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EUROPEAN PATENT APPLICATION

21 Application number: **89117773.5**

51 Int. Cl.5: **D06F 58/28**

22 Date of filing: **26.09.89**

30 Priority: **06.10.88 IT 4576188**

43 Date of publication of application:
11.04.90 Bulletin 90/15

84 Designated Contracting States:
AT DE FR GB IT SE

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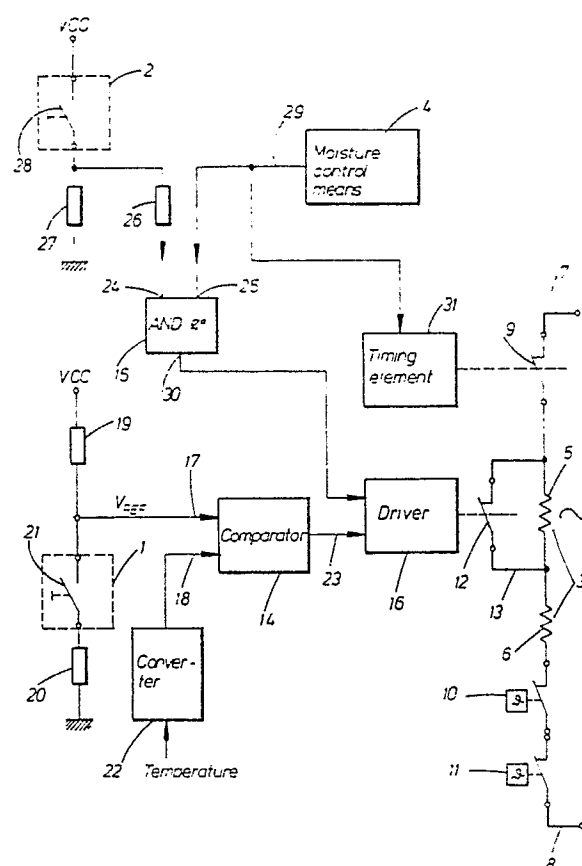
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54 **A laundry drying control device for a clothes drier.**

57 A laundry drying control device for a clothes drier comprising an electrical heating element divided into two portions (5, 6), portion (5) being adapted to be short-circuited by a driver (16) controlled by an electronic comparator (14) or by a logical AND gate (15).

The device is adapted to control the run of "acrylic" drying cycles by switching on the maximum power of only the portion (6) of the heating element until the operating drying temperature is reached, and then switching on a reduced heating power via the two portions (5, 6) of the heating element.

The device is adapted to control the run of "extra dry" drying cycles by switching on the maximum heating power and then the reduced heating power for a supplementary period after the end of drying.



A laundry drying control device for a clothes drier

The present invention relates to an electronic control device for a clothes drier adapted to allow for the run of drying cycles for drying the laundry in a predetermined manner and for limited durations.

Italian patent application no. 45702 A/88, filed by the same applicant on Jan. 25, 1988, describes a laundry drying control device for a clothes drier comprising a microprocessor containing encoded information on the drying cycles to be selected and adapted to control the run of the selected cycles; first, second and third selector means adapted to select drying cycles with nominal power and with reduced power of a heating element with adjustable power and adapted to keep the heating element switched on for a supplementary period; and integrator means constituted by electrical capacitors connected with two sensor electrodes disposed within the drum of the machine and adapted to be short-circuited by the damp laundry.

This control device further comprises an electronic comparator adapted to switch on and off the heating element of the machine in accordance with a comparison between the charging voltage level of the integrator means and a predetermined reference voltage level and the microprocessor of the device is designed to generate through one of its outputs a continuous rectangular enabling signal and to send this signal to the microprocessor through a corresponding input, making it pass through the integrator circuit and the second and third selector means.

The microprocessor is in particular in a position to identify, at the output of the comparator, the absence or presence of the enabling signal when the drying cycles have been selected through the first or second selector means, and an enabling signal identical but complementary to the preceding one when the drying cycles are selected through the third selector means.

In accordance with the identified enabling signal, the microprocessor thus controls the run of the drying cycles with nominal or reduced power of the heating element or with supplementary switching on of the element.

The control device thus constituted allows for a correct run of the drying cycles for the laundry in the machine, providing for the heating element to be switched on with the fixed and invariable power for the entire duration of each selected cycle. However, this does not allow for an adaptation of the heating power effectively required for drying the laundry during the run of the cycle, for a power which is variable while the laundry is dried, resulting in higher consumption of electrical power.

The invention is based on the problem of overcoming the above -mentioned disadvantages and limits by means of a laundry drying control device for a clothes drier realized in such a way as to effect the run of each drying cycle with optimal consumption of electrical power and with a limited duration of the cycle.

This control device is in particular adapted to switch on the electrical heating element with the maximum heating power during the initial phase of each "acrylic" drying cycle for drying delicate synthetic fabrics, the temperature of the fabrics being slowly increased until the operating value is reached and the heating element being then switched on with reduced power for the entire duration of the cycle.

Similarly, this control device is in a position to keep the electrical heating element switched on with reduced heating power during the run of the so-called "extra dry" drying cycles for completely drying cotton and resistant synthetic fabrics, having the heating element switched on for a supplementary time period.

This and other goals are achieved by the inventive device specified in the claims at the end of the patent.

The features of the invention will become more evident from the following description, intended solely as a nonrestrictive example, with reference to the adjoined drawing showing the block diagram of the inventive control device.

Referring to this drawing, one can see an electronic laundry drying control device for a clothes drier realized in substantially the same way as the device described in Italian patent application no. 45702 A/88, filed by the same applicant on Jan. 25, 1988, and capable of controlling the automatic run of cycles for drying laundry consisting of cotton and resistant synthetic fabrics, the cycles being performed with the maximum heating power until the predetermined laundry drying level is reached, or keeping the heating element with adjustable power of the machine switched on for a predetermined supplementary period so as to effect complete drying of the laundry (these drying cycles being known as "extra dry cycles").

This device is also capable of controlling the automatic run of cycles for drying laundry consisting of delicate synthetic fabrics, the cycles being performed with reduced heating power until the predetermined laundry drying level is reached (these drying cycles being known as "acrylic cycles").

In the present case the control device substantially comprises first and second selector means 1

and 2 constituted by conventional push-button switches disposed in the control panel of the machine and adapted to be operated separately and manually to select the aforesaid "acrylic" drying cycle or the "extra dry" cycle with the heating element of the machine being switched on for a predetermined supplementary period, said device also comprising, as in the case of patent application no 45702 A/88, further selector means (not shown) for selecting "extra dry" drying cycles with the maximum heating power. These selector means shall not be described here since they are not relevant to the effects of the invention.

This control device further comprises at least one electrical heating element 3 with adjustable power and a moisture control means 4 both realized in the way described below and adapted to effect the heating of the laundry drying air and to predetermine the drying level required for each laundry load, respectively.

In particular, electrical heating element 3 is subdivided into at least a first and a second portion 5, 6 which are interconnected electrically, preferably in series, and supplied by conductors 7 and 8 of the electrical circuit of the machine through an electrical contact 9 of the normally closed type and provided for the purposes to be described below, and through safety thermostats 10, 11 interconnected in series and calibrated so as to switch off the heating element portions in the presence of elevated temperature within the machine.

Portions 5 and 6 of heating element 3 are further dimensioned to supply a reduced heating power so as to effect an adequate drying temperature for delicate synthetic fabrics when both these portions are energized, and a maximum heating power so as to effect a drying temperature more elevated than the preceding one, although without damage to the fabrics, when only portion 6 of the heating element is energized, a state obtained by short-circuiting the other portion 5 of the heating element due to the closing of an electrical contact 12 on an electrical conductor 13 connected to the heads of portion 5, the closing being performed in the ways described below.

In its turn, moisture control means 4 is constituted by an integrator circuit equipped with a plurality of electrical capacitors collected with limiting resistors, diodes and further electronic components known as such, the circuit being adapted to vary the time constant of the capacitors in accordance with the drying level required by the laundry, and by two sensor electrodes disposed within the rotating drum of the machine (not shown) and connected with the integrator circuit and with the ground of the machine, the electrodes being adapted to be short-circuited by the damp laundry to be dried.

The integrator circuit and sensor electrodes, which are not represented in the drawing, are identical to the corresponding electrical components described in the above-mentioned Italian patent application no. 45702 A/88 and therefore have the same functions as these components.

To allow for control of the switching on and off of portion 5 of the heating element in order to vary the heating power for the purposes and in the ways described below, the present device further comprises an electronic comparator 14 and a logical AND gate 15 of the conventional type and a driver 16 or similar driving element controlled alternatively by comparator 14 or by logical AND gate 15 for moving electrical contact 12 associated with the driver from the normal closed position to the open position with respect to conductor 13, in which states portion 5 is switched off and on, respectively, with respect to other portion 6 of the heating element.

In particular, comparator 14 is provided with two inputs 17 and 18 respectively connected with a first resistor 19 supplied by a predetermined continuous voltage V_{cc} , the resistor being adapted in turn to be connected in parallel with a second resistor 20 that is grounded, due to the closing of contact 21 of first selector means 1, the contact being connected with the second resistor, and with a conventional electronic converter 22 adapted to detect constantly the temperature levels of the drying air within the clothes drier and to convert these temperature levels into corresponding voltage levels.

The comparator is further provided with an output 23 connected to driver 16 whose logical level is determined by comparison between a predetermined reference voltage V_{REF} applied to input 17 of the comparator and generated by the closing of contact 21 and a variable voltage generated by converter 22 during the run of the drying cycle selected through first selector means 1.

The level of reference voltage V_{REF} is in particular selected so as to be identical to the voltage level generated by converter 22 and applied to input 18 of comparator 14 upon attainment of the operating temperature during drying, at which temperature delicate synthetic fabrics are dried in a satisfactory manner without danger of overheating or damage thereto.

In this operative state of comparator 14, given that both voltages applied to inputs 17 and 18 of the comparator are equal, the logical level of comparator output 23 is thus switched from level 0 to level 1, thereby energizing driver 16 which thus opens contact 12, thereby connecting portions 5 and 6 of the heating element mutually in series.

Conversely, the reference voltage assumes a level higher than the voltage level generated by

converter 22 in accordance with the operating temperature during drying when contact 21 of selector means 1 is kept in the open position, in which state only voltage V_{cc} is applied to input 17 of comparator 14 through resistor 19.

In this operative state of comparator 14, given that both voltages applied to inputs 17 and 18 of the comparator are different and cannot in any way become identical, since the operating temperature of the machine and thus also the voltage generated by converter 22 remain constant, the level of this voltage being lower than that of the above-mentioned voltage V_{cc} , it follows that output 23 of the comparator is always kept at logical level 0, in which state driver 16 is not energized and keeps contact 12 closed and portion 5 of the heating element therefore short-circuited.

In its turn, logical AND gate 15 is provided with two inputs 24 and 25 connected respectively to a first resistor 26 connected electrically to a second resistor 27 that is grounded and can be energized by the above-described predetermined continuous voltage V_{cc} due to the closing of contact 28 of second selector means 2, the contact being connected to both resistors 26 and 27, and with output 29 of moisture control means 4 specified above.

AND gate 15 is further provided with an output 30 connected to driver 16 whose logical level is determined by comparison between the voltage levels applied respectively to inputs 24 and 25 of the gate.

In particular, as soon as the drying cycle is selected closing contact 28 of selector means 2, input 24 of AND gate 15 is subjected to predetermined voltage V_{cc} , while in its turn the other input 25 of the gate is not subjected to an identical predetermined voltage which is drawn by output 29 of moisture control means 4, given that the latter generates the voltage only upon attainment of the predetermined drying level for the laundry.

In this operative state of AND gate 15, output 30 thereof thus remains at logical level 0 and therefore driver 16 is not energized so that portion 5 of the heating element is kept short-circuited, in which state there is the maximum drying power of the drying air.

Conversely, as soon as the predetermined drying level for the laundry is reached, input 25 of AND gate 15 is also subjected to the predetermined voltage generated by moisture control means 4 and present at output 29 thereof, in which state output 30 of the gate is switched to logical level 1, thereby energizing driver 16 and thus connecting in series portions 5 and 6 of the heating element, thereby obtaining a reduced heating power for the drying air.

Finally, the inventive control device further comprises a timing element 31 or similar

conventional-type element connected electrically to output 29 of moisture control means 4 and mechanically to electrical contact 9 in order to allow for closing or opening of the contact, thereby switching heating element 3 on or off in accordance with the absence or presence of the predetermined voltage at input 29 of the moisture control means.

The modes of functioning of the present control device during the run of the "acrylic" and "extra dry" cycles to be triggered by selector means 1 and 2 will now be described.

The "acrylic" cycle is triggered by closing contact 21 of selector means 1 and preparing moisture control means 4 and timing element 31 to obtain the desired drying level for the laundry.

In this way, reference voltage V_{REF} with a predetermined fixed level and the voltage generated by converter 22 and proportional to the drying temperature are applied respectively to inputs 17 and 18 of comparator 14, the initial level of the latter voltage being minimal and lower than that of voltage V_{REF} .

In these states, output 23 of comparator 14 is at logical level 0 so that driver 16 remains deenergized, thereby maintaining portion 5 of the heating element short-circuited. In its turn, timing element 31 remains deenergized, given that output 29 of moisture control means 4 is not subjected to the above-mentioned predetermined voltage, since the drying level provided for the laundry has not yet been reached.

Consequently, the timing element keeps electrical contact 9 closed so that only portion 6 of the heating element is energized, in which state the run of the drying cycle is effected with the maximum heating power and thus with rapid heating of the laundry and of the machine to the corresponding operating temperature.

In this state one thus obtains a considerable reduction of the duration of the total drying cycle without any overheating or damage to the fabrics.

Thus, as soon as the operating temperature is reached, in which state the voltage generated by converter 22 has reached reference voltage level V_{REF} , output 23 of comparator 14 is switched to logical level 1 so that driver 16 is energized and opens contact 12, thereby interconnecting in series portions 5 and 6 of the heating element. In this state, the drying cycle is thus performed with a reduced heating power until the drying level required by the laundry is reached. As soon as this drying level is reached, the above-described predetermined voltage is applied to output 29 of moisture control means 4, thereby energizing timing element 31 which opens electrical contact 9, thereby switching off portions 5 and 6 of the heating element.

In this way, the drying cycle is ended and the machine prepared for the run of the following cooling phase, which is performed in the conventional way and controlled by further electrical components (not shown) of the clothes drier.

In its turn, the "extra dry" cycle is triggered by closing contact 28 of selector means 2 and preparing moisture control means 4 and timing element 31, as above, to obtain the desired drying level for the laundry.

In this way, the predetermined voltage V_{cc} is applied to input 24 of logical AND gate 15, while the other input 25 of the gate is not live, given that output 29 of moisture control means 4 is not live either since the drying level provided for the laundry has not yet been reached. In these states, output 30 of logical AND gate 15 is at logical level 0 so that driver 16 remains deenergized, thereby keeping portion 5 of the heating element short-circuited. In its turn, timing element 31 also remains deenergized and thus effects the switching on of portion 6 of the heating element only, in the ways and for the purposes already described in the corresponding phase of the "acrylic" drying cycle.

As soon as the drying level provided for the laundry is reached, output 29 of moisture control means 4 and thus input 25 of AND gate 15 are subjected to the aforesaid predetermined voltage, so that output 30 of the AND gate is switched to logical level 1, thereby energizing driver 16 which opens contact 12 and thus interconnects in series portions 5 and 6 of the heating element.

At the same time, the presence of the predetermined voltage at output 29 of moisture control means 4 energizes timing element 31 which therefore keeps electrical contact 9 closed and thus portions 5 and 6 of the heating element switched on for a period of time predetermined by the timing element, during which a supplementary drying of the laundry is performed with reduced heating power, thereby avoiding undesirable overheating of the laundry and the electrical components of the machine.

At the end of this time period, timing element 31 automatically opens electrical contact 9, thereby switching off portions 5 and 6 of the heating element and preparing the machine for the run of the subsequent cooling phase analogous to that of the "acrylic" cycles.

The present control device can be advantageously incorporated in a conventional microprocessor adapted to control the run of all the operative functions of the clothes drier.

Claims

1. An electronic laundry drying control device

for a clothes drier comprising at least an electrical heating element with adjustable power, first and second selector means adapted to select drying cycles with reduced power of the heating element and to keep the element switched on for a predetermined supplementary period, respectively, and further comprising moisture control means adapted to effect the drying of the laundry at predetermined drying levels in accordance with the cycles respectively selected by means of the first and second selector means, characterized in that the heating element (3) is subdivided into at least a first and a second portion (5, 6) interconnected electrically, the first portion (5) being adapted to be short-circuited selectively through first and second comparator means (14, 15) associated respectively with the first and second selector means (1, 2) upon attainment of the operating temperature and of the drying level required during drying, respectively, the control device further comprising switching means (31) adapted to be driven by the moisture control means (4) and to switch on and off the first and second portions (5, 6) of the heating element during each drying cycle respectively selected.

2. The control device of claim 1, characterized in that the first comparator means comprise an electronic comparator (14) whose inputs (17, 18) are connected respectively with a predetermined reference voltage (V_{REF}) to be applied through the first selector means (1), and with a voltage level that is variable in accordance with the drying temperature and generated by an electronic converter (22), the comparator (14) being connected at its output (23) with a driver (16) or similar driving element adapted to close or open an electric contact (12) with respect to a conductor (13) connected to the heads of the first portion (5) of the heating element.

3. The control device of claim 2, characterized in that the second comparator means comprise a logical AND gate (15) whose inputs (24, 25) are connected respectively with a predetermined voltage (V_{cc}) to be applied through the second selector means (2), and with a further predetermined voltage identical to the preceding one and to be applied through the output (29) of the moisture control means (4), the logical AND gate (15) being connected at its output (30) with the driver (16).

4. The control device of claim 3, characterized in that the switching means comprise a timing element (31) or similar element connected electrically with the output (29) of the moisture control means (4) and mechanically with an electrical contact (9) of the normally closed type, in its turn connected to the first and second portions (5, 6) of the heating element, the electrical contact (9) being adapted to be opened by the timing element (31)

only at the end of the drying cycle respectively selected.

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