United States Patent

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[54] **GAS HEATED AUTOMATIC CLOTHES DRYER WITH THERMISTOR FLAME SENSOR CIRCUIT**
2 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** **263/10,** 34/45, 263/33
[51] **Int. Cl.** **F27b 17/00,** F26b 21/06
[50] **Field of Search** 263/33, 10; 34/45

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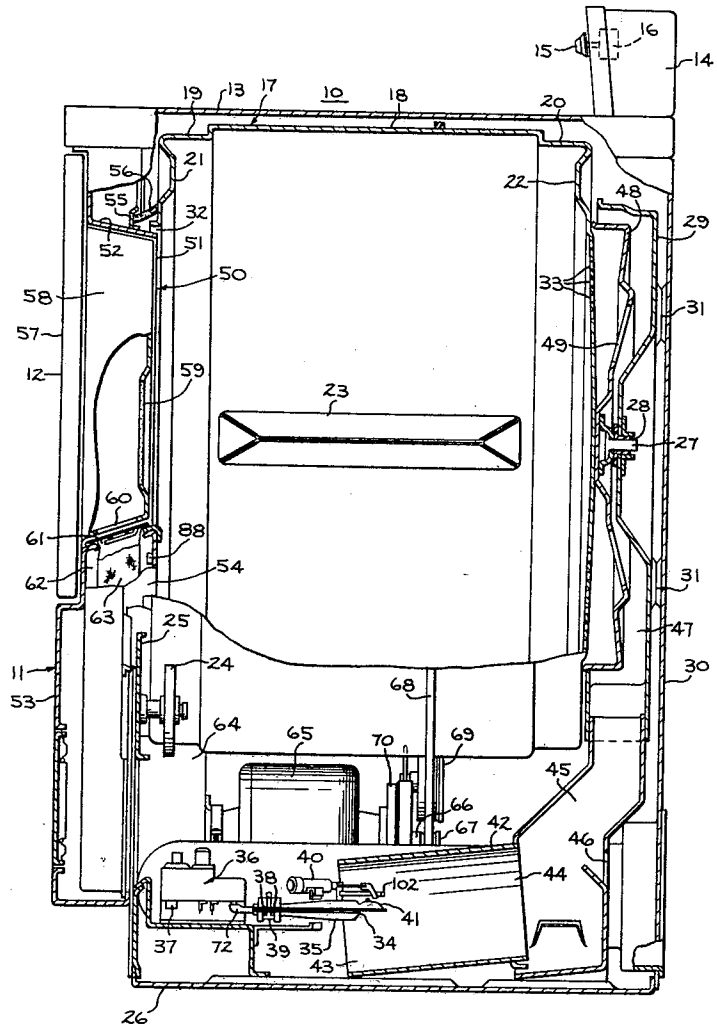
ABSTRACT: A control circuit is provided to control the operation of a gas-heated automatic clothes dryer having a positive temperature coefficient thermistor positioned to sense burning of gas within the burner and to correspondingly control the supply of gas to the burner.

An electrically operated valve for supplying gas to the burner is controlled by a time delay bimetal switch having a bimetal heater in electrical series with the thermistor whereby the output of the bimetal heater depends upon the resistance of the thermistor. The increased resistance of the thermistor in the presence of flame is effective to disable the bimetal heater from opening the bimetal switch thereby maintaining gas flow to the burner, the heater, unless disabled by the thermistor, being effective to open the bimetal switch and deenergize the valve after a predetermined interval, thereby to terminate gas flow to the burner in the absence of flame.



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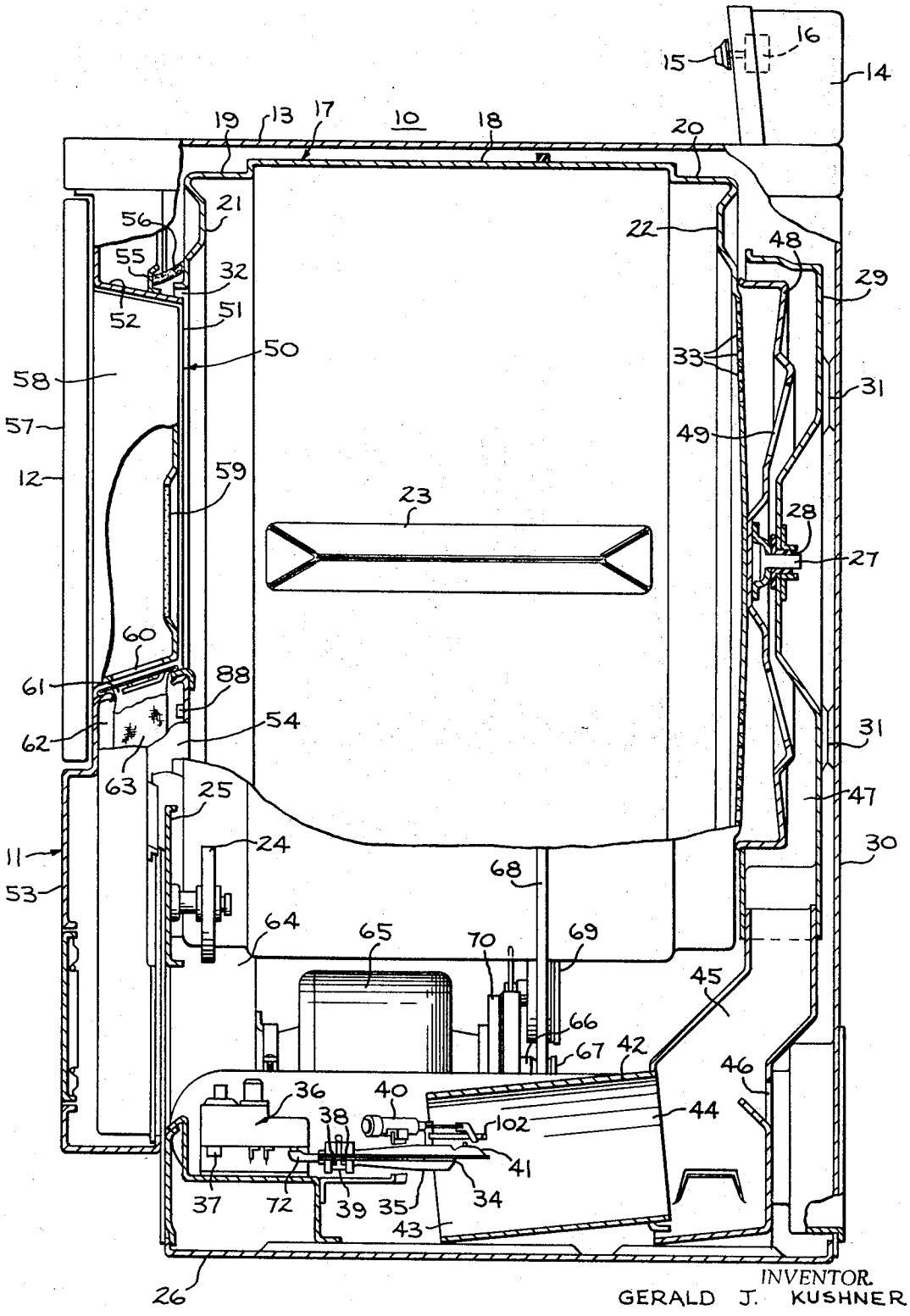

FIG. 1

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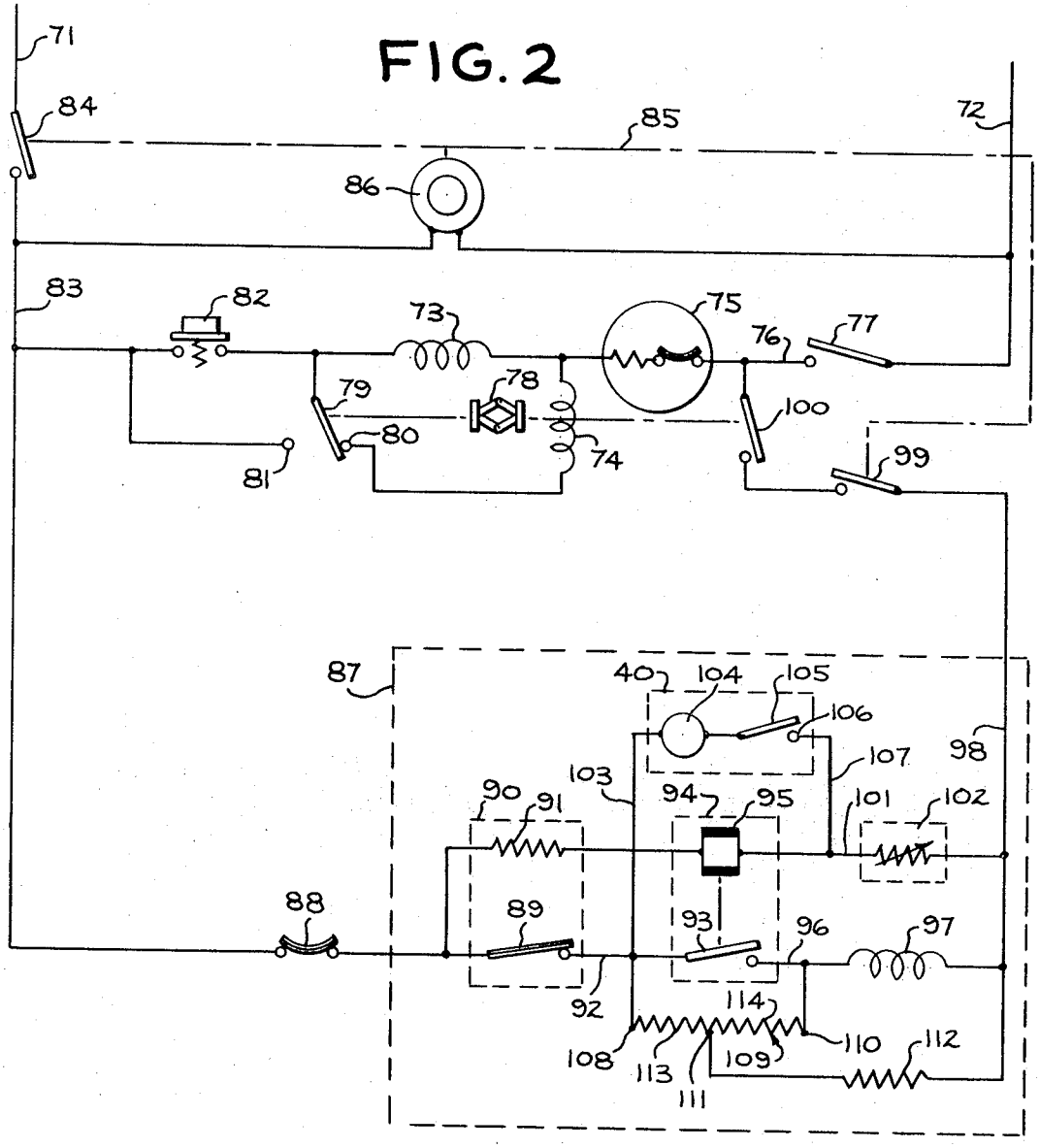
FIG. 2



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GAS HEATED AUTOMATIC CLOTHES DRYER WITH THERMISTOR FLAME SENSOR CIRCUIT

BACKGROUND OF THE INVENTION

This invention relates generally to gas-heated automatic clothes dryers, and more particularly to a control circuit therefor employing a positive temperature coefficient thermistor to sense the presence or absence of flame within the burner and to correspondingly control the supply of gas to the burner.

It is desirable in gas-heated automatic clothes dryers to provide a safety means in the form of a flame detector to sense the presence or absence of burning within the burner and to close a valve in the burner gas supply when no ignition has occurred within the burner after a reasonable period of ignition time. It is also desirable that such a flame detector perform other associated functions in response to the presence of burning within the burner such as terminating the operation of an igniter means. Prior art flame detectors have included various complicated mechanical means, some employing bimetallic elements and the like. However, such mechanical means are expensive to manufacture and frequently difficult to maintain over long periods of use.

It is therefore an object of my invention to provide a gas-heated automatic clothes dryer having a control circuit including a simple and inexpensive flame detector having no moving parts.

It is a further object of my invention to provide a control circuit of the aforementioned type employing a positive temperature coefficient thermistor positioned to sense the presence or absence of burning within the burner and to correspondingly control the supply of gas to the burner.

SUMMARY OF THE INVENTION

Briefly stated in accordance with one aspect of the present invention, there is provided a gas-heated automatic clothes dryer comprising a gas burner assembly adapted to heat a stream of air flowing past the burner assembly, an electrically operated valve for supplying gas to the burner, and a time delay bimetal switch having contacts connected to control the valve. Means including a positive temperature coefficient thermistor and a bimetal heater are provided for controlling the operation of the bimetal switch. The means include a control circuit connecting the thermistor and the bimetal heater in electrical series, whereby the output of the bimetal heater depends on the resistance of the thermistor. The increased resistance of the thermistor in the presence of flame is effective to disable the bimetal heater from opening the bimetal switch thereby maintaining gas flow to the burner. The heater, unless disabled by the thermistor, is effective to open the bimetal switch and deenergize the valve after a predetermined interval, thereby to terminate gas flow to the burner in the absence of flame.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of a clothes dryer suitable for incorporation of the improved control of the present invention therein, the view being partly broken away and partly in section to illustrate details; and

FIG. 2 is a schematic electric circuit diagram illustrating a basic control for the dryer of FIG. 1, incorporating one embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings and initially to FIG. 1 thereof, there is illustrated a domestic automatic clothes dryer 10 including an appearance and protective outer cabinet 11 having a door or closure 12 to provide access to the interior of the cabinet for loading and unloading fabrics. Provided on the top 13 of cabinet 11 is a control panel 14 which may, in a conventional way, include a suitable manual control 15 connected to a control assembly 16 mounted in the panel 14. By manual setting of control 15, the machine may be caused to start and automatically proceed through a cycle operation.

Within cabinet 11, there is provided a clothes tumbling container or drum 17 mounted for rotation on a substantially horizontal axis. Drum 17 is substantially cylindrical in shape, having a center cylindrical wall portion 18, and outer cylindrical wall portions 19 and 20, located respectively adjacent an annular front wall 21 and a circular rear wall 22 of the drum. Wall portions 18, 19 and 20 are imperforate over their entire area so that the outer shell of the drum is imperforate. On the interior surface of wall portion 18 there are a plurality of clothes tumbling ribs 23 so that clothes are lifted up when the drum rotates, and then permitted to tumble back down to the bottom of the drum. The front of the drum 17 may be rotatably supported within outer casing 11 by suitable idler wheels, one of which is indicated by the numeral 24. These wheels are rotatably secured to the top of the member 25 which extends up from the base 26 of the machine. The wheels 24 are disposed beneath the drum, in contact with portion 19, so as to support the portion 19 on each side to provide a stable support.

The rear end of drum 17 receives its support by means of a stub shaft 27 extending from the center of wall 22. Shaft 27 is secured within a bearing 28 formed in a bafflelike structure 29 which, in turn, is rigidly secured to the backwall 30 of the cabinet 11 by any suitable means such as welding at a number of points 31. With the arrangement shown, the drum may rotate on a horizontal axis, with rollers 24 providing the front support and stub shaft 27 within bearing 28 providing the rear support.

In order to provide for the flow of a stream of drying air through the clothes drum, it is provided with a central aperture 32 defined by the wall 21 and a plurality of perforations 33 in the rear wall 22. Perforations 23 in the present case are formed to extend around the rear wall in an annulus. The air provided to the drum is heated by a gas flame which issues from the outlet 34 of a burner 35. Burner 35 receives a regulated supply of gas from a control valve assembly 36, the gas being supplied to the assembly 36 through a supply pipe or conduit (not shown) connected to the assembly inlet 37. Reference is made to the copending Application Ser. No. 759,450 of Mr. F. M. White which is assigned to the assignee of the instant invention and which discloses the details of a valve suitable for use as valve assembly 36. In the conventional way, primary air is drawn into the burner through an inlet opening 38, which is controlled by a shutter 39. The primary air and gas are mixed in the burner and are ignited by means of an igniter generally indicated at 40. The gas flame is then spread out by a spreader 41 formed at the outlet end of the burner. This is located just within a combustion chamber 42 so that secondary air is drawn in through the end 43 of the chamber 42 and is heated to a high temperature.

The outlet end 44 of chamber 42 communicates with an upwardly extending duct 45, which is provided with additional air openings 46 in order to reduce the temperature of the air and gas mixture to an appropriate extent. The heated mixture (hereafter called heated air) then flows upwardly through duct 45 and enters a generally circular heat diffuser chamber 47 formed between the member 29 and a baffle 48, which is rigidly secured to the outer surface of wall 22. Baffle 48 has openings 49 formed therein so that the heated air may flow from the chamber 47 through the openings 49 and perforations 33 into the drum 17.

The front opening 32 of the drum is substantially closed by means of a stationary bulkhead generally indicated by the numeral 50. Bulkhead 50 is made up of a number of adjacent members including the inner surface 51 of the access door 12, a stationary frame 52 formed as a flange on front wall 53 of the cabinet, the inner surface of an exhaust duct formed by the cooperation of member 54 and the front wall 53 of the cabinet, and an annular flange 55 mounted on the frame 52 of the front wall 53. It will be noted that a suitable clearance is provided between the inner edge of aperture 32 and the edge

of bulkhead 50 so that there is no rubbing between the drum and the bulkhead during rotation of the drum. In order to present substantial air leakage through the aperture 32, a suitable ring seal 56 is secured to the flange 55 in sealing relationship with the exterior surface of the drum wall 21.

Central aperture 32, in addition to serving as part of the airflow passage to the drum, also serves as a means whereby clothes or other fabrics may be loaded into and unloaded from the drum. Door 12, whose inner surface forms part of the bulkhead closing the opening, is mounted on cabinet 11 so that when the door is opened fabrics may be inserted into and removed from the drum through the door frame 52. It will be noted that the door includes an outer, flat imperforate section 57 and an inwardly extending hollow section 58, mounted on the flat imperforate section 57 and an inwardly extending hollow section 58, mounted on the flat outer section. Hollow section 58 extends into the door frame 52 when the door is closed, and the door surface 51 which comprises part of the combination bulkhead 50 is actually the inner wall of the hollow section.

The air outlet from the drum is provided by a perforated opening 59 formed in the inner wall 51 of hollow door section 58. The bottom wall section of door 12 and the adjacent wall of door frame 52 are provided with aligned openings 60 and 61, opening 61 providing an entrance to a duct 62 formed by the cooperation of member 54 with front wall 53. A lint trap 63 may be positioned in the exhaust duct 62 within opening 61 and supported by the door frame 52. Duct 62 leads downwardly and communicates with a housing 64. Housing 64 contains a blower (not shown) which is directly driven by motor 65. The blower draws heated air through the duct 63 and then exhausts it from the cabinet 11 through an appropriate duct (not shown).

In addition to driving the blower, motor 65 constitutes the means for effecting rotation of drum 17. In order to effect this rotation, motor 65 is provided with a shaft 66 having a small pulley 67 and also entirely around the wall section 18 of drum 17. The relative circumferences of the pulley 67 and the wall section 18 cause the drum to be driven by the motor at a speed suitable to effect tumbling of fabrics in the drum. In order to effect proper tensioning of the belt 68, a suitable idler assembly 69 is secured to the same support 70 which supports one end of the motor. Thus, air is pulled through the drum and, at the same time, the fabrics within the drum are tumbled. The air is heated by the flame emitted by the burner 35. The heated air passing through the drum causes vaporization of moisture from the clothes, and the vapor is carried off with the air as it passes out of the machine.

Referring now to FIG. 2, there is shown a schematic electric circuit diagram illustrating a basic or simplified control arrangement for the dryer of FIG. 1 and incorporating one embodiment of the present invention. It will be understand that many refinements such as temperature selection means, multiple cycle selection means, and fabric temperature or resistance responsive control means for automatically concluding the operation of the dryer, etc. have not been shown in the circuit of FIG. 2 for the sake of simplicity as they do not form a part of the present invention.

The control circuit includes a pair of conductors 71 and 72 adapted to be connected to a suitable source of electric energy or power. For domestic use this normally will be a 115 volt AC power supply. The main motor 65 of the machine is a single-phase, induction-type motor, having a main winding 73 and a start winding 74, connected at a common end through a conventional motor protector 75 to a conductor 76. The conductor 76 is connected to one side of a door switch 77, which has its other side connected to the supply conductor 72. The door switch is open when the door 12 is open and is closed when the door is closed.

The start winding 74 and the main winding 73 are connected in parallel under the control of a speed responsive device 78 which is responsive to the rotation of the rotor of the motor 65. The speed responsive device 78 controls a switch 79 which is engageable with contacts 80 and 81, being engaged with contact 80 when the machine is at rest and moving into engagement with contact 81 as the motor comes up to speed. Engagement with contact 80 connects the start winding 74 in parallel with the main winding 73, while movement of the switch 79 away from this position opens the start winding. Thus, as the motor comes up to speed the start winding is deenergized and the motor then continues to run on the main winding 73 alone.

Starting of the motor is provided by a manually operable switch 82 which, for instance, in the structure of FIG. 1 may be moved to its closed position by pulling out on the manual control 15. Switch 82 connects the motor to a conductor 83 which, in turn, is connected to the supply conductor 71 through a switch 84. Switch 82 is biased to its open position as shown; however, when the manual control 15 is pulled out, and providing switches 77 and 84 are closed, energization of the motor is provided. Within less than a second, under normal circumstances, the motor 65 comes up to speed so that switch 79 moves from contact 80 and engages contact 81. This forms a bypass around the switch 82 for the main winding 73 and the motor 65 continues to be energized when the manual control 15 is released and switch 82 opens.

As indicated by the dash line 85, the switch 84 is under the control of a timer motor 86. The timer motor may also be connected to the manual control 15 so that rotation of the manual control will cause the timer motor to rotate and thus close the switch 84 to provide power to the control circuit The operation of the machine is terminated when the timer motor has rotated a sufficient amount to open the switch 84. It will be noted that the timer motor is connected on one side to the conductor 83 and on the other side to the conductor 72 so that it is energized any time the switch 84 is closed.

The control of the gas flow to the burner 35 and its ignition is accomplished by a flow control arrangement generally indicated at 87, which connects through a conventional thermostat 88 to conductor 83. The thermostat 88 is normally closed and is adapted to open in response to a predetermined high temperature and to reclose when the temperature it senses reaches a relatively low level. As shown in FIG. 1, the thermostat 88 is placed in duct 62 so that it senses and responds to the temperature of the air leaving the machine. This air temperature is responsive to the temperature of the fabrics being dried.

From the thermostat 88 one branch circuit extends through the bimetal switch arm 89 of a time delay bimetal switch 90 having a bimetal heater 91, to a conductor 92. The conductor 92 is connected to the switch 93 of a relay 94, which has an actuating coil 95. The other side of the switch 93 is connected by a conductor 96 to one side of a coil 97 for a solenoid within control valve 36. The other side of the coil 97 is connected by a conductor 98 to a switch 99, which also is controlled by the timer motor 86. The switch 99 is connected to the conductor 76 through a switch 100, which is controlled by the speed responsive device 78 so that the switch 100 is closed only when the motor 65 is rotating at operational speed.

From the thermostat 88 another branch circuit extends through the bimetal heater 91 of the time delay bimetal switch 90, the actuating coil 95 of the delay 94, a conductor 101, and a flame sensor 102 to the conductor 98. The flame sensor 102 is positioned as shown in FIG. 1 to sense the ignition of the gas and the air mixture being emitted by the burner 35 and comprises a positive temperature coefficient thermistor having a resistance value proportional to the sensed temperature. Thus as the sensed temperature rises, the resistance of the thermistor rises, causing the voltage across it to increase, thereby sufficiently reducing the current flow through heater 91 and coil 95 to disable these two elements. The bimetal arm 89 of switch 90 is normally closed, as shown; however, after a predetermined period of heating caused by current flow through the heater 91, it will open to deenergize the circuit. This period is designed to be substantially longer than ignition normally takes so that the bimetal switch 90 serves as a safety

device to turn off the flow of gas in the event of a malfunction which prevents ignition.

From conductor **92** another branch circuit extends through a conductor **103** to a motor **104** and then to contacts **105** and **106** of the igniter **40**. A conductor **107** connects the contact **106** to conductor **101**. With this branch circuit, so long as the bimetal switch arm **89** is closed and the resistance of flame sensor **102** is low, the igniter will be energized. The contacts **105** and **106** are biased closed and the motor **104** serves to open them when there is current flow to the igniter **40** causing a spark to be emitted between the contacts. The opening of the contacts also deenergizes the motor **104** so that the contacts are returned to their closed position. This process is repeated to provide sparks at the burner **35** until the gas and air mixture is ignited to increase the resistance of flame sensor **102**, or until the bimetal arm **89** of the bimetal switch **90** opens.

One end terminal **108** of a dropping resistance **109** is connected to the conductor **92** while the other end terminal **110** of the dropping resistance is connected to the conductor **96**. Thus the dropping resistance is connected in parallel with the switch arm **93** of the relay **94**. Intermediate terminal **111** of the dropping resistance is connected to one end of a heater **112** for a bimetal element within valve **36**. The other side of the heater **112** is connected to the conductor **98**. The intermediate terminal **111** divides the dropping resistance into two sections. The first of these **113** extends from the end terminal **108** to the intermediate terminal **111** while the other section **114** extends from the intermediate terminal **111** to the end terminal **110**.

The switch **93** is normally open and is moved to its closed position by current flow through the coil **95**. Thus, at the beginning of operation of the dryer, that is until the resistance of flame sensor **102** has been increased to inactivate the coil **95**, the switch **93** will be closed. When the switch **93** is closed it effectively forms a shunt or a bypass between the end terminals **108** and **110** of the dropping resistance. This effectively shorts out the dropping resistance from the circuit for the coil **97** of the solenoid valve **36** and places the two sections **113** and **114** of the dropping resistance in parallel in the circuit for the heater **112** of the bimetal element element of valve **36**. Then, when the resistance of flame sensor **102** increases in response to ignition of the air and gas mixture, the switch **93** will open. With switch **93** open, the circuit for the coil **97** extends through both sections of the dropping resistance **109** in series and the circuit for the heater extends through the section **113** of the dropping resistance. Thus, initially a high voltage is placed on the coil **97** to open the solenoid valve **36** and a minimum dropping resistance is connected in series with the bimetal heater **112** so that its heating effect will be greater and the bimetal element of valve **36** will quickly open. Then, upon ignition of the air and gas mixture, a large resistance is placed in series with the solenoid coil **97** to drop the voltage applied to it to a lower holding value and greater resistance is placed in series with the bimetal heater so that its heating is reduced and it can be more effectively controlled.

For a typical cycle of operation the user would open the door **12**, load the damp fabrics into the drum **17**, then close the door **12**, which closes switch **77**. The user then would rotate the manual control **15** which rotates the timer **86** to close the switches **84** and **99**. Then, the user would pull out on the manual control **15**, closing the switch **82**. Initially the main motor **65** will start on both the main winding **73** and the start winding **74**. When the moor comes up to speed, the speed responsive device **78** moves the switch arm **79** from contact **80** to contact **81** to disconnect the start winding **74** and to form a connection around switch **82** so that the motor continues to operate on the main winding along when the manual control **15** is released, opening switch **82**.

Until the main motor **65** comes up to speed there can be no gas provided to the machine because switch **100** must be closed by the speed responsive device to complete the circuit for the control arrangement. Once the switch **100** is closed, a circuit is completed through the thermostat **88**, switch arm **89**, switch **93**, and conductor **96** to coil **97**. From coil **97** the circuit extends through the conductor **98**, switch **99**, switch **100**, conductor **76** and the door switch **77** back to the supply conductor **72**. Thus, the coil **97** will be energized so that gas may flow through control valve **36**.

At the same time a circuit is formed from the conductor **92** through the end terminal **108** and dropping resistance section **113** to the intermediate terminal **111** and form the conductor **92** through the switch **93**, end terminal **110** and dropping resistance section **114** to the intermediate terminal **111**. From intermediate terminal **111** the circuit extends through the bimetal heater **112** to the conductor **98**. Thus, the bimetal heater **112** is energized with a minimum dropping resistance connected in series with it (resistor sections **113** and **114** being in parallel) so that its heating effect is greater than normal and the bimetal switch within valve **36** quickly opens, allowing gas to flow to the burner **35**.

The circuit for the igniter **40** is completed from the conductor **92** through the conductor **103**, motor **104**, contacts **105** and **106**, and conductor **107** to the conductor **101**. From conductor **101** it extends through the flame sensor **102** to conductor **98**. The igniter causes a repeating spark to occur which will ignite the air and gas mixture flowing through burner **35**.

Until ignition occurs, a circuit is complete from the thermostat **88** through the bimetal switch heater **91** and coil **95** of the relay switch **93** to be closed and the bimetal switch arm **89** to be heated. Once the igniter has caused the air and gas mixture to ignite, the resistance of flame sensor **102** quickly increases. This disables the igniter **40**, the heater **91** and the coil **95**, causing switch **93** to open so that the circuit for the solenoid coil **97** now extends from the conductor **92** through the dropping resistance **109** to the coil **97**. Solenoid valves normally require a relatively large voltage to be applied to a coil in order to initially overcome the biasing spring and open the valve. However, once the valve is open, a lower voltage will effectively hold it open and such lower voltage reduces the heating effect on the valve. By use of the dropping resistance **109** and the switch **93** such an operation is provided. The energizing circuit for the bimetal heater **112** now extends from the conductor through the end terminal **108** and dropping resistance section **113** to the intermediate terminal **111** and then to the heater. Thus, the effective resistance connected in series with the heater **112** has been increased. The resultant heating of the bimetal element within valve **36** is thus reduced from the initial high level for causing quick opening of the valve **36** to a lower level appropriate for maintaining the valve open.

The dryer continues in operation with the flame from the burner heating the air drawn through the dryer to evaporate the moisture from the fabrics. When the upper operating temperature is reached thermostat **88** will open. This deenergizes the valve control circuit and the valve **36** closes to shut off the gas supply. The temperature in the machine begins to fall and when it reaches the reset level, thermostat **88** recloses and reenergizes the valve control circuit. The valve **36** is reopened, as explained above, and the gas is reignited to once again provide heat. This operation continues to provide an average temperature in the machine which is designed to effectively dry the fabrics without overheating them. After a predetermined period of drying the timer motor **86** causes the switch **99** to open. This completely deenergizes the flow control apparatus, then the heat to the dryer is stopped. The main motor continues to run for a relatively brief period of time thereafter so that the fabrics are tumbled while a stream of cool air is drawn through the dryer to reduce the temperature of the fabrics to a comfortable handling level. Then the timer motor causes switch **84** to open, completely deenergizing the control circuit and turning off the machine.

As was previously mentioned, my system is particularly adapted for use in gas heated automatic clothes dryers wherein it is desirable to provide a safety means in the form of a control circuit including a flame detector to sense the

presence or absence of burning within the burner and to correspondingly control such functions as the supply of gas to the burner and the operation of an igniter means. From the foregoing description it should now be apparent that the present invention, by providing a control including a positive temperature coefficient thermistor positioned to sense burning of gas within the burner provides such a flame detector which is simple and inexpensive and which has no moving parts.

As will be evident from the foregoing description, certain aspects of the invention are not limited to the particular details of construction of the example illustrated, and it is contemplated that other modifications, applications or variations will occur to those skilled in the art. It is therefore intended to cover such modifications, applications and variations as do not depart from the true spirit and scope of the invention.

I claim:

!. A gas-heated automatic clothes dryer comprising:

a gas burner adapted to heat a stream of air blowing past said burner;

an electrically operated valve for supplying gas to said burner;

a time delay bimetal switch having contacts connected to control said valve;

means including a positive temperature coefficient thermistor and a bimetal heater for controlling the operation of said bimetal switch; and

said means including a control circuit connecting said thermistor and said bimetal heater in electrical series, whereby the output of said bimetal heater depends upon the resistance of said thermistor, the increased resistance of said thermistor in the presence of flame being effective to disable said bimetal heater form opening said bimetal switch thereby maintaining gas flow to said burner, said heater, unless disabled by said thermistor, being effective to open said bimetal switch and deenergize said valve after a predetermined interval, thereby to terminate gas flow to said burner in the absence of flame.

2. The invention of claim 1 additionally including:

an electrically operated igniter for initiating flame at said burner;

an igniter circuit connected in electrical series with said thermistor and with said time delay bimetal switch for supplying current to said igniter when said bimetal switch is closed and when the resistance of said thermistor is low, whereby said igniter will provide a means of igniting the gas flow at said burner during the period of the time delay of said bimetal switch and will be disabled by said thermistor when said thermistor senses flame within said burner.