Aug. 31, 1965 J. T. WILLIAMS ETAL 3,203,679

AUTOMATIC CONTROL OF PLURAL HEATERS IN A CLOTHES DRIER

Filed Oct. 17, 1960 2 Sheets-Sheet 1

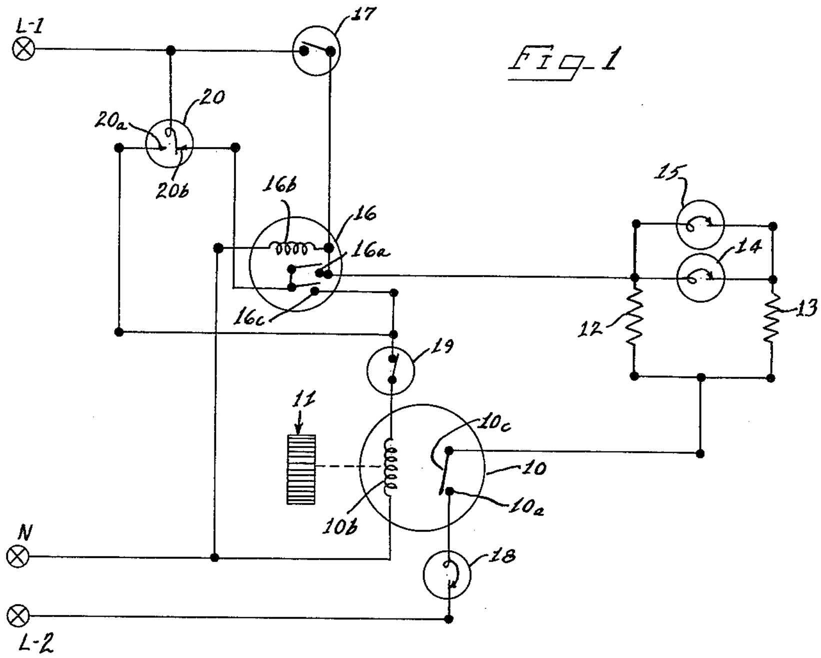

Fig. 1

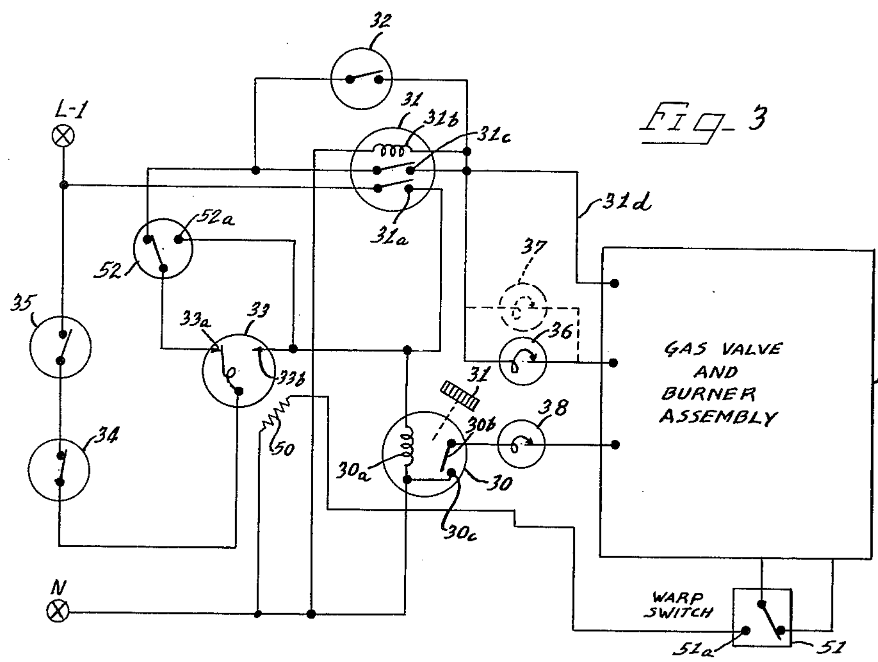

Fig. 3

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Fig-4

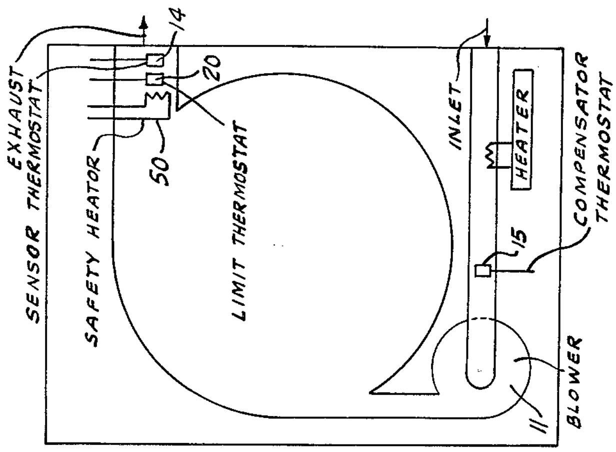
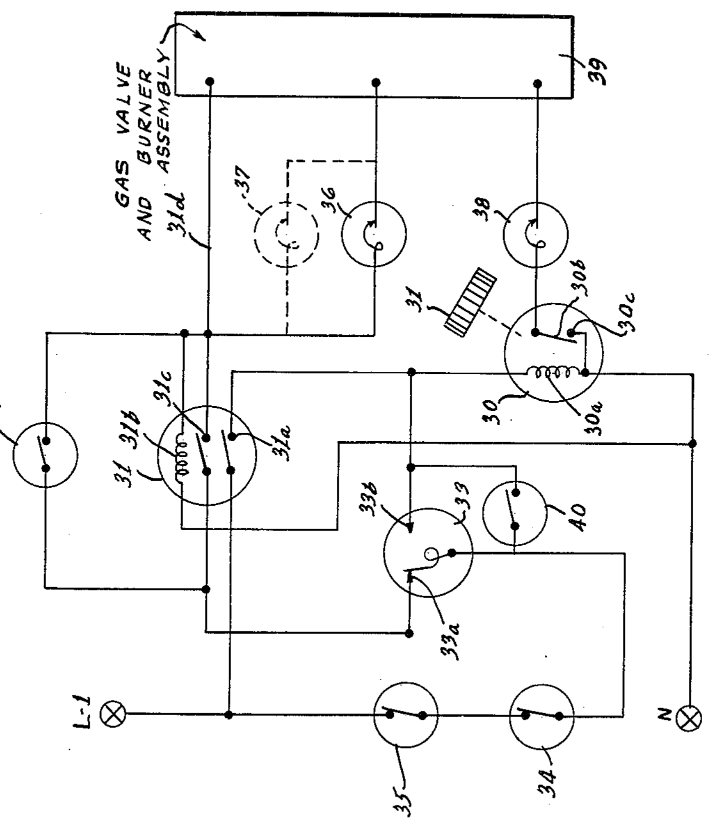


Fig-2



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United States Patent Office

3,203,679
Patented Aug. 31, 1965

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AUTOMATIC CONTROL OF PLURAL HEATERS IN A CLOTHES DRIER

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Filed Oct. 17, 1960, Ser. No. 63,105
8 Claims. (Cl. 263—10)

The present invention relates broadly to a laundry appliance and method therefor, and is especially directed to a dryer control responsive to the change of the dryer exhaust temperature for reducing the thermal energy input when the exhaust temperature exceeds a predetermined point.

It is known that in a drying operation, such as occurs in a clothes dryer, as a particular clothes load becomes dry, a progressively diminishing amount of the heat supplied to the incoming dryer air is converted into latent heat of evaporation of water, while a progressively increasing amount of the incoming heat becomes sensible heat and, therefore, produces a rising exhaust air temperature. It is also known that clothes being dried automatically can withstand more heat while still relatively wet, and further, that the temperature in a dryer reaches maximum near the end or dryest portion of the drying cycle. Therefore, by sensing the exhaust air temperature and controlling the heat input in accordance with the measured temperature, a relatively great amount of thermal energy may be directed to the clothes at the beginning of a drying cycle and a lesser amount near the end thereof, so that there is obtained an efficient and non-harmful drying of the clothes load.

It is accordingly an important aim of the present invention to provide an improved laundry method and appliance which accomplishes the stated objectives.

Another object of this invention lies in the provision of improved control means for a domestic dryer apparatus.

Still another object of the instant invention is to provide a relatively low cost and highly simplified automatic control system for both electrical and gas drying apparatus, and which functions effectively with a wide variety of garment materials and load weights.

A further object of this invention lies in the provision of a dryer control system which effectively operates independent of clock timers.

A still further object of the instant invention is to provide a dryer apparatus and method which operates at a controlled maximum drying temperature, so that there is no overdrying of the materials under treatment and accordingly no staining or browning thereof.

An even further object of the invention lies in the provision of a dryer control system permitting the use of relatively high heat inputs when the clothes are relatively moist, and which reduces the amount of applied heat energy as the moisture content of the clothes is reduced.

Other objects and advantages of the invention will become more apparent during the course of the following description, particularly when taken in connection with the accompanying drawings.

In the drawings, wherein like numerals designate like parts throughout the same:

FIGURE 1 is a circuit diagram illustrative of one dryer control system embodying the novel concepts of this invention;

FIGURE 2 is a circuit diagram illustrative of another dryer control system featuring the teachings of this invention; and

FIGURE 3 is a diagram showing a portion of circuitry representative of one modification of the circuit diagram of FIGURE 2;

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FIGURE 4 is a schematic view illustrating a drying chamber with circulating means for air in the chamber, a plurality of thermally responsive means arranged to sense exhaust temperature, a compensator thermostat arranged in the inlet and a heater.

Although the principles of the present invention are of general applicability, a particularly useful application of the disclosures herein made, involve the drying of clothes in a domestic clothes dryer. It will be understood, however, that the inventive subject matter may be applied with equal facility to other forms of drying apparatus.

Drying is the removal of an evaporable fluid, usually water, which may be accomplished by heating the wet material to a temperature above that corresponding to the vapor pressure of the surrounding atmosphere, or by reducing the vapor pressure of the surrounding atmosphere below the vapor pressure of the liquid in the material to be dried.

Changing a substance to a vapor state is a process called vaporization, a term which includes boiling and sublimation, as well as evaporation, which is a conversion of liquid to the vapor state that occurs only at the surface of the liquid.

Evaporation occurs at all temperatures and continues until the liquid disappears, or until the space surrounding the liquid has become saturated with vapor. In the process of evaporation, a liquid is gradually transformed to a vapor by loss of molecules at its surface. The molecules of a liquid are regarded as in a state of continual, but disordered motion, moving about in all directions and with various speeds. In this motion there will be instances where a molecule is approaching the liquid surface with a sufficient velocity to carry it beyond the range of attraction of the surface molecule; this molecule then leaves the liquid and becomes a molecule of vapor.

The rate of evaporation of free moisture to be removed from a batch of materials such as clothes, depends upon the vapor pressure of the moisture in the material corresponding to its temperature and the vapor pressure of the moisture in the air corresponding to its absolute humidity, although it will be appreciated that other factors such as the physical properties of the materials being dried and the movement or flow of the ambient air are also involved. In any event, the rate of evaporation is proportional to the difference in vapor pressure between the liquid in the materials to be dried and that of the liquid in the immediate vicinity of the materials to be dried.

The quantity of heat which must be given to a unit mass of liquid to convert it to vapor without a change of temperature, is called the heat of vaporization.

Thus, in a clothes drying operation, the addition of a predetermined quantum of thermal energy per unit of time to an air stream directed into a drying zone, will either result in the conversion of the free moisture into vapor, and will thus be a measure of the heat of vaporization given to the free moisture on the materials within the drying zone, or the temperature of the drying zone and the materials contained therein will be elevated by direct conduction and convection. Thus, if the addition of thermal energy is terminated, the air stream will cool down at a rate reflecting the evaporative conditions in the drying zone.

In addition, and assuming a relatively constant input of thermal energy to the air stream throughout the drying cycle, when the clothes are relatively wet in the substantially constant drying rate portion of the cycle the major amount of heat input added results in the conversion of the free moisture into vapor, and the minor amount elevates the temperature of the drying zone. On the other hand, as the clothes reach a relatively dry condition in the remaining portion of the drying cycle and contain little free moisture, the major amount of thermal energy added raises the drying zone temperature, while a minor amount of the added heat input is used to convert the liquid to vapor. As a result, when a constant heat input is used throughout the drying cycle, there is not only a waste of thermal energy as the clothes approach dryness and for the remaining portion of the cycle, but as well, a continuance of a constant or uniform heat input to relatively dry clothes frequently results in staining or browning of the load due to the high input temperatures to the clothes load. Further, in many systems the heat input is maintained at a relatively low level in order to avoid overdrying near the end of the drying cycle, and as a result the heat input level when the clothes are relatively wet is much lower than the clothes can actually withstand in their wet condition. This of course unduly prolongs the drying cycle.

In accordance with the principles of this invention, first and second thermostats connected by relay means in control of the machine motor are located in the exhaust air stream. One thermostat, referred to as a sensor thermostat, is in direct control of at least a portion of the heating means, which may be a plurality of resistance elements or a gas valve and burner assembly having two or more heat input levels, while the second thermostat, referred to as a limit thermostat, in the exhaust air stream is of the two, or hot and cold, position type.

In one embodiment of the invention, a manual momentary make switch connects with the relay coil means, and closing of the momentary make switch contacts energizes the relay to start the drive motor and to complete a circuit to the heating means and the sensor thermostat through the "cold" contact of the two position limit thermostat and the contacts of the relay. With all heating elements energized or the gas burner at maximum output, clothes drying continues until the exhaust air temperature reaches the pre-set reading of the sensor thermostat, whereupon at least one heating element is deenergized or the gas burner output stepped down. As the clothes become progressively more dry under this reduced heat input, the exhaust air temperature rises, indicative of the fact that a lesser amount of the thermal energy in the incoming dryer air is converted into latent heat of vaporization of water in the clothes. The increasing exhaust air temperature causes the two, or hot and cold, position limit thermostat to switch from the cold to the hot position, which deenergizes the relay means to open the circuit to the heating elements or gas valve and burner assembly. The machine motor remains in operation by being energized through the hot contact in the two position or limit thermostat, until this thermostat senses a predetermined lower exhaust air temperature and returns to its cold position. Since the relay means is deenergized, the circuit to the drive motor is now open and all operation ceases. The circuit can then only be completed by again actuating the momentary make switch.

The "timerless" control system described may incorporate therein a compensator thermostat located in the inlet air stream in electrical parallel with the sensor thermostat. The compensator thermostat is effective to maintain a higher heat input, as by keeping all heating elements in operation, if there exists either a low ambient, a low voltage, a high air flow or a predominant combination thereof. The compensator thermostat senses the air temperature before it enters the drying chamber, although it is of course appreciated that the compensator thermostat is not required in all applications.

The control system of this invention can further embody switch means by-passing the limit or two position thermostat, in order to energize the machine motor independent of the limit thermostat without energizing the heating means. In this manner, the clothes can be tumbled without the addition of thermal energy thereto. As well, the novel control system herein disclosed as used for gas drying can incorporate heating means to actuate the limit thermostat to its hot position for automatically shutting off power to the gas valve and eventually deenergize the entire machine if an ignition failure occurs. Various other novel aspects of this invention will be noted and will become apparent during the course of the description now to follow.

It will be appreciated that the principles of the instant invention are of general applicability, however, a particularly useful application of the present novel concepts may be made, as has been stated, to a domestic clothes dryer such as is customarily referred to as a home laundry appliance. Moreover, the improvements of the instant invention are adaptable for use with an automatic dryer control comprising components and circuitry which, in some respects, are essentially conventional. For example, it is contemplated that the present invention would be utilized in a domestic dryer of the type utilizing a machine motor shown in FIGURE 1 at **10** used for rotatively driving a tumbling drum (not shown) and a diagrammatically illustrated air translating means **11** such as a blower, which moves air through the drum providing a treatment zone wherein a batch of wet clothes are to be dried.

In the form of the invention shown in FIGURE 1, a a pair of heating means **12** and **13** are provided, and illustratively each heating element may have a rating of 2800 watts, although obviously both the rating and the number of heating elements may be widely varied. Further, as will be noted in connection with FIGURES 2 and 3, the heating means may take the form of a gas valve and burner assembly having a variable output.

The heating elements **12** and **13** are connected in parallel, and bridging the heating elements is a sensor thermostat **14** located in the exhaust air stream. The sensor thermostat **14** may be of the conventional SPST disc type or of the "rod and tube" type and is a commercially available component. The sensor thermostat **14** may be constructed with different set temperatures built therein, and illustratively the control temperature may be 145° using only the two heating elements **12** and **13**. It is desirable that the sensor thermostat **14** reclose at 142° or 143°.

Connected in parallel with the sensor thermostat **14** is a compensator thermostat **15**, located in the inlet air stream and being of the SPST disc type. As will be later noted, the compensator thermostat **15** is not at all times required, although its use is desirable in order to compensate for voltage, air flow and ambient variations. The opening value of the compensator thermostat **15** would be dependent on its exact location in the inlet air stream to the drying chamber.

The heating elements **12** and **13**, sensor thermostat **14** and compensator thermostat **15** are connected to contact **16*a*** of relay means **16**, which may take the form of a DPST relay with a 115 volt pilot coil **16*b*** therein. The relay means **16** is in circuit with a start switch such as a momentary push-to-start switch **17**, desirably taking the form of a manual SPST momentary make switch. The start switch **17** receives power through line L–1, and as will be shortly described, actuation of the start switch energizes the coil **16*b*** of relay means **16** causing relay contacts **16*a*** and **16*c*** to close.

A second power line L–2 connects with contact **10*a*** of centrifugal switch **10*c*** of the machine motor **10**, and in the line L–2 is a safety thermostat **18** of the SPST disc type, which is normally closed and opens in the presence of abnormally high temperatures to break the circuit to the heating elements **12** and **13**.

A ground line N connects with the winding **10*b*** of the drive motor, and in circuit with this winding is a door switch **19** which closes when the dryer loading door is closed. It may be observed from FIGURE 1 that the door switch **19** is connected to contact **16*c*** of the relay means **16**, and is also in circuit with contact **20*a*** of a limit thermostat **20**. The limit thermostat **20** is positioned in the exhaust air stream and is of the SPDT disc or of the "rod and tube" type. In the embodiment shown, the contact 20*a* of the limit thermostat 20 is the "hot" contact, and contact 20*b* is the "cold" contact.

The operation of the "timerless" control system illustrated in FIGURE 1 may be described as follows. With the door switch 19 closed and the limit thermostat 20 in its normal cold position 20*b* as shown, the start switch 17 is depressed momentarily to energize the coil 16*b* of the relay means 16. Energization of the relay coil 16*b* closes relay contacts 16*a* and 16*c* and completes one branch of the circuit through the contact 16*a* to the heating elements 12 and 13, sensor thermostat 14 and compensator thermostat 15, and a second circuit through the relay contact 16*c* through the closed door switch 19 to the drive motor winding 10*b*. When the motor 10 approaches its operating speed, centrifugal switch arm 10*c* closes against contact 10*a* to complete the circuit from the safety thermostat 18 through the drive motor centrifugal switch to the heating elements 12 and 13, placing the heating elements across lines L–1 and L–2.

As the clothes drying operation proceeds with an increasing total amount of moisture being removed, a greater amount of the heat input is in the form of sensible heat, rather than being used to convert the moisture into latent heat of vaporization. When the exhaust air temperature reaches the trigger temperature of the sensor thermostat 14, this thermostat opens to remove the heating element 13 from the circuit neglecting at the present time compensator thermostat 15. If the load is dry or almost dry when sensor thermostat 14 opens, the exhaust air temperature with only element 12 energized will continue to rise, but at a decreased rate, under average drying conditions to the temperature necessary to switch the limit thermostat 20 from contact 20*b* to contact 20*a*. If, however, a considerable amount of moisture is still present in this load at the time the sensor thermostat 14 opens, the temperature of the exhaust air will decrease with only element 12 energized until the closing temperature of the sensor thermostat 14 is reached thus again energizing both elements 12 and 13. This process continues until enough moisture is removed whereby the exhaust air temperature will continue to rise with only element 12 energized.

The limit thermostat 20 is set to move from its cold 20*b* to hot 20*a* position at a temperature somewhat above the operating temperature of the sensor thermostat, and illustratively the limit thermostat may switch from cold contact 20*b* to hot contact 20*a* at 150° F. When this occurs, the relay coil 16*b* is deenergized opening relay contacts 16*a* and 16*c* to open the circuit to the single energized heating element 12. The heating elements 12 and 13 cannot be energized without again actuating the start switch 17.

At this point it will be observed that deenergization of the relay coil 16*b* by the limit thermostat 20 causes the drive motor 10 to be energized through hot contact 20*a* of the limit thermostat 20. As the exhaust air temperature then decreases by reason of no heat input from the heating elements 12 and 13, the limit thermostat 20 will move from hot contact 20*a* to cold contact 20*b* at a predetermined temperature to deenergize or open the entire circuit, shutting off the drive motor 10. This time between the opening of contact 20*b* to its closing is effective as a cool down period.

The compensator thermostat 15, if used in the dry control circuit of FIGURE 1, is positioned in the air inlet stream to the load being dried and is influenced by the source of heat input. The temperature that this normally closed thermostat 15 senses is directly affected by the ambient air temperature, the flow rate of the air stream through the dryer, and the quantity of heat being supplied by the heat source. It is desirable to choose an opening value for thermostat 15 such that if the combination of drying variables present (ambient air temperature, air flow, and heat input) produce normal input and exhaust air stream temperatures, the thermostat 15 will open such that when sensor thermostat 14 opens the dry cycle will proceed under the operation of element 12 only, as previously explained.

If, however, the compensator thermostat 15 senses a combination of drying variables that give inlet and exhaust air stream temperatures considerably below thermal (low ambiant air temperatures, high air stream flow rate, and low heat input due to low voltage or poor gas quality each tend to produce below normal conditions), the compensator thermostat 15 will not open and when sensor thermostat 14 opens, heating element 13 will remain energized through thermostat 15. The dry cycle will continue as previously explained only with both heating elements 12 and 13 energized.

Since a combination of drying variables that give below normal inlet and exhaust air stream temperatures also result in the load being drier when the sensor thermostat 14 first opens than with normal drying conditions present, the action of the compensator thermostat 15 is very desirable since it operates under these conditions to shorten the time period between the opening of the sensor thermostat 14 to the switching of the limit thermostat from its cold 20*b* to its hot 20*a* position. The thermostat 15 also operates as a safety device in the presence of extremely low inlet and exhaust air stream temperatures in that if the dry cycle were allowed to continue under one heating element operation after sensor thermostat 14 opened there is a possibility that the exhaust air stream temperature would drop, and the one operating heating element would not be able to heat the air to the value necessary to operate limit thermostat 20, thus the dry cycle would continue indefinitely. The thermostat 15 would prevent one heating element operation under these drying conditions and eliminate this possibility.

It should be readily apparent from this description that a similar result would be produced if compensator thermostat 15 were connected to a third heating element (not shown) rather than being connected to heating element 13.

Even though, as earlier explained, the compensator thermostat is not basic to the control system of FIGURES 1, 2 and 3, its usage does give these control systems the versatility they need to be used in mass produced domestic machines that are exposed to the complete extremes of the very important drying variables. Most automatic dry control systems fail because they are not versatile.

It has been noted hereinabove that the instant "timerless" control system is also of important application with gas as well as electric dryers to reduce the thermal energy input as the moisture content of the clothes decreases. In common with the described system of FIGURE 1, the control systems of FIGURES 2 and 3 are provided with commercially available components connected in a novel manner to produce continuously reliable and accurate results. In addition, as will be later described, the systems of FIGURES 2 and 3 may include switch means to permit the operator to manually control the dryer for tumble and air with no heat, and as will be noted during the description of FIGURE 3, there may further be incorporated in the control system heater means acting upon the limit thermostat to assure that the entire dryer operation will be terminated if a failure of gas ignition occurs.

Referring now to FIGURE 2, there is shown a machine motor 30 for driving a tumbling drum (not shown) and a diagrammatically illustrated air translating means 31, such as a blower. A ground line N is connected to the winding 30*a* of the drive motor 30, and when the motor 30 approaches running speed it actuates contact arm 30*b* of the motor centrifugal switch against contact 30*c*.

The opposite side of the motor winding 30*a* is connected to contact 31*a* of relay means 31 having a coil 31*b*. It may be seen that one side of the coil 31*b* connects to the ground line, while the opposite side of the coil leads to a start switch 32, which in the manner of FIGURE 1, may be a manual SPST momentary make switch.

The start switch, on the other hand, connects to "cold" contact 33*a* of a limit thermostat 33 located in the exhaust air stream, and being of the SPDT disc type as in FIGURE 1. The limit thermostat 33 receives power from line L–1, and in this embodiment it may be noted that there is included a stop switch 34 and door switch 35, the stop switch being normally closed and in control of the complete circuit so that all components may be deenergized if so desired.

It may be observed from FIGURE 2 that cold contact 33*a* of limit thermostat 33 leads to contact 31*c* in the relay means 31. The relay contact 31*c* further connects with a sensor thermostat 36 of the normally closed type, and which may be provided by a SPST disc type or a "rod and tube" type thermostat, as was described in connection with FIGURE 1. The sensor thermostat 36 is located in the exhaust air stream and has a pre-set trip temperature built therein, which as earlier noted may be about 145° F. for 5600 watt operation as shown in FIGURE 1 or 160° F. for 37,000 B.t.u. per hour gas operation as shown in FIGURE 2. As in FIGURE 1, there is provided in the control system of FIGURE 2 a compensator thermostat 37 connected in parallel across the sensor thermostat 36, although as was also earlier noted, the compensator thermostat is not required in all applications. However, when employed, the compensator thermostat is positioned in the inlet air stream, and may be provided by a SPST disc type member.

Connecting with the drive motor 30 centrifugal switch contact 30*c* is a safety thermostat 38, and lines from the safety thermostat 38, sensor thermostat 36 and relay means 31 and start switch 32 are connected to a gas valve and burner assembly, generally designated by the numeral 39 and indicated only diagramatically since such gas valve and burner assemblies are conventional structures, the details of which are very well known to those versed in the art. In the instant embodiment, the valve and burner assembly 39 is of the two level type, although obviously a different number of levels of thermal energy output can be provided therein.

It may in certain circumstances be desired to tumble the clothes without adding heat energy thereto, and for this purpose in the control system of FIGURE 2 a fluff switch 40 bridges the limit thermostat 33 to provide power to the drive motor 30 and blower 31 without actuating the heating means 39.

The "timerless" control system of FIGURE 2 operates generally in the manner of the system of FIGURE 1, and accordingly only a brief summary of its operation will be undertaken. As appears in FIGURE 2, closing of the door switch 35 and depressing the monetary make switch 32 completes a circuit through the stop switch 34 and limit thermostat cold contact 33*a* to the relay means 31, energizing the coil 31*b* to actuate the contacts 31*a* and 31*c*, the latter contact completing one branch of the circuit through the sensor thermostat 36 to the gas valve and burner asseembly 39, while the relay contact 31*a* completes the other branch of the circuit, energizing the drive motor winding 30*a* to close centrifugal contact arm 30*b* against contact 30*c* to complete a circuit for the energization of the gas valve and burner assembly to add a relatively high amount of thermal energy to the tumbling drum.

As the drying operation proceeds, the clothes become dry and there is less refrigeration effect, so the exhaust air temperature rises. When this temperature reaches the pre-set or trigger point of the sensor thermostat 36, the thermostat opens, stepping down the level of heat output by deenergizing a gas valve in assembly 39. If at this time the clothes are sufficiently dry to allow the lesser heat input from assembly 39 as energized through line 31*d* to maintain the exhaust temperature high enough to prevent re-setting of the sensor thermostat 36, the drying continues at this lowered input. In the case of small loads, the 160° temperature may have been reached prematurely due to by-passing of input to the exhaust, and if so, the reduced input appears quickly in the exhaust, and the sensor thermostat 36 re-sets to provide a full input.

In normal circumstances, however, the sensor thermostat 36 steps down the heat input, and with this condition, the exhaust temperature continues to increase until the limit thermostat 33 moves from its cold position 33*a* to its hot position 33*b*, as described in connection with FIGURE 1, and when the "hot" contact 33*b* is actuated, the relay coil 31*b* is deenergized, opening contacts 31*a* and 31*c* which removes all heat input. The drive motor 30, however, is now energized through hot contact 33*b* of the limit thermostat 33, and this will continue to be the case until the exhaust air temperature drops during the cool down and moves from its hot position 33*b* to its cold position 33*a*, breaking the circuit to the drive motor 30 to stop said motor.

The compensator thermostat 37 in FIGURE 2 functions in the manner of the thermostat 15 in FIGURE 1, and accordingly no further description thereof is believed to be necessary. However, as was stated, the compensator or thermostat is not required in all applications, although its use is desirable if it is anticipated that there may be low ambient, low voltage or high air flow conditions.

The circuit illustrated in FIGURE 3 differs principally from that of FIGURE 2 by its inclusion of heater means 50 positioned to superficially heat the limit thermostat 33 and connected at one side to the ground line N and at its opposite side to warp switch means 51 in the gas valve and burner assembly 39. As is known in the art such assemblies conventionally incorporate therein a warp switch which opens in the event of a failure of the gas to ignite, the warp switch thereupon closing the gas supply valve to block any further flow of gas to the burners. In the system of FIGURE 3, the conventional warp switch is provided with a second contact 51*a* leading to the heater means 50, so that when the warp switch 51 opens heater 50 is energized and the limit thermostat 33 is superficially heated to its hot position 33*b*, deenergizing the relay coil 31*b* which in turn deenergizes contacts 31*a* and 31*c* to shut off power to the gas valves in the assembly 39 also deenergizing heater 50. The drive motor 30 continues to function, and accordingly, when the limit thermostat returns to its cold position 33*a* the circuit to the drive motor 30 is broken and the entire machine is then deenergized.

It may be observed that in the "timerless" control system of FIGURE 3 a SPDT fluff switch 52 is provided. This prevents any momentary energization of the relay means 31 and gas valves in the assembly 39 when the fluff switch is in the fluff position 52*a*, and as well, the fluff switch 52 as thus located in the circuit prevents starting a normal dry cycle while a non-heated air tumble is in process. In the embodiment shown in FIGURE 2 it would be possible during a fluff cycle to energize the gas valve assembly 39 by depressing start button 32.

In other respects the control systems of FIGURES 2 and 3 correspond one to the other, and accordingly, like numerals from FIGURE 2 have been applied to FIGURE 3.

There has been discussed in the preceding paragraphs various changes and modifications which can be effected in the dryer control system of this invention, and it is believed apparent therefrom that numerous variations can be practiced without departing from the novel concepts of this invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a dryer operable through a drying cycle and having means forming a drying chamber, a plurality of independently operable heating means for evaporating moisture from articles placed within said chamber, a drying control circuit including said heating means, relay means in said circuit, switch means in said circuit in control of

said relay means, drive means in said circuit for controlling the circulation of air through said drying chamber, and a plurality of thermally responsive means in said circuit located to sense the temperature of exhaust air from said chamber and operable upon sensing a first temperature of exhaust air to first deactivate at least one of the heating means to provide a reduced thermal input to the articles under normal operating conditions and operable upon sensing a second temperature of exhaust air to then deactivate said relay means and drive means, terminating the drying cycle.

2. In a dryer operable through a drying cycle and having means forming a drying chamber, a plurality of independently operable heating means for evaporating moisture from articles placed within said chamber, a drying control circuit including said heating means, relay means in said circuit, switch means in said circuit in control of said relay means, first thermally responsive means in said circuit located to sense a first temperature of exhaust air from said chamber and operable to deactivate at least one of the heating means to provide a reduced thermal input to the articles, and a second thermally responsive means in said circuit located to sense a second and relatively higher temperature of exhaust air and operable to deactivate said relay means and the remaining heating means.

3. In a dryer operable through a drying cycle and having means forming a drying chamber, a plurality of independently operable heating means for evaporating moisture from articles placed within said chamber, a drying control circuit including said heating means, driven means in said circuit for controlling the circulation of air through said drying chamber, relay means in said circuit connected to said heating means and to said drive means, switch means in said circuit in control of said relay means to energize said heating means and said drive means, a sensor thermostat located in the exhaust air stream and sensing a first temperature of exhaust air from said chamber and operable to deactivate at least one of the heating means to provide a reduced thermal input to the articles, and a limit thermostat located in the exhaust air stream and sensing a second temperature greater than said first temperature to deactivate the remaining heating means when said second temperature is reached and operable to thereafter deactivate the drive means when the exhaust air temperature drops below said second temperature.

4. In a dryer operable through a drying cycle and having means forming a drying chamber, a plurality of independently operable heating means for evaporating moisture from articles placed within said chamber, a drying control circuit including said heating means, relay means in said circuit, switch means in said circuit in control of said relay means, first thermally responsive means in said circuit located to sense a first temperature of exhaust air from said chamber and operable to deactivate at least one of the heating means to provide a reduced thermal input to the articles, a second thermally responsive means in said circuit located to sense a second and relatively higher temperature of exhaust air and operable to deactivate said relay means and the remaining heating means, and a third thermally responsive means in said circuit located in the inlet air stream downstream of said heating means and detecting the temperature of said inlet air stream to compensate for variations in rate of air flow and heat input to said drying chamber and variations in ambient air temperature by maintaining more than a single heating means in operation after actuation of said first thermally responsive means.

5. In a dryer operable through a drying cycle and having means forming a drying chamber, a plurality of independently operable heating means for evaporating moisture from articles placed within said chamber, a drying control circuit including said heating means, drive means in said circuit for controlling the circulation of air through said drying chamber, relay means in said circuit connected to said heating means and to said drive means, switch means in said circuit in control of said relay means to energize said heating means and said drive means, a sensor thermostat located in the exhaust air stream and sensing a first temperature of exhaust air from said chamber and operable to deactivate at least one of the heating means to provide a reduced thermal input to the articles, and a two position limit thermostat located in the exhaust air stream and having a first and relatively lower temperature position connected to said relay means and a second and relatively higher temperature position by-passing said relay means and connected to said drive means, said limit thermostat being operable when said second temperature is reached to deactivate said relay means and all remaining heating means, and when said first limit temperature is again reached to deactivate said drive means.

6. In a dryer operable through a drying cycle and having means forming a drying chamber, a plurality of independently operable gas-fired heating means for evaporating moisture from articles placed within said chamber, a drying control circuit including said heating means, relay means in said circuit, switch means in said circuit in control of said relay means, drive means in said circuit for controlling the circulation of air through said drying chamber, a sensor thermostat located in the exhaust air stream and sensing a first temperature of exhaust air from said chamber and operable to deactivate at least one of said heating means to provide a reduced thermal input to the articles, a two position limit thermostat located in the exhaust air stream and having a first and relatively lower temperature position connected to said relay means and a second and relatively higher temperature position bypassing said relay means and connected to said drive means, said limit thermostat being operable when said second temperature is reached to deactivate said relay means and remaining heating means, and when said first temperature is again reached to deactivate said drive means, and a heater located to superficially heat said limit thermostat and connected to said gas-fired heating means, said heater being energized if the gas-fired heating means fails to operate to move said limit thermostat from its first to its second temperature position to deenergize said relay means, all of said heating means and said heater, and said limit thermostat deenergizing said drive means upon cooling to said first temperature.

7. In a clothes dryer, a circuit to control the drying process of articles to be dried in said clothes dryer comprising, a plurality of heating means, air translation means for forcing a stream of air through said clothes dryer, first temperature responsive switch means in said circuit controlling the energization of at least one of said heating means, second temperature responsive switch means in said circuit controlling the energization of all of said heating means, said first temperature responsive means being effective upon the sensing of a first elevated exhaust air stream temperature in said dryer to deenergize said one heating means and said second temperature responsive means being effective upon the sensing of a second elevated exhaust air stream temperature higher than said first elevated temperature in said dryer exhaust air stream to deenergize all of said heating means to denergize said air translation means at a temperature lower than said second elevated exhaust air stream temperature.

8. In the invention of claim **7** in which said dryer is provided with an air inlet and an air outlet through which said air stream is passed, a third temperature responsive means in said circuit in electrical parallel with said first temperature response means and downstream of said heating means to sense the resultant temperature of the inlet air stream to said dryer due to the influence of the heat input, ambient air temperature, and air stream flow rate to override said first temperature responsive means.

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