine, and blower means are arranged for blowing air over the heater and through the tumbling means for drying the clothes therein. By my invention a new and improved control system is incorporated within the dryer for obtaining three different operations therefrom, namely a clothes drying operation of timed length, a temperature controlled drying operation wherein operation is terminated automatically when the clothes have dried, and a timed clothes tumbling operation wherein the clothes are tumbled without heat. My improved control system includes a motor driven timer, a heater cycling thermostat responsive to the temperature of the inlet air entering the tumbling means from the heater, and a second thermostat responsive to the temperature of the exhaust air leaving the tumbling means. The system utilizes these three elements and a plurality of circuits to produce the three different operations.

The circuits of the control system all include switch means operated by the timer, which must be closed to start the various operations and which terminate the operations when they are opened. The heater is energized by a circuit through the heater cycling thermostat, which circuit is closed for the clothes drying operations and which is open for the clothes tumbling operation. The drive motor is energized by a circuit which is closed for all three operations. Two different circuits are provided for energizing the timer to determine the length of the various operations. By the one circuit the timer is energized continuously and this circuit is utilized to produce the timed clothes drying operation and the timed clothes tumbling operation. By the second circuit the timer is controlled by both the exhaust thermostat and the heater cycling thermostat so that it is not energized at the beginning of the operation but rather is energized only after both the inlet air and the exhaust air reach predetermined high temperatures. This circuit is utilized to produce the temperature controlled operation, and it is effective to energize the timer so that the operation is terminated automatically when the clothes have dried. The control is selectively adjusted to close the various circuits and produce the different operations by means of suitable manually operated means which may include a rotatable control dial and a plurality of push buttons.

The subject matter which I regard as my invention is pointed out with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, may be best understood by reference to the following description taken in conjunction with the accompanying drawings in which:

Fig. 1 is a perspective view of a domestic clothes dryer including a control system embodying my invention, the view being partially broken away in order to show details;

Fig. 2 is a schematic diagram of the control system itself;

Fig. 3 is an enlarged fragmentary view showing the operator controls of the control system;

Fig. 4 is a chart showing the sequence of operation of the timer operated switches included in the system of Fig. 2; and

Fig. 5 is a chart showing the relationship between the push buttons of the operator controls and the switches in the control system operated thereby.

Referring now to Fig. 1 I have shown therein a clothes dryer 1 which is illustrative of the various clothes dryers in which my new and improved control system may be used. The dryer 1 includes a rotatable drum or basket 2 which is mounted for rotation about a generally horizontal axis. The basket 2 is disposed within an outer enclosing cabinet structure 3, and aligned openings 4 and 5 are provided respectively in the front walls of the basket and the cabinet structure for the loading and unloading of the clothes from the basket. The openings 4 and 5 are flanged as shown to prevent clothes from dropping down between the basket and the cabinet. A door 6 hingedly mounted on the cabinet closes the opening 5 during the operation of the dryer.

For rotating the basket 2 during operation of the dryer there is provided an electric motor 7 which is connected to the basket by a suitable belt drive 8. The pulleys (not shown) mounting the belt drive are so arranged that the basket 2 is driven at a suitable speed for tumbling articles of clothing. The basket 2 preferably includes upstanding ribs on the inner surface thereof to aid in producing the tumbling action. Besides driving the basket 2 the motor 7 also serves to drive air moving means for circulating a stream of air through the basket during the operation of the machine. The air moving means comprises a centrifugal blower 9 which is driven by the motor 7 by means of a direct coupling 10. The blower 9 draws in

air from the surrounding room through a conduit 11 which leads from a screened air inlet opening 12 in the toeboard 13 of the cabinet.

The air drawn in by the blower 9 is discharged through an opening 14 at the top thereof into a space 15 which is separated from the rotating basket 2 by a baffle 16. As shown, the baffle 16 extends upwardly from the base of the machine to a point in the general vicinity of an electrical heating element 17 mounted at the top of the machine, the baffle 16 being curved arcuately around the perforated side wall 18 of the basket for a portion of its length. The air discharged from the blower 9 flows upwardly through the space 15 and passes outwardly therefrom across the electrical heating element 17. The air still under pressure from the blower then flows downwardly through the foraminated cylindrical wall 18 of the basket. A generally arcuate baffle or wrap-around 19 confines the flow path of the air so that it is positively passed through the wall 18 into the basket. The air moves downwardly through the basket and the articles of clothing being tumbled therein and next passes into a collecting chamber 20 lying beneath the basket 2 on the opposite side of the baffle 16 from the space 15. From the chamber 20 the air is discharged out of the cabinet into the surrounding room through an appropriate lint trap structure 21 mounted in the toe-board 13.

The machine 1 is intended for use both as a clothes drying means and as a clothes sprinkling means. When the machine is to be used as a clothes dryer the heater 17 is energized along with the drive motor 7. Thus the air discharged from space 15 absorbs heat from the heater 17 as it passes thereover. The heated air then extracts moisture from the clothes being tumbled in the drum as it passes therethrough. The heating element, however, is not energized when the machine is being used as a clothes sprinkling means. Thus the air passing through the drum is not heated and it does not extract moisture from the clothes. Any suitable means may be used to sprinkle the clothes during this operation, but it is preferred to use a container which can be mounted on the drum 2 so as to discharge water onto the clothes at a slow rate as the basket rotates. A suitable container for this purpose is shown and described in the copending application of Eugene G. Olthuis, Serial No. 430,794 filed May 19, 1954 and assigned to the same assignee as the present invention. It will be understood, of course, that if the sprinkling means are not mounted within the drum, this clothes tumbling operation of the dryer without heat may be used for fluffing previously dried clothes or for any other purpose wherein it is desired to tumble the clothes without the application of heat.

Referring now to Fig. 2 I have shown therein a control system for the dryer 1, which embodies my invention in one preferred form thereof. This control system provides for a plurality of different clothes treating operations to be carried out within the dryer. It provides for a temperature controlled clothes drying operation wherein the dryer is controlled by the temperatures of both the inlet air to the tumbling drum and the exhaust air leaving the drum so that the drying operation is automatically terminated when the clothes have fully dried. It also provides for a clothes drying operation of timed length wherein the length of the operation is preset by the operator. In this timed drying operation the heater 17 may be selectively energized at two different levels to supply heat at a high rate or a lower rate. The control further provides for a clothes tumbling operation of timed length wherein the heater is not energized at any time.

In order to time the lengths of the timed clothes drying operation and the timed clothes tumbling or sprinkling operation, and also in order to terminate the temperature controlled operation when the clothes have fully dried, the control system includes a timer mechanism 22. This timer mechanism operates continuously during both the timed drying operation and the timed sprinkling operation, but is controlled by the temperatures of the inlet and exhaust air of the drum 2 during the temperature controlled operation so that it begins running only at a suitable time after the operation is initiated to terminate the operation when the clothes have fully dried. The timer mechanism includes a timer motor 23 and a plurality of cams 24, 25 and 26 which are driven by the timer motor through suitable one-way clutch means. The cams 24, 25 and 26 are arranged to operate switches 27, 28 and 29 respectively through suitable cam followers which ride on their peripheries, and these switches are connected in the control system for controlling the heater 17, the drive motor 7 and the timer motor itself. The two switches 27 and 28 are connected respectively in the circuits for energizing the heater 17 and the drive motor 7, the switch 27 being connected serially in the heater circuit and the switch 28 being connected serially in the drive motor circuit. The switch 29 is connected in one of two alternate circuits for energizing the timer motor 23, which one timer circuit also passes through the switch 28. The drive motor circuit, the heater circuit, the two timer motor circuits, and the connection of the switches 27, 28 and 29 in these circuits will be more fully described hereinafter.

In order that the switch operating cams 24, 25 and 26 may be adjusted to any desired position, the timer mechanism is provided with a rotatable dial 30 which is mounted on the same shaft as the cams. By adjusting the dial 30 and thus the cams 24, 25, and 26, the timer may be set so as to produce either the automatic temperature controlled drying operation or the timed clothes drying and clothes sprinkling operations. The timer dial includes two ranges, one for the temperature controlled automatic drying operation and the other for the two timed operations, with the two ranges being separated from each other by suitable off or machine inoperative sectors. Within the time range the selection between drying and tumbling without heat is made by suitable push buttons as described below. The timer mechanism may be mounted at any suitable point within the machine but preferably is mounted on the backsplasher 31 thereof as is shown in Fig. 1.

For determining the length of the automatic drying operation wherein the timer mechanism 22 is thermostatically controlled, the control system includes a pair of thermostats 32 and 33. The one thermostat 32 is positioned so as to sense the temperature of the inlet air entering the drum from the heater 17 and the other thermostat 33 is positioned so as to sense the temperature of the exhaust air leaving the drum through the space 20. These two thermostats are connected in the control system so that the timer mechanism 22 does not begin to operate during the automatic drying operation until both the inlet air to the drum and the exhaust air from the drum have reached predetermined high temperatures. In other words the two thermostats control the timer motor to produce this result, and thereby the timer mechanism is made effective to terminate the drying operation at the time the clothes have fully dried. The thermostats may be positioned within the machine in any suitable manner. For example, the thermostat 32 may be mounted on the wrap around 19 and the thermostat 33 may be mounted on a bracket 34 in the exhaust air collecting space.

Besides serving as a portion of the means for controlling the timer mechanism during the automatic drying operation, the inlet air thermostat 32 also acts as a heater cycling thermostat. In other words it is connected to cycle the heater 17 on and off in response to the temperature of the inlet air. As a result of this cycling the inlet air is prevented from rising to a temperature above the temperature safe for synthetics and other delicate fabrics. In other words the heater cycling thermostat controls the heater so as to keep the machine temperature safe for all kinds of fabrics, and this control is effec-

tive not only during the automatic drying operation but also during the timed drying operation.

In order to select the desired operation the control system includes a plurality of push buttons **35**, **36**, **37** and **38** in addition to the timer dial **30**. These push buttons control a plurality of switches **39**, **40**, **41**, **42**, and **43** which are connected in the various circuits of the control. The manner in which the push buttons control the various switches is indicated by the chart of Fig. 5. In this chart an X mark indicates that a switch is closed and a blank indicates that it is open. For example, if the push button **35** is pushed, switches **40** and **42** are closed while switches **39**, **41** and **43** are opened. Similarly, if the push button **36** is depressed the switches **39**, **41** and **42** are closed while the switches **40** and **43** are opened. Since any suitable mechanical linkage may be used between the push buttons and the switches to effect the results indicated by this chart, and since the mechanism forms no part of the present invention, it has not been illustrated herein.

The manner in which the switches **39**—**43** are connected in the control system and the results obtained from them are explained in detail hereinafter. Briefly stated, however, the switches **42** and **43** provide for energizing the heater **17** at two different levels during the time drying operation and for disconnecting it completely during the timed sprinkling operation. The switches **40** and **41** provide for energizing the timer motor **23** through alternate circuits thereby to allow selection of either the automatic drying operation or the timed operations; and the switch **39** provides a safety timer circuit if the operator should depress the wrong push button when the dial is set in the automatic range.

To obtain the different operations of the dryer the operator sets the dial **30** and operates one of the push buttons. To obtain the automatic temperature controlled operation of the dryer the operator sets the dial in the "automatic" range **44** and depresses the "auto" (automatic) push button **35**. If she wishes to set the machine for the clothes tumbling or sprinkling operation, the operator sets the dial in the "time" range **45** and depresses the "sprinkle" push button **38**. If she wishes to set the machine for the timed drying operation she sets the dial in the time range **45** and depresses either the "Hi" (high) button **36** or the "Lo" (low) button **37**. Depressing the button **36** results in the heater being energized at its higher level during this operation and the depressing of the button **37** results in the heater operating at its lower level during this operation.

To explain in detail the connections and the operation of my improved control system, let it be assumed that the operator desires to conduct an automatic temperature controlled drying operation in the dryer. To do this she, of course, sets the dial **30** in the "automatic" range and depresses the "auto" push button **35**. As indicated by the cam chart of Fig. 4 this setting of the dial **30** closes the switches **27** and **28** while causing the switch **29** to remain open, and as indicated by the chart of Fig. 5 the depressing of the push button **35** closes switches **40** and **42** while opening switches **39**, **41** and **43**. As a result of these settings the drive motor is energized by a circuit through the timer operated switch **28**, and the heater is energized by a circuit through the timer operated switch **27**, the heater cycling thermostat **32** and the manually operated switch **42**. A circuit is also set up for energizing the timer motor **23**, but this circuit passes through the exhaust thermostat **33** so that it is not energized until such time as the exhaust air temperature rises to a predetermined high temperature. Further, in this timer motor circuit the heater cycling thermostat **32** is effective to short out the timer motor until such time as a predetermined high temperature of the inlet air exists. Thus both the inlet and the exhaust air temperatures must be at high values before the timer motor is energized. This control of the timer motor by the two thermostats results in its not being energized when the operation begins, but rather becoming energized only after the clothes have substantially dried. Once the timer motor is energized, it then begins to turn the timer cams toward the No. 1 Off position whereby after a short period first the heater circuit and then the drive motor circuit are de-energized to terminate the operation of the machine.

In my preferred control all the electrical components of the control system are energized from a three-wire power supply comprising the supply conductors **46** and **47**, and a neutral line **48**. For domestic use it is contemplated that there will be a voltage of approximately 220 volts between the supply conductors **46** and **47** and a voltage of approximately 110 volts between the neutral line **48** and each of the supply conductors.

When the dial **30** is moved into the automatic range **44** and the push button **35** is depressed, the circuit for energizing the drive motor is completed between the supply conductor **47** and the neutral line **48**. Commencing with the neutral line **48** this circuit extends through a fusible link **49**, a conductor **50**, the timer operated switch **28** and a conductor **51** to the contacts **52** of a door switch **53**. The door switch is controlled by the door **6** of the machine so that the contacts **52** are closed when the door is closed and are opened when the door is open. This switch is thus effective to break the motor circuit and halt the drum rotation whenever the door is opened. From the contacts **52** of the door switch the drive motor circuit continues through a fusible link **54** and a conductor **55** to the main and start windings **56** and **57** of the motor **7**, and from the windings **56** and **57** the motor circuit is completed through a conductor **58** to the supply conductor **47**. As shown, the run winding **56** is connected directly to the conductor **58** and the start winding **57** is connected thereto through the contacts **59** of a motor centrifugal switch **60**. The centrifugal switch **60** is operated by the motor **7** and it is so arranged that the contacts **59** are closed whenever the motor is at rest but are opened as soon as the motor comes up to speed. Thus the start winding **57** is connected in the circuit only until the motor comes up to speed. It is then removed from the circuit by the centrifugal switch and the motor continues to run under the action of the main winding alone. With the motor **7** energized through this circuit, it will be seen that it will continue to operate until such time as either the timer operated switch **28** or the door switch contacts **52** are opened.

The heater circuit completed by setting the dial in the automatic range and depressing the push button **35** is energized across the supply conductors **46** and **47**. Commencing with the supply conductor **46**, the heater circuit extends through a conductor **61**, the timer operated switch **27**, and a conductor **62** to the heater cycling thermostat **32**. From the thermostat **32** it proceeds through a conductor **63** to the one portion **17***a* of the heater. From the portion **17***a* the circuit continues through the closed switch **42** and a conductor **64** to a set of back contacts **65** of the motor centrifugal switch **60**. These contacts **65** are open when the motor is at rest but are closed as soon as the motor comes up to speed. Assuming the contacts **65** to be closed, the circuit is then completed through the conductor **58** to the supply conductor **47**.

Energized through this circuit, it will be seen that the heater will remain energized under the control of the cycling thermostat **32** so long as the timer operated switch **27** and the centrifugal switch contacts **65** remain closed. The opening of any of these switches or contacts will, however, interrupt the heater circuit and de-energize the heater. Due to the action of the thermostat **32** the heater is cycled intermittently so as to keep the temperature of the inlet air to the drum below the temperature which might result in harm to sheer fabrics or synthetics. For example, it is contemplated in one embodiment of

my invention that the inlet air temperature will not be allowed to rise above 170° F. as a result of the action of the cycling thermostat 32.

With the switch 42 closed and the switch 43 opened so that only the portion 17*a* of the heater is energized and not the portions 17*b*, the maximum wattage output is produced by the heater. For example in one preferred embodiment of my invention it is contemplated that the heater will produce approximately 4700 watts when the portion 17*a* is energized in this manner. Incidentally, it will be noted that if the drive motor should stop rotating for any reason as for example due to the opening of the door 6, the heater will be de-energized due to the opening of the centrifugal switch contacts 65. This, of course, provides for operator safety.

The operation of the dial 30 to the automatic range 44 and the depressing of the auto push button 35 also closes connections for a circuit for energizing the timer motor 23. This circuit is connected across the supply conductors 46 and 47 but unlike the drive motor and the heater circuits it is not energized immediately upon the initiation of the dryer operation. Rather this circuit is closed only after the clothes have substantially dried. The circuit is controlled by the joint action of the exhaust thermostat 33 and the heater cycling thermostat 32 to produce this result. Commencing with the supply line 46, the timer motor circuit extends through a conductor 66 to the timer motor 23 itself, and thence it extends through conductors 67 and 68 to the exhaust thermostat 33. From the exhaust thermostat it extends through conductors 69 and 70 to the manually operated switch 40 and thence through a resistor 71 to the conductor 63. The circuit is completed from the conductor 63 through the heater portion 17*a*, the switch 42, the conductor 64, the centrifugal switch contacts 65 and the conductor 53. It will be noted that in this circuit the timer operated switch 29 and the manually operated switch 39 are connected in parallel with the exhaust thermostat 33. However, as shown by the charts of Figs. 4 and 5 these switches are both open during the automatic drying operation so that the timer motor circuit can be closed only when the exhaust thermostat 33 closes. The circuit is, however, not wholly under the control of the exhaust thermostat since the heater cycling thermostat 32 is connected in parallel or shunt across the series combination of the timer motor itself and the exhaust thermostat. Specifically, the heater cycling thermostat is connected in parallel with the timer motor and the exhaust thermostat by the conductor 61, the timer operated switch 27 and the conductor 62. With this arrangement of the heater cycling thermostat 32 the timer motor is shorted out whenever the thermostat 32 is closed, whereby it can be energized only when the thermostat 32 is opened and the exhaust thermostat 33 is simultaneously closed.

In the timer motor circuit the resistor 71 acts as a voltage dropping resistor to cause the proper voltage to be applied to the timer motor 23 when it is energized. For example, in the illustrated embodiment for use with a 220 volt power supply, the size of the resistor 71 is such that when the thermostat 32 is open and the thermostat 33 is closed, approximately 110 volts is applied to the timer. In other words the resistance of resistor 71 combined with that of the heater resistor 17*a* is approximately equal to the impedance of the timer so that the supply voltage divides equally between the timer and the two resistors.

The exhaust thermostat 33 is arranged so that it closes only at an exhaust air temperature which indicates that the clothes have been substantially dried. As the clothes are being dried within the drum 2, the temperature within the interior of the dryer rises slowly. In fact, for a period of the dryer operation the amount of heat supplied to the air and the clothes from the heating element 17 may even be approximately equal to the amount actually used for moisture extraction and during that period a temperature plateau will occur. This plateau or region of very slow rise is within the general temperature range no matter what type of fabrics are being dried. The dryer operates at this plateau or with a very slow rise until such time as the clothes are substantially dried. Then when the clothes are substantially dried, the clothes temperature and the temperature of the exhaust air begin to rise more rapidly. The thermostat 33 is calibrated so that it closes at a temperature slightly above where this rapid temperature rise occurs. The thermostat thereby closes the timer motor circuit only after the clothes are substantially dry.

If the heater cycling thermostat 32 is open when the exhaust air thermostat 33 closes, the timer motor is then energized and begins to rotate the cams so as to terminate the machine operation. However if the heater cycling thermostat 32 should be closed, the timer motor will not be energized until such time as it does open. Further, the timer motor can run only so long as the thermostat 32 remains open. This action insures that the average temperature of the inlet air to the tumbling drum does not decrease during the period the timer motor runs to terminate the machine operation. During this period the thermostat maintains the inlet air at the same average temperature as during the time before the thermostat 33 closed, and thereby the drying action may be completed more quickly than if the control system allowed the inlet air temperature to decrease. If the operation continues long enough so that the thermostat 32 cycles the heater and timer motor inversely one or more times, the average temperature of the exhaust air even rises slowly. Thereby the exhaust air thermostat remains closed continuously leaving the timer motor, in effect, under the control of the heater cycling thermostat.

The timer motor is utilized to terminate the automatic drying operation since some additional drying time is required after the exhaust thermostat opens to dry the clothes completely, and this additional drying time varies depending upon the type of fabrics being dried. For example heavy items such as bedspreads, shag rugs, bath towels, slip covers, overalls, etc., take somewhat longer to finish drying after the exhaust air thermostat 33 closes than do most cottons and linens. Similarly cottons and linens take longer to dry after the exhaust air thermostat has closed than do items such as lingerie, sheer fabrics, diapers and items of various synthetic fabrics. The timer motor provides an adjustment feature whereby the operator may set the machine to operate for a greater or lesser period after the exhaust thermostat has closed, thereby to obtain the proper drying effect for the particular fabric being dried. By setting the timer control dial 30 at "L" (light) the timer motor will run for the least amount of time before shutting the machine off, by setting the dial at "N" (normal) the timer motor will run for an intermediate length of time, and by setting the dial at "H" (heavy) it will run for the greatest length of time. In this manner it is insured that no matter what type of fabrics are being dried, a correct drying effect will be provided. Of course, if the load being dried includes different types of fabrics the dial may be set at points intermediate the marked positions of the "automatic" range 44.

As soon as the timer motor 23 is energized it begins to drive the cams toward the off position so that first the switch 27 and then the switch 28 is opened. As soon as the switch 27 is opened, the heater is turned off to stop the application of heat to the clothes. The switch 28 does not however open simultaneously with the heater switch 27. Rather it remains closed for a short time thereafter for a cool-down period. During this period the drive motor continues to operate driving the blower 9 and the drum 2 so that cool air is blown through the tumbling clothes. This reduces the temperature of the clothes and also the temperature of the interior of the dryer so that the operator may remove the clothes from the machine without discomfort. The cool-down pe-

ried is terminated when the timer opens switch **28** so as to deenergize the drive motor **7**. The de-energizing of the drive motor terminates the operation of the machine completely and the operator may then open the door **6** and remove the fully dried clothes.

Since the timer motor circuit passes through the contacts **65** of the motor centrifugal switch **60**, the de-energizing of the driver motor by timer switch **28** also terminates the operation of the timer motor. The contacts **65** are opened as the drive motor stops rotating, and thereby the timer **23** is de-energized so that all the electrical components of the machine are removed from operation.

During the period that the timer motor is running before the cool-down period begins, the temperature in the interior of the dryer decreases slowly so long as the heater cycling thermostat **32** is open. If this temperature, or more accurately the inlet air temperature, should drop to a certain predetermined lower value before the heater switch **27** is opened, the heater cycling thermostat **32** will close so as to re-energize the heater and shunt the timer motor. The heater then continues in operation with the timer motor off until such time as the predetermined higher temperature is reached at which time the heater cycling thermostat again opens. At that time the heater is again removed from operation and the timer placed back in operation to move the cams toward the machine shut-down position. The heater and the timer may thus be cycled inversely one or more times before the dryer operation is finally terminated. This action causes the clothes to be tumbled long enough and at the right temperature to insure their drying, with the average temperature within the dryer not dropping during the period.

If the dial is set in the L (light) position of the automatic range the timer normally shuts down the dryer before the temperature falls to the point where the heater cycling thermostat re-energizes the heater. Thus there is usually no inverse cycling of the heater and the timer when the dial is set at the L (light) position. If, however, the dial is set in the N (normal) or H (heavy) positions of the automatic range it is contemplated that the thermostat may cycle the timer and the heater inversely one or more times before the dryer operation is terminated.

Besides the above-described automatic drying operation my improved control system also provides for a timed clothes drying operation and a timed sprinkling operation. For either of these operations the dial **30** is set within the time range **45**, the position within the time range being selected according to the amount of time that is desired for the machine to operate. Then if it is desired to dry clothes, either the button **36** or the button **37** is depressed. If it is desired to apply a maximum amount of heat to the clothes, the button **36** is depressed, whereas if it is desired to apply a lesser amount of heat to the clothes, the button **37** is depressed. The button **37** for the lower heating setting is ordinarily depressed when it is desired to dry synthetics and other delicate fabrics which might be injured if heated too rapidly or to too high a temperature. If it is desired to tumble the clothes without heat, for example for sprinkling purposes, then the button **38** is depressed.

Assuming that it is desired to dry clothes for a timed period under high heat, and that the dial **30** has been set and the button **36** has been depressed to effect this result, then circuits are completed for the drive motor, the heater and the timer as follows. The heater circuit and the drive motor circuit are identical with those described above for the automatic drying operation. In other words the heater is energized by the circuit through the timer operated switch **27** and the heater cycling thermostat **32**, and the drive motor is energized by the timer operated switch **28**. The timer motor is however energized by a different circuit so that it is energized continuously during this operation. The timer motor circuit extends between the conductor **46** and the neutral line **48** by means of the timer operated switch **28** and the manually operated switch **41**. Commencing with the supply conductor **46** the timer circuit extends through conductor **66** and the timer motor **23** to conductor **67** and thence through the switch **39**, which is now closed, to the conductor **70**. From the conductor **70** it continues through the conductor **72** to the manually operated switch **41**, which is also now closed, and from the switch **41** it extends through conductor **73** and fusible link **54** to the contacts **52** of the door switch. From the door switch it is completed through conductor **51**, timer operated switch **28**, conductor **50** and fusible link **49** to the neutral line **48**.

Energized through this circuit it will be seen that the timer motor will continue in operation until such time as the timer operated switch **28** is opened. The switch **28** as shown by the cam chart is opened only at the end of the operation so that the timer motor thus runs continuously to provide an operation of timed length. Incidentally, it will be noted that the opening of the door switch de-energizes the timer motor simultaneously with the drive motor, whereby only the periods that the machine is in operation are counted by the timer mechanism.

Referring to the cam chart of Fig. 4 it will be noted that the switch **27** is opened slightly before the switch **28** in this timed drying operation. Thus there is a cool-down period provided in the timed clothes drying operation just as in the automatic clothes drying operation.

If it is desired to operate the dryer with the heater operating at its lower level of energization, then the push button **37** is operated instead of the push button **36**. The result of this operation of the button **37** is that the switch **42** is opened while the switch **43** is closed, and that places the heater portion **17*b*** in series with the heater portion **17*a*** in the heater circuit. With the switches so operated the heater circuit extends through heater portion **17*a*** and **17*b*** in series, and then is joined to the line **64** through the conductor **74** and the switch **43**. The placing of the heater portion **17*b*** in series with the portion **17*a*** results in the heater presenting greater resistance whereby there is less wattage output from it. As a result of the heater operating at a lower level, the temperature within the dryer rises more slowly whereby the heater may even continue in operation throughout the entire drying cycle without ever being cycled on and off by the heater cycling thermostat **32**. In other words the inlet air may never be raised to a temperature at which the cycling thermostat will open the heater circuit. However, if the temperature does rise to that point, the thermostat **32** will cycle the heater in the usual manner. The drive motor and timer motor circuits remain the same as during the high temperature timed drying operation since the switches **39** and **41** are closed no matter which heat button **36** or **37** is depressed.

If it is desired to tumble clothes without heat, for example for sprinkling them, the dial **30** is again set in the time range **45**, but the sprinkle push button **38** is depressed rather than either of the drying pushbuttons **36** and **37**. As shown in Fig. 5 the depressing of the sprinkle push button closes the switches **39** and **41** and leaves the remaining switches **40**, **42** and **43** open. The opening of the switches **42** and **43** breaks the heater circuit whereby the heater cannot be energized at any time. However, the same drive motor and timer motor circuits are completed as during the timed drying operation. Thus the timer motor and the drive motor are both energized, the drive motor causing rotation of the drum and the passage of air through the drum and the timer motor timing the length of the operation. The operation is terminated at such time as the timer motor rotates the cam **25** far enough to open the switch **28** and break both circuits.

From the above it will be seen that my new and improved control system provides for three different operations of a clothes drying machine. Firstly, it provides for a temperature controlled drying operation whose length is automatically controlled so as to produce fully dried clothes. In this automatic operation the control of the

timer motor by the two thermostats, one responsive to the inlet air and the other responsive to the exhaust air, produces a particularly efficient control both maintaining the inlet air temperature high for quick drying and insuring that the dryer operation is terminated at the proper time. The control system also provides for a timed drying operation wherein the dryer may be set to operate for a predetermined length of time. In this timed drying operation the heater may be energized at two different levels so as to give greater flexibility of the effects obtained. Further, the control system provides for a clothes tumbling operation without heat which may advantageously be used for sprinkling or fluffing clothes.

It is, of course, realized that the operator may at times make a mistake when she sets the controls of the dryer. For example, she might set the dial in the automatic range **44** and depress one of the buttons **36**, **37** or **38** instead of depressing the automatic push button **35**. Conversely, she might set the dial in the time range **45** and depress the automatic push button **35**. However, no matter how she may mis-set the dial or the push buttons, the machine will still time itself out. In other words the timer motor **23** will still be energized so as to turn the timer cams toward an off position. If the operator should set the dial in the automatic range and then depress any one of the high, low, or sprinkle push buttons **36**, **37** or **38** the timer motor will be energized by a circuit through switches **39** and **41**. With the dial set in the automatic range the timer operated switch **29** is open, but the depressing of any one of the push buttons **36—38** closes the switches **39** and **41** and opens switch **40**. That completes a timer motor circuit across conductor **46** and neutral line **48**. Commencing with conductor **46** this circuit comprises conductor **66**, the timer motor itself, conductor **67**, switch **39**, conductors **70** and **72**, switch **41**, conductor **73**, fusible link **54**, door switch contacts **52**, conductor **51**, timer operated switch **28**, conductor **50** and fusible link **49**. This circuit remains until such time as cam **25** opens switch **28**, whereupon it is opened simultaneously with the drive motor circuit to terminate machine operation.

Oppositely, if the operator should set the dial in the time range **45** but depress the automatic push button **35**, then the switches **39**, **41** and **43** would be open and switches **40** and **42** closed. The timer circuit of the previous possible mis-setting thus cannot be completed. However, with the timer set in the time range, the timer operated switch **29** is closed so that the timer will be connected across the heater cycling thermostat by conductor **66**, switch **29**, conductor **70**, switch **40** and the resistor **71**. Thus no matter what the condition of the exhaust air thermostat **33**, as soon as the heater cycling thermostat opens, the timer will be driven toward the off position; and therefore no matter how the operator mis-sets the controls, the timer will ultimately reach an off position and terminate the machine operation.

Besides those components already described, it will be noted that my new and improved control system includes an ozone lamp **75** for freshening the air inside the dryer and a light **76** for illuminating the interior of the dryer. The ozone lamp and the illuminating light are connected in series and are energized whenever the machine is in operation and also whenever the door is opened. When the machine is in operation, they are energized between the neutral line **48** and the supply conductor **47** by a circuit through the timer operated switch **28**. Commencing with the neutral line **48**, this circuit extends through the fusible link **49**, the conductor **50**, the timer operated switch **28** and the conductor **51** to the illuminating lamp **76**. It then extends through the lamps **76** and **75** in series to the conductor **47**. When the door is opened, the lamp circuit is then completed through a set of back contacts **77** of the door switch. This circuit like the other circuit is energized between the neutral line **48** and the conductor **47**. Commencing with the line **48**, the circuit extends through the fusible link **49**, the conductor **50** and another conductor **78** to the back contacts **77** of the door switch. It then extends through the contacts **77** to the lamp **76** and then through the lamp **75** in series to the conductor **47**. Since the contacts **77** are closed whenever the door is opened, it will thus be seen that the lamps are energized whenever the door is open as well as when the dryer is in operation.

While in accordance with the patent statutes I have described what at present is considered to be the preferred embodiment 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 my invention, and I, therefore, aim in the appended claims to cover all such changes and modifications as come within the true spirit and scope of my invention.

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

1. In a clothes dryer having clothes tumbling means, a drive motor for driving said tumbling means, a heater, and blower means for blowing air over said heater and through said tumbling means for drying the clothes therein, a control system for producing selectively a timed clothes drying operation, a temperature controlled clothes drying operation of automatically controlled length, and a timed clothes tumbling operation without heat, said control system comprising a timer mechanism including a timer and switch means operated by said timer, a heater cycling thermostat responsive to the temperature of the inlet air entering said tumbling means from said heater, an exhaust air thermostat responsive to the temperature of the exhaust air leaving said tumbling means, a heater circuit including said heater cycling thermostat for energizing said heater during both of said clothes drying operations, a drive motor circuit including timer operated switch means for energizing said drive motor continuously during all three of said operations, a first timer circuit including timer operated switch means for energizing said timer continuously during both said timed clothes drying operation and said timed clothes tumbling operation, a second timer circuit including said exhaust air thermostat for energizing said timer during said temperature controlled clothes drying operation, with said timer being de-energized at the beginning of said temperature controlled clothes drying operation and being energized only after the exhaust air reaches a pre-determined high temperature, and manually operable means for selectively adjusting said control system to obtain the desired one of said operations, said exhaust air thermostat and said timer being interconnected with said heater cycling thermostat so that said timer can be energized by said exhaust air thermostat during said temperature controlled drying operation only when said heater cycling thermostat is open.

2. In a clothes dryer having clothes tumbling means, a drive motor for driving said tumbling means, a heater, and means for blowing air over said heater and through said tumbling means for drying the clothes therein, a control system for producing selectively a timed clothes drying operation, a temperature controlled clothes drying operation of automatically controlled length and a timed clothes tumbling operation without heat, said control system comprising a timer mechanism including a timer and switch means operated by said timer, a heater cycling thermostat responsive to the temperature of the inlet air entering said tumbling means from said heater, an exhaust air thermostat responsive to the temperature of the exhaust air leaving said tumbling means, a heater circuit including said heater cycling thermostat for energizing said heater during both of said clothes drying operations, a drive motor circuit including timer operated switch means for energizing said drive motor continuously during all three of said operations, a plurality of manually operated switches, a first timer circuit including timer operated switch means and at least one of said manually operated switches for energizing said timer continuously during both said timed clothes drying operation and said

timed clothes tumbling operation, a second timer circuit including said exhaust air thermostat and a second of said manually operated switches for energizing said timer during said temperature controlled clothes drying operation, and circuit means interconnecting said exhaust air thermostat and said timer with said heater cycling thermostat so that said timer can be energized by said exhaust air thermostat during said temperature controlled drying operation only when said heater cycling thermostat is open, and manually operable means for adjusting said timer mechanism and said manually operated switches to arrange said system to obtain the desired one of said operations.

3. The combination of claim 2 wherein said timer includes an automatic range for said temperatures controlled operation and a time range for both of said timed operations, and said manually operable means comprise a rotatable dial for adjusting said timer mechanism into said ranges and a plurality of push buttons for adjusting said manually operable switches.

4. The combination of claim 2 wherein said heater circuit includes a pair of said manually operable switches for energizing said heater at different levels during said timed drying operation, thereby to produce selectively a low heat operation and a high heat operation.

5. In a clothes dryer having clothes tumbling means, a heater, blower means for blowing air over said heater and through said clothes tumbling means for drying clothes therein, and a drive motor for driving said tumbling means, a control system for producing selectively a timed clothes drying operation, a temperature controlled clothes drying operation of automatically controlled length, and a timed clothes tumbling operation without heat, said control system comprising a timer mechanism including a timer and a plurality of switches operated by said timer, a heater cycling thermostat responsive to the temperature of the inlet air entering said tumbling means from said heater, an exhaust air thermostat responsive to the temperature of the exhaust air leaving said tumbling means, a normally open centrifugal switch operated by said motor, a heater circuit including one of said timer operated switches and said heater cycling thermostat for energizing said heater during both of said clothes drying operations, a drive motor circuit including a second of said timer operated switches for energizing said drive motor continuously during all three of said operations, a plurality of manually operable switches, a first timer circuit for energizing said timer continuously during said timed clothes drying operation and said timed clothes tumbling operation, said first timer circuit including said second timer operated switch and at least one of said manually operated switches, a second timer circuit for energizing said timer during said temperature modified clothes drying operation, said second timer circuit including said exhaust air thermostat, said heater, one of said manually operated switches and said centrifugal switch, and means for selectively adjusting said timer mechanism and said manually operable switches to connect said control system to obtain the desired one of said operations.

6. The combination of claim 5 wherein said exhaust air thermostat and said timer motor are connected in series circuit relation across said heater cycling thermostat so that said timer motor can be energized during said temperature controlled clothes drying operation only when said exhaust air thermostat is closed and said heater cycling thermostat is open.

7. In a clothes dryer having clothes tumbling means, a drive motor for driving said tumbling means, a heater, and blower means for blowing air over said heater and through said clothes tumbling means for drying the clothes therein, a control system comprising a timer mechanism having a timer motor and switch means operated by said timer motor for controlling said heater and said drive motor, an inlet air thermostat for cycling said heater in response to the temperature of the inlet air entering said tumbling means from said heater, an exhaust air thermostat responsive to the temperature of the exhaust air leaving said drum for controlling said timer motor, and circuit means connecting said inlet air thermostat in parallel circuit relation with said timer motor so that said timer motor can be energized by said exhaust air thermostat only when said inlet air thermostat is open.

8. In a clothes dryer having clothes tumbling means, a heater, blower means for blowing air over said heater through said tumbling means for drying the clothes therein and a drive motor for driving said tumbling means and said blower means, a control system comprising a timer mechanism having a timer motor and switch means operated by said timer motor for controlling said heater and said drive motor, an inlet air thermostat for cycling said heater in response to the temperature of the inlet air entering said tumbling means from said heater, an exhaust air thermostat responsive to the temperature of the exhaust air leaving said tumbling means for controlling said timer motor, and circuit means connecting said exhaust air thermostat and said timer motor in a shunt circuit across said inlet air thermostat so that said timer motor can be energized only when said exhaust air thermostat is closed and said inlet air thermostat is open.

9. In a clothes dryer having clothes tumbling means, a drive motor for driving said tumbling means, a heater and blower means for blowing air over said heater and through said clothes tumbling means for drying the clothes therein, a control system comprising a timer mechanism having a timer motor and switch means operated by said timer motor for controlling said heater and said drive motor, an inlet air thermostat for cycling said heater in response to the temperature of the inlet air entering said tumbling means from said heater, an exhaust air thermostat responsive to the temperature of the exhaust air leaving said drum, a normally open centrifugal switch driven by said drive motor, and a circuit for energizing said timer motor including said exhaust air thermostat and said motor centrifugal switch, with said timer motor circuit being opened by centrifugal switch when said drive motor is de-energized by said timer operated switch means at the close of the clothes drying operation.

10. In a clothes dryer having clothes tumbling means, a drive motor for driving said tumbling means, and a heater for heating the clothes being tumbled to dry said clothes, a control system comprising a timer mechanism having a timer motor and switch means operated by said timer motor for controlling said heater and said drive motor, a normally open switch closed in response to the rotation of said drive motor, and a circuit for energizing said timer motor including said normally open switch, with said timer motor circuit being de-energized by said switch when said drive motor is de-energized by said timer operated switch means at the close of the clothes dryer operation.

11. In a clothes dryer having clothes tumbling means, a drive motor for driving said tumbling means, a heater, and blower means for blowing air over said heater and through said tumbling means for drying the clothes therein, a control system for producing selectively a timed clothes drying operation and a temperature controlled clothes drying operation of automatically controlled length, said control system comprising a timer mechanism including a timer and switch means operated by said timer, a heater cycling thermostat responsive to the temperature of the inlet air entering said tumbling means from said heater, an exhaust air thermostat responsive to the temperature of the exhaust air leaving said tumbling means, a heater circuit including timer operated switch means and said heater cycling thermostat for energizing said heater during both of said operations, a drive motor circuit including timer operated switch means for energizing said drive motor continuously during both of said operations, a first timer circuit including timer operated switch means for energizing said timer motor continuously during said timed clothes drying operation, a second timer circuit in-

cluding switch means operated by said timer and said exhaust air thermostat for energizing said timer during said temperature controlled clothes drying operation, with said timer being de-energized at the beginning of said temperature controlled drying operation and being energized by said exhaust thermostat only after the exhaust air reaches a predetermined high temperature, said timer including presettable means for varying its period of operation in said temperature controlled operation after it is energized by said exhaust thermostat, and manually operable means for selectively adjusting said control system to obtain the desired one of said operations.

12. In a clothes dryer having clothes tumbling means, a drive motor for driving said tumbling means, a heater, and blower means for blowing air over said heater and through said clothes tumbling means for drying the clothes therein, a control system for producing selectively a timed clothes drying operation and a temperature controlled clothes drying operation of automatically controlled length, said control system comprising a timer mechanism including a timer and switch means operated by said timer, a heater cycling thermostat responsive to the temperature of the inlet air entering said tumbling means from said heater, and exhaust air thermostat responsive to the temperature of the exhaust air leaving said tumbling means, a heater circuit including timer operated switch means and said heater cycling thermostat for energizing said heater during both of said operations, a drive motor circuit including timer operated switch means for energizing said drive motor continuously during both of said operations, a plurality of manually operated switches, a first timer circuit including timer operated switch means and one of said manually operated switches for energizing said timer continuously during said timed clothes drying operation, a second timer circuit including said exhaust air thermostat and a second of said manually operated switches for energizing said timer during said temperature controlled clothes drying operation, means connecting said heater cycling thermostat in parallel circuit relation with said timer in said second timer circuit so that said timer can be energized by said exhaust air thermostat during said temperature controlled drying operation only when said heater cycling thermostat is opened, and manually operable means for adjusting said timer mechanism and said manually operated switches to select the desired one of said operations.

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