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HUMIDITY SENSING CONTROL FOR A CLOTHES DRIER

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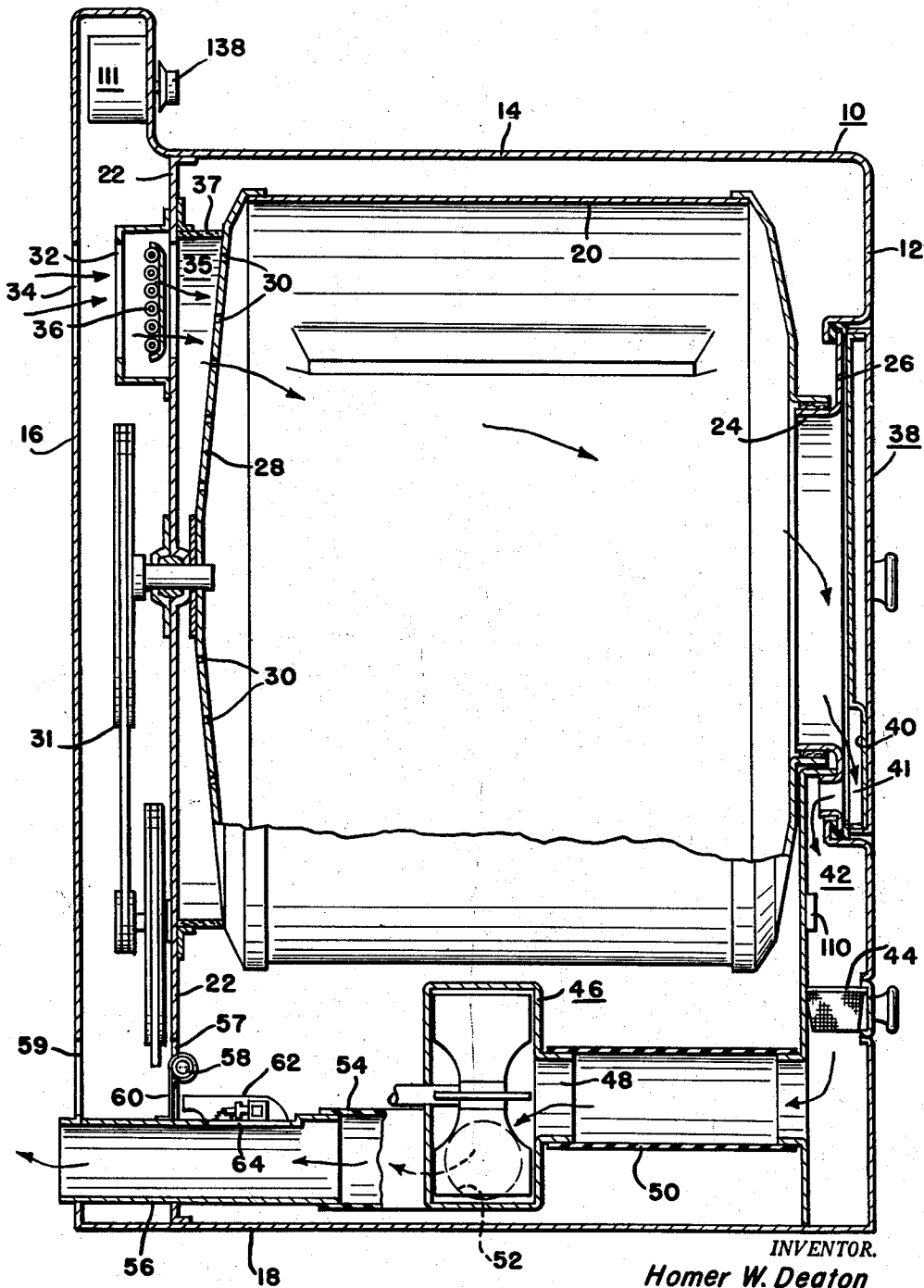


Fig. 1

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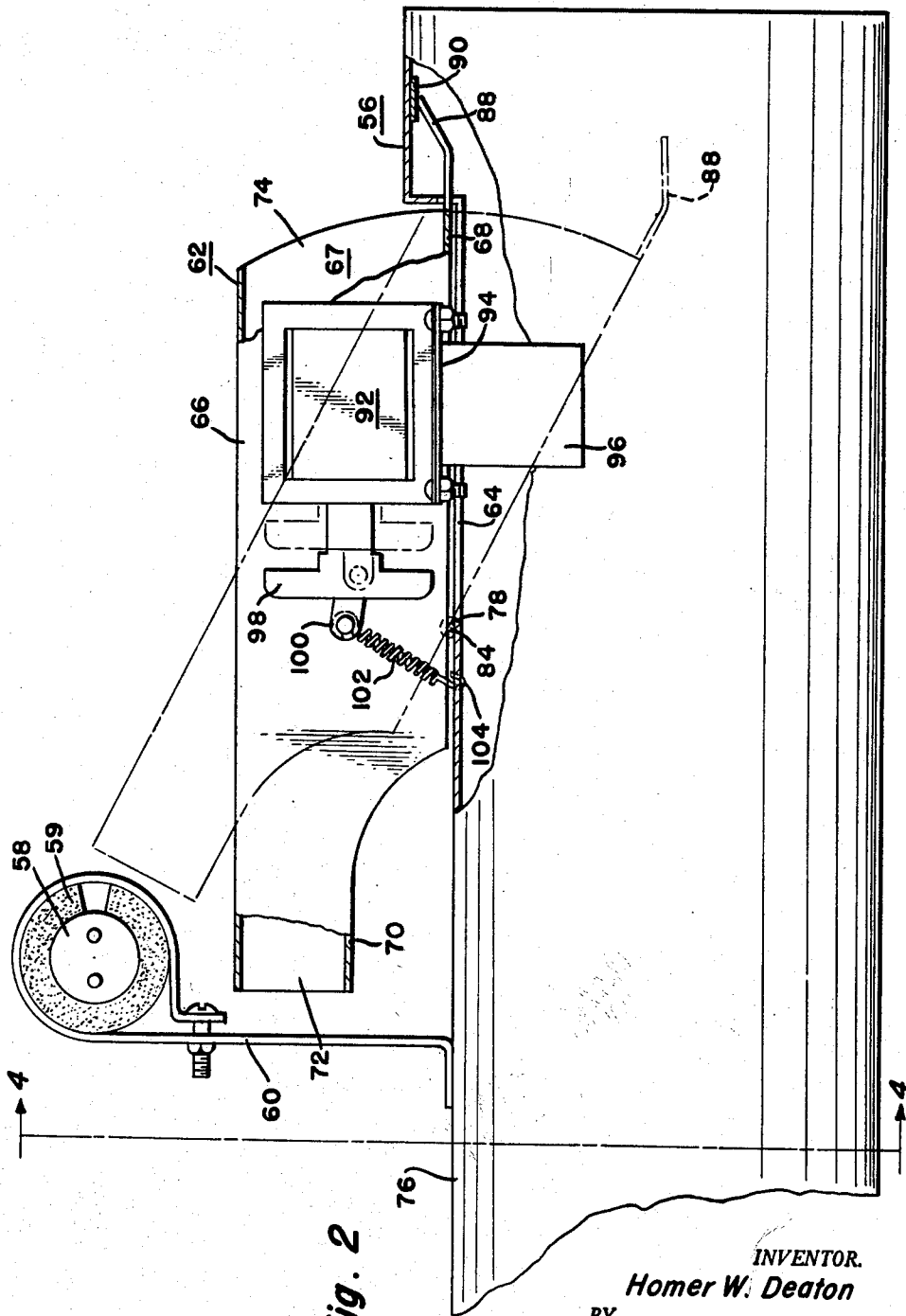


Fig. 2

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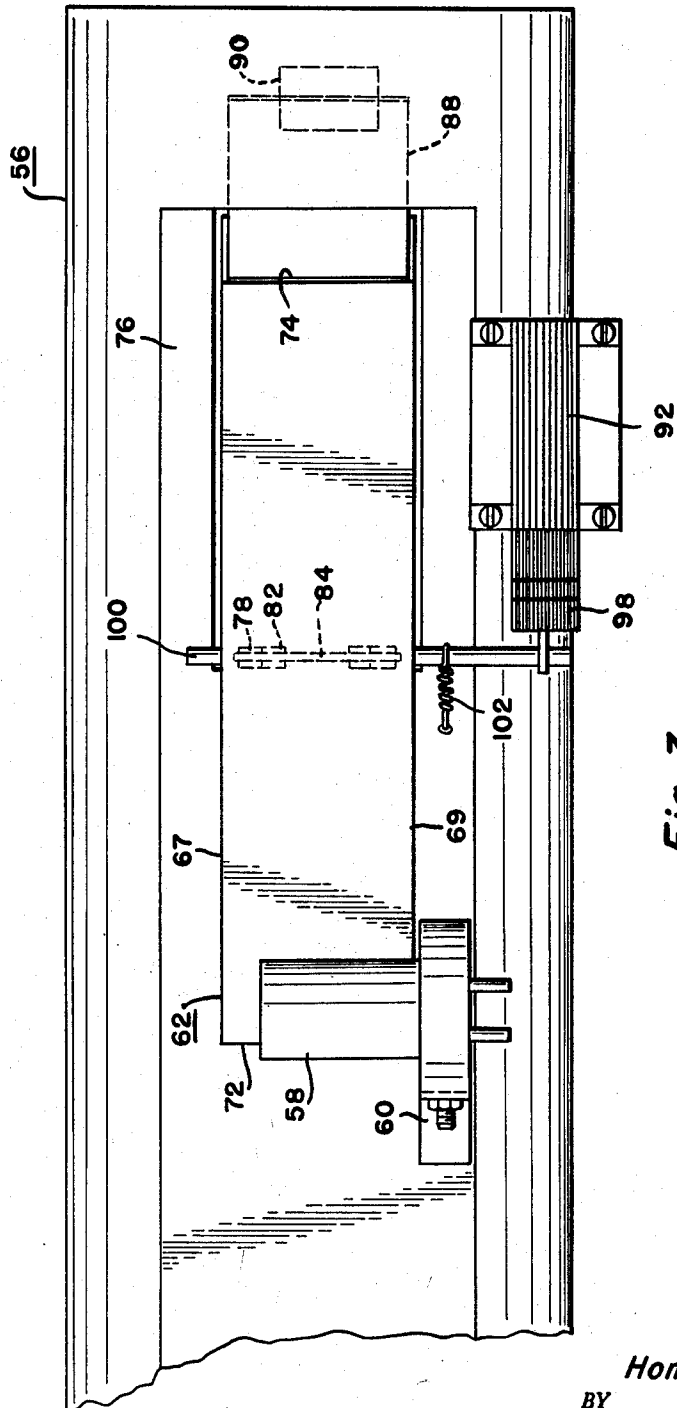
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HUMIDITY SENSING CONTROL FOR A CLOTHES DRIER

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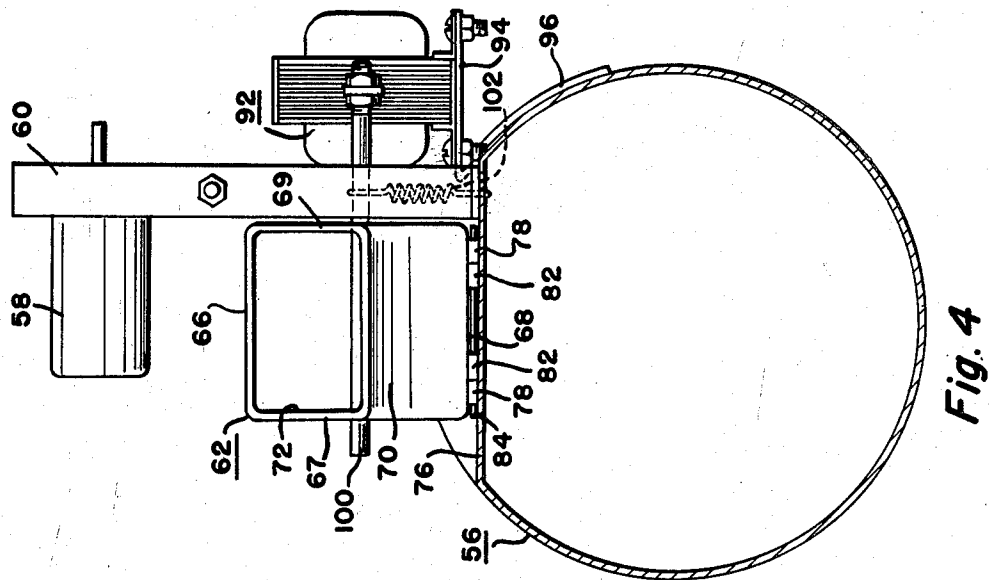


Fig. 4

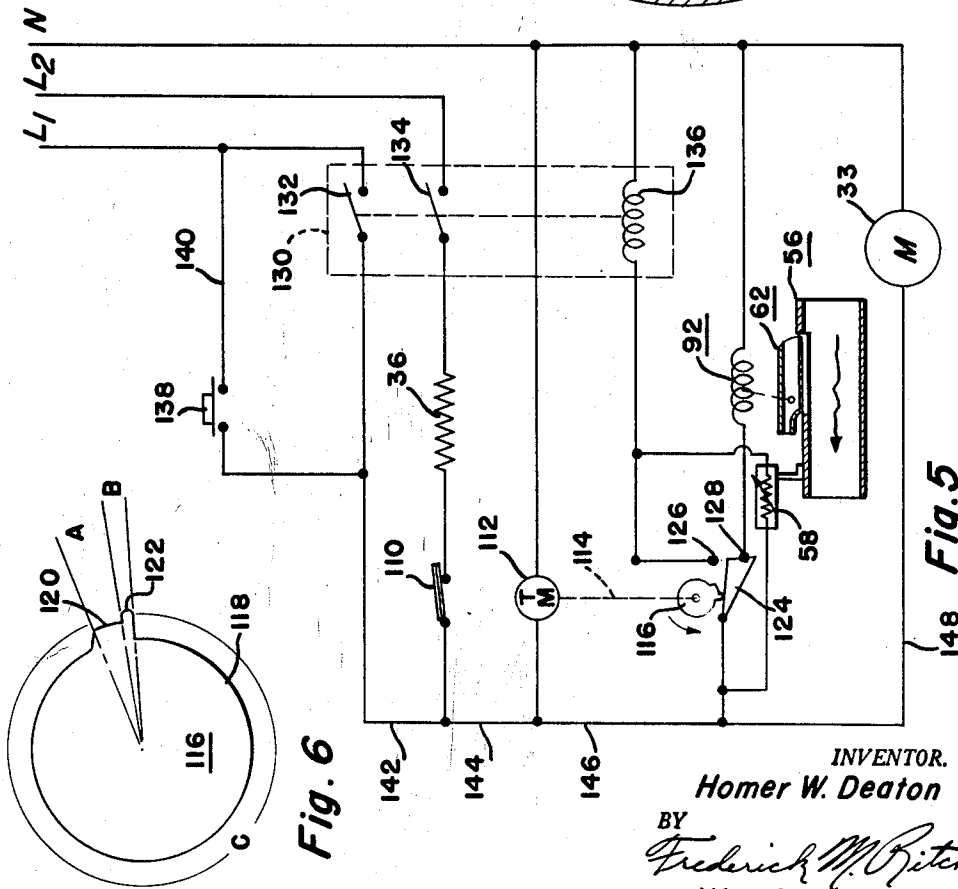


Fig. 6

Fig. 5

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HUMIDITY SENSING CONTROL FOR A CLOTHES DRIER

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9 Claims. (Cl. 34-45)

This invention relates to a domestic appliance and more particularly to an improved termination control for a clothes dryer.

Many arrangements have been taught for terminating the operation of a clothes dryer after the clothes are properly dried. One method of accomplishing dryer termination is through the use of a humidity sensing element positioned in the clothes dryer air stream. Experience has shown that the operation of a humidity sensing element so placed is not consistent where a plurality of consecutive clothes drying cycles are run. The temperature of the sensing element itself tends to increase with each cycle—a fact which makes it more difficult for the element to take on the necessary moisture from the dryer air stream to give a true indication of a clothes dryness. It is to the solution of this and other problems that this invention is directed.

Accordingly, it is an object of this invention to provide a dryer termination control which includes a humidity sensing element periodically exposed to the air stream of a clothes dryer.

It is a more particular object of this invention to provide a by-pass or bleed off duct associated with a main dryer air duct and adapted to periodically divert air from the main duct over a humidity sensing element.

A more general object of this invention is the provision of a humidity sensing element for a dryer control circuit wherein the sensing element is maintained in a protected position out of the normal air stream of the dryer and subjected only intermittently to a sample of the dryer air.

A still more general object of this invention is the provision of a dryer termination control circuit including a humidity sensing element which is maintained at constant ambient conditions.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

FIGURE 1 is a side sectional view, partly in elevation, of a clothes dryer suitable for use with this invention;

FIGURE 2 is a fragmentary side elevational view, partly in section, showing the humidity sensing arrangement of this invention;

FIGURE 3 is a fragmentary top elevational view of the FIGURE 2 arrangement;

FIGURE 4 is a sectional view taken along line 4—4 in FIGURE 2;

FIGURE 5 is a schematic wiring diagram including the novel termination control circuit of this invention; and

FIGURE 6 is an enlarged view of the timer cam shown in FIGURE 5.

In accordance with this invention it is desirable to provide a termination control for a clothes dryer in which a humidity sensing element is maintained in a protected position normally remote from the flow of the moisture laden dryer air. Intermittently throughout the drying cycle the sensing element may be exposed to short blasts or samples of exhaust air. If the condition of the air, as sensed by the sensing element, indicates that the clothes or fabric are dry, then the cycle will be terminated with the clothes in a proper end point dryness condition.

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With reference to FIGURE 1, a clothes dryer 10 is illustrated. The dryer is comprised of a box-like casing having a front wall 12, a top wall 14, a rear wall 16 and a bottom wall 18. A tumbling drum 20 is rotatably mounted on a rear bulkhead 22 and relatively rotatably supported by a cylindrical collar portion 24 of a front port plate 26. Suitable means such as a belt and pulley arrangement 31 are provided to transmit power from a motor or prime mover (FIGURE 5). A rear wall 28 of the tumbling drum is perforated as at 30 to receive air entering the tumbling drum from a heater chamber 32 and a rear wall opening 34 in line with the heater housing. A primary heater 36 within the heater housing 32 is adapted to heat air before it enters the tumbling drum 20. For introducing clothes to the tumbling drum, the casing front wall 12 is provided with an opening closed by a hingedly mounted access door 38. The door 38 is provided with a recess or indentation 40 spaced from the front of the port plate 26 to form an air passage 41 leading to a front duct 42 in which any conventional lint collecting means such as 44 may be positioned.

For inducing an air flow through the tumbling drum 20 an air blower 46 is installed in the bottom portion of the dryer and adapted to be driven by the motor 33. The blower includes an inlet 48 connected by way of a flexible conduit 50 to the front duct 42. The outlet 52 of the blower 46 is connected by way of another flexible conduit 54 to an exhaust duct 56 which extends through aligned openings 57 in the rear bulkhead and 59 in the rear wall 16 of the dryer casing to connect with the atmosphere. Thus the air flow circuit for the dryer 10 is as follows: Outside air enters the dryer casing through the rear wall opening 34 and proceeds through the primary heater housing 32 and past the heater 36 where it is heated prior to entering an annular air space 35 adjacent the rear wall of the tumbling drum closed by an annular drum seal 37. The heated air is drawn evenly through the perforations 30 in the rear wall of the tumbling drum and picks up moisture from the clothes or fabric being tumbled. This moisture laden air then leaves the front end of the tumbling drum 20 and enters the front duct 42 by way of the passage 41 in the dryer access door 38. Next the lint is removed from the circulating air by the filtering means 44, the blower 46 then exhausting the air through the exhaust duct 56 to the atmosphere.

In accordance with this invention the duration of the drying cycle depends on the signal of a humidity sensing element shown generally at 58. The element 58 is supported by a sensing element bracket 60 which is fastened in any conventional manner to the exhaust duct 56. A bushing or spacer 59 of rubber or other suitable thermally non-conducting material is interposed between bracket and element to prevent the conduction of heat from the duct 56 to the element. An auxiliary by-pass or termination control duct 62 is pivotally mounted to the top of the exhaust duct 56 and is adapted to insert periodically through a by-pass duct access opening 64 in the exhaust duct 56 to divert a portion of the exhausting air stream over the sensing element 58. If the moisture content of the by-passed portion of the air indicates a sufficiently low relative humidity, the drying cycle will be terminated.

The arrangement for periodically scooping a portion of the air flowing in the exhaust duct will be understood more fully in connection with FIGURE 2. In this view the termination control duct 62 is shown formed into a box-like open-ended casing having a top wall 66, a bottom wall 68, sidewalls 67, 69 and a curved bottom wall portion 70. These walls define at one end of the duct an outlet opening 72 and at the opposite end of the duct an inlet opening 74. Adjacent its access opening 64 the exhaust duct 56 is formed with a flattened

top wall portion 76 which has circularly bent hinge tab portions 78. Similarly, circularly bent portions 82 extend downwardly from the bottom wall 68 of the by-pass duct 62 and inwardly adjacent the hinge tabs 78 on the exhaust duct. A hinge pin 84 may be inserted through the hinge tabs 78 and 82, thereby pivotally connecting the termination control duct 62 to the exhaust duct 56. Note in FIGURE 2 that the termination control duct 62 may be positioned in a first solid line position which places its inlet opening 74 outside the exhaust duct 56—an extension 88 from the bottom wall 68 of the duct 62 abutting a damping block or bumper 90 on the inside of the duct 56 to so position the by-pass duct. The second exhaust air scooping or by-pass position is shown in phantom line in FIGURE 2 to illustrate how the outlet opening 72 of the by-pass or termination control duct 62 is placed in juxtaposition to the humidity sensing element 58 when the inlet opening 74 resides within the exhaust duct 56—the by-pass duct extension 88 serving to scoop a portion of the exhaust air into the open inlet end of the control duct 62. This air portion is then by-passed over the sensing element 58.

For pivoting the by-pass or termination control duct 62 a solenoid 92 is supported on a generally V-shaped bracket 94 having one leg 96 thereof fastened in any suitable means to the exhaust duct 56. The armature 98 of the solenoid 92 is connected to a duct actuator pin 100 which extends through the sidewalls 67 and 69 of the by-pass duct 62. A return spring 102 is interconnected between the pin 100 and the exhaust duct 56 as at 104. Thus when the solenoid 92 is energized, the armature 98 is moved to the phantom line position in FIGURE 2, the termination control duct 62 is pulled to its phantom line position and the inlet 74 of the control duct is positioned into air scooping relationship with the interior of the exhaust duct 56. With the solenoid 92 deenergized the return spring 102 will act to move the solenoid armature and the termination control by-pass duct 62 to the solid line position.

Although any conventional humidity sensing element 58 may be used in the drying cycle control of this invention, a particularly effective element for operating directly a control circuit component without power amplification is taught in the copending application Serial No. 855,756 and Serial No. 855,589, filed November 27, 1959. The element 58 should be a fast acting type to signal a humidity condition substantially instantaneously so that the period of deflecting exhaust air over the element may be of short duration as will be described more fully next following.

The operation of the novel dryer termination control of this invention will be described in connection with FIGURE 5 wherein a schematic wiring diagram is set forth. A conventional 230 volt three wire power supply has been shown as L₁, L₂ and N. The dryer may include a drying temperature control thermostat 110 which may be positioned in the front duct 42 of the dryer. For initiating the operation of the drying cycle a cycle control 111 is provided with a timer motor 112 to rotate constantly a timer shaft 114 on which a drying cycle cam 116 is affixed. The configuration of the cam 116 is more particularly shown in FIGURE 6 and includes a circular portion 118, a first rise 120 and a second higher rise 122. With the cam 116 rotated once every two minutes the rise 120 should be equivalent to an arcuate distance A of one and one-half seconds whereas the rise 122 should be equivalent to an arcuate distance B of one-half second. The major arcuate distance C on the cam periphery will then define a period of one minute and 58 seconds.

The timer cam 116 is designed to operate a wiping timer switch blade 124 between a relay coil contact 126 and a by-pass duct solenoid coil contact 128. The switch blade 124 is designed so that it will engage the contact 126 only when the switch blade is biased by

the circular cam portion 118. When the contact switch blade 124 is motivated by the cam rise 120 for one and one-half seconds, the switch blade 124 will contact both contacts 126 and 128; and when the cam rise 122 biases the switch blade 124, by-pass duct solenoid contact 128 only will be engaged.

For controlling the power supply during the drying cycle, a relay 130 is included which has a power switch 132 and a heater switch 134. Both relay switches 132 and 134 are opened and closed together by a relay actuating coil 136.

To start a drying cycle in accordance with the teachings of this invention, a start button 138 is depressed. The start button may be of any conventional type which includes a time delay before opening sufficiently long to allow the moisture to start evaporating from the clothes being tumbled. When the button 138 is pushed, power will flow to the prime mover 33 from L₁, line 140, lines 142, 144, 146 and 148, the prime mover 33 and return to the neutral supply lead. This will initiate the operation and rotation of the tumbling drum 20 and the blower 46. At the same time that the prime mover 33 is energized, the timer motor 112 will be energized as follows: from L through line 140, start button 138, lines 142, 144, timer motor 112 to the neutral N side of the line. The energization of the timer motor 112 will cause the cam 116 to be rotated in a counterclockwise direction and the timer switch blade 124 will be closed immediately solely on the relay coil contact 126, thereby energizing the relay coil 136. As the relay coil is energized, the relay switch 132 will be closed to by-pass the start button 138 and the relay switch 134 will be closed to energize the primary heater 36 through L₁, the switch blade 132, line 142, thermostat 110, the primary heater 36, the relay switch 134 to the other side of the line L₂. Immediately the air temperature drawn through the drying chamber 20 will increase and moisture will start evaporating from the tumbling fabric. As aforesaid, it is important that the start circuit button 138 remain closed until enough moisture has started evaporating from the fabric that the sensing element will pass a sustaining current to the relay coil 136.

As the drying cycle progresses the timer motor 112 will remain continuously energized to rotate the cam 116 once in every two minutes. For approximately one minute and fifty-eight seconds of each revolution the timer switch blade 124 will be closed only on the contact 126 to energize the relay coil 136. For the next one and one-half seconds the switch blade 124 will be engaged with both contacts 126 and 128 to energize both the relay coils 136 and the termination control duct solenoid coil 92. During this one and one-half second interval the solenoid 92 will be energized and the termination control duct 92 tilted momentarily to produce a blast of air from the duct 56 over the humidity sensing element 58. And lastly, the cam 116 will be effective to move the switch blade 124 to the contact 128 only for a brief humidity sensing control interval of one-half second, placing the sensing element 58 in complete control of the relay coil 136. During this half second control interval the duct 62 remains tilted to by-pass air over the element. Note that the sensing element 58 is in parallel with the timer switch blade 124 and contact 126 and thus in a position to pass an energizing flow of current to the relay coil 136 only so long as the moisture content of the air is sufficiently high to provide a low resistance current flow path through the sensing element 58. It should be understood that the cam actuated timer switch blade 124 will be constantly shifted throughout the drying cycle. On all but the last of the timer switching cycles the movement of the switch blade 124 away from the contact 126 will not deenergize the relay coil 136 since the blast of air ejected over the sensing element 58 will contain sufficient moisture to cause the element to sustain the energization of the relay coil 136. So long as the

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coil 136 remains energized, power relay switch 132 remains closed.

Eventually the clothing or fabric will reach its proper end point dryness and on the last timer cycle the cam 116 will move the switch blade 124 away from the relay coil contact 126 to the termination control duct solenoid coil contact 128. On this last sensing cycle the air within the duct 56 will be relatively dry to indicate a clothes dryness. The sensing element 58 will not be exposed to any moisture and therefore it will have a high resistance. Since the element resistance is high, this parallel circuit to the relay coil 136 will be effectively blocked and the relay coil will be deenergized. Once the coil 136 is deenergized the relay power switch 132 opens and the circuit is deenergized to the timer motor. Thus the drying cycle has been terminated automatically at the proper end point dryness for the fabric.

It should now be seen that an improved automatic drying cycle termination control has been provided by the teachings of this invention. Even different fabrics which tend to give up moisture at different rates are dried properly and equally well with the control. To accomplish these ends the humidity sensing element is maintained in a relatively constant ambient atmosphere remote from the dryer air flow and subjected solely to intermittent blasts of dryer exhaust air as an indication of clothes dryness. It should be appreciated that suitable seals may be provided around the termination control duct 62 where it enters the exhaust duct 56 to prevent undue leakage in the area of the sensing element 58.

While the embodiment of the invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. A drying cycle control for a clothes dryer comprising, means actuatable for terminating said drying cycle, an exhaust duct for receiving air from said dryer and having an opening, a humidity sensing element connected to the outside of said exhaust duct adjacent said opening and actuatably connected to said terminating means for terminating said drying cycle, a termination control duct having an inlet and an outlet and pivotally mounted to the outside of said exhaust duct adjacent said opening for pivotal movement in and out of said opening, said termination control duct having a first position for closing said opening wherein said inlet and said outlet are outside of said exhaust duct and a second position wherein said inlet is positioned inside said exhaust duct to divert said air and said outlet is positioned adjacent said humidity sensing element to direct said air into contact with said sensing element, and means for periodically pivoting said termination control duct into said second position.

2. A drying cycle control for a clothes drying chamber comprising, means actuatable for terminating said drying cycle, an exhaust duct for receiving air from said chamber and having an opening parallel to the flow of said air, a humidity sensing element connected to the outside of said exhaust duct adjacent the downstream end of said opening and actuatably connected to said terminating means for terminating said drying cycle, a termination control duct having an inlet end and an outlet end substantially normal to said flow of said air and pivotally mounted between said inlet end and said outlet end to the outside of said exhaust duct at said downstream end of said opening for rocking pivotal movement of said inlet end in and out of said opening, said termination control duct having a first position for closing said opening wherein said inlet end and said outlet end are outside of said exhaust duct and a second position wherein said inlet end is positioned inside said exhaust duct to divert said air and said outlet end is positioned for directing said air diverted toward said humidity sensing element, and means for periodically pivoting said termination control duct into said second position.

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comprising, means actuatable for terminating said drying cycle, an air circulation duct for receiving air from said chamber and having an opening, a humidity sensing element actuatably connected to said terminating means for terminating said drying cycle, a bleed off duct having an inlet end pivotally mounted to the outside of said air circulation duct adjacent said opening for pivotal movement in and out of said opening, said bleed off duct having a first position wherein said inlet end is outside of said air circulation duct and a second position wherein said inlet end is positioned inside said air circulation duct to bleed off a portion of said air onto said humidity sensing element, and means for periodically pivoting said bleed off duct into said second position.

4. In combination with a clothes dryer having means defining a drying air flow which has passed through the clothes being dried, a termination control arrangement for a clothes drying cycle comprising a primary heater to heat said air flow, a timing cam, a timer motor for rotating said cam, a power supply line, a relay having a first switch in said power supply line, a second switch in series with said primary heater and a relay coil for actuating said first and second switches, a humidity responsive device in series with said relay coil, means for periodically directing said air flow onto said humidity responsive device including an operating solenoid coil in parallel with said relay coil, a timer switch blade actuated by said cam and sequentially engaging a first contact in series with said relay coil and a second contact in series with said solenoid coil, said timer switch blade and said first and second contacts being in parallel with said humidity responsive device, said primary heater and said timer motor, and time delay start switch means connected to said power supply line in parallel with said first switch and in series with said primary heater, said timer motor, said humidity sensing element and said timer switch blade for initiating said clothes drying cycle, said drying cycle terminating when said air flow is dry and said first contact is open.

5. A drying cycle control for a drying chamber having inlet and outlet passages therein and impeller means for producing an air flow from said inlet to said outlet including, a power supply for said impeller means having a relay switch and a manually closable, self-opening start switch in parallel with said relay switch, a relay coil for closing and opening said relay switch when said relay coil is energized and deenergized respectively, an air flow humidity responsive resistance device in selective communication with said outlet passage and in series with said relay switch and said relay coil and operative upon high humidity to pass sufficient power to energize said relay coil and operative upon low humidity to deenergize said relay coil, means for periodically exposing said humidity responsive resistance device to said air flow including said humidity responsive device being exposed when said actuating coil is energized, an actuating coil, and timing means having a first switch in series with said relay coil, a second switch in series with said actuating coil and means for opening and closing said first and second switches sequentially throughout a drying cycle, whereby said humidity responsive resistance device is placed in power flow control relationship to said relay coil when said second switch is closed and said first switch is open.

6. In combination with means for producing a fabric drying air flow which has passed through the fabric being dried, a power supply for said air flow producing means, power supply switch means for energizing and deenergizing said air flow producing means, means for actuating said power supply switch means, means for sensing the moisture content of air, means for periodically exposing said sensing means to said air flow, and timing switch means connected to said power supply switch means and sequentially in series with said actuating means and said exposing means and in parallel with said sensing means for periodically placing said sensing means in power supply control relationship with said actuating means to

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open said power supply switch and deenergize said air flow producing means when said timing switch means is in series with said exposing means and said fabric is dry.

7. The combination of claim 6 wherein said exposing means includes a pivotally mounted duct for selectively diverting said air flow over said sensing means.

8. A drying cycle control for a fabric drying chamber comprising, means actuatable for terminating said drying cycle, means for conveying air from said chamber and having an opening, humidity sensing means actuatably connected to said terminating means for terminating said drying cycle, bleed off means having an inlet and movably mounted adjacent said opening in said air conveying means for movement in and out of said opening, said bleed off means having a first position wherein said inlet end is outside of said air conveying means and a second position wherein said inlet end is positioned inside said air conveying means to bleed off a portion of said air into humidity sensing relationship with said humidity sensing means, and means for periodically moving said bleed off means into said second position.

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comprising, means actuatable for terminating said drying cycle, means for conveying air from said chamber and having an opening, humidity sensing means actuatably connected to said terminating means for terminating said drying cycle, movable means movably mounted adjacent said opening in said air conveying means for movement in and out of said opening, said movable means having a first position outside of said air conveying means to prevent the exposure of said humidity sensing means to the air in said air conveying means and having a second position inside said air conveying means to effect the exposure of said humidity sensing means to at least a portion of said air in said air conveying means for sensing the humidity thereof, and means for periodically moving said movable means into said second position.

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