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(54) Clothes dryer with a PTC resistance heater

(57) The invention concerns a clothes dryer with a PTC resistance heater for drying air guided by a blower through the dryer drum. The starting current can be reduced without changing the program control, and the heating current can be automatically adapted to the operating conditions of the startup and heating phase when a line-side NTC heater consisting of at least one NTC resistor is series-connected to the PTC resistance heater, and that at least one PTC resistor of the PTC resistance heater thermally contacts an NTC resistor of the line-side NTC heater.

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Description

[0001] The invention concerns a clothes dryer with a PTC resistance heater for the drying air that is conducted via a blower through the dryer drum.

[0002] Such a clothes dryer is prior art in DE OS 25 59 035 and DE 26 53 322 C2. Since the resistance value of the PTC resistor is small at low temperatures, very high start current arises in the cold-start phase. Additional overload protection does not have to be used however, since the resistance of the PTC resistor increases more-or-less exponentially as the temperature increases which automatically restricts the heating current and acts as overload protection.

[0003] To reduce the high starting current in the cold phase, it has also been suggested that the PTC resistor be preheated with an auxiliary heater. However, this increases the complexity of the heating elements. In another variation, the heater consist of several PTC resistors that are arranged so that they can be switched from a series-connection at the beginning of the drying program to parallel or partially-parallel-connection by the program control depending on the time or temperature. This increases the complexity of the program control, however.

[0004] The problem of the invention is to create a heater for a clothes dryer of the initially-cited type that independently reduces the starting current, automatically adapts to the operating conditions, and protects from overheating.

[0005] This problem is solved according to the invention as follows: A line-side NTC heater consisting of at least one NTC resistor is series-connected to the PTC resistance heater, and at least one PTC resistor of the PTC resistance heater thermally contacts an NTC resistor of the line-side NTC heater.

[0006] This cleverly exploits the different reactions to temperature of the PTC and NTC resistors. The high cold resistance of the NTC resistors limits the starting current during the cold-start in the series-connection to the PTC resistors. As the temperature increases, the resistance of the NTC resistors decreases, and the resistance of the PTC resistors increases until a target heating current is attained in the heating phase. The overall resistance circuit of the NTC and PTC resistors automatically controls itself so that a controller is no longer necessary. As the temperature further increases, the resistance of the PTC resistors continues to decrease and prevents the heater from overheating so that an independent safety circuit is not required for overload protection. The entire resistance heater contacts the hot drying air so that the overall resistance automatically adapts to the predominant operating conditions, and the PTC and NTC resistors that are in thermal contact with each other assume the regulatory function.

[0007] The overall heater contacts the drying air automatically since it is located in an air channel through which the drying air flows.

[0008] In the cold-start phase, the line-side NTC heater limits the starting current in the cold-start phase by its temperature-related resistance characteristic, while in the heating phase, the PTC resistance heater limits the heating current by its temperature-related resistance characteristic and protects against overheating.

[0009] A simple electrical design of the overall heater is provided by joining the PTC resistors in the PTC resistance heater in a series-connection, parallel-connection or mixed connection, and joining the NTC resistors in the line-side NTC heater in series-connection, parallel-connection, or a mixed connection to obtain the desired resistance characteristic for all phases of the drying procedure.

[0010] The design is distinguished in that the PTC and NTC resistors are preferably designed as plates and electrically contact plate-shaped contact bodies and/or plate shaped cooling bodies with cooling ribs, and that the contact bodies and cooling bodies in the PTC resistance heater and line-side NTC heater contact the PTC resistors and NTC resistors corresponding to the overall heating system.

[0011] The thermal contact between the PTC resistance heater and line-side NTC heater is provided as follows: At least one PTC resistor electrically and thermally contacts a surface of at least one cooling body, and at least one NTC resistor electrically and thermally contacts the other surface.

[0012] The invention will be further explained with reference to exemplary embodiments portrayed in the drawings. Shown are:

Fig. 1 a schematic illustration of the drying circuit of a clothes dryer,

Fig. 2 a first exemplary embodiment of an overall heater consisting of the NTC and PTC resistors that can be inserted in the air channel of the drying circuit,

Fig. 3 the circuit diagram for the heating element from Fig. 2,

Fig. 4 a second exemplary embodiment of the overall heater installed in the air channel consisting of NTC and PTC resistors, and

Fig. 5 the circuit diagram for the heating element from Fig. 4.

[0013] Fig. 1 schematically illustrates a closed drying air circuit of a clothes dryer. The clothes to be dried are put into the dryer drum 2 and then circulated by the rotating dryer drum 2. The dryer drum 2 rotates on an axis 3. The front of the dryer drum 2 is connected to an air channel 7 with a blower 4 that sucks the drying air from the dryer drum 2 and pushes it through a subsequent condenser 8. This cools and dehydrates the drying air.

After passing through the condenser 8, the drying air passes through the air channel 9 and the following heating element 1 into the air channel 5 and then returns into the opposing side of the dryer drum 2. Then the dehydrated and heated drying air again absorbs evaporated moisture from the clothes 6 and is again fed through the drying air circuit.

[0014] As can be seen in Fig. 2, an overall resistance heater consisting of NTC and PTC resistors is installed at the transition from air channel 9 to air channel 5. This overall resistance heater 1 consists of a series-connected line-side NTC heater VH, and a PTC resistance heater WH. In the line-side NTC heater VH, there are two NTC resistors NTC1 and NTC2 followed by two parallel-connected PTC resistors PTC1 and PTC2 or PTC3 and PTC4.

[0015] The phase L of an AC voltage is applied to a plate-shaped metal contact body KK. The metal contact body KK is electrically and thermally connected to the two plate-shaped NTC resistors NTC1 and NTC2. The NTC resistors NTC1 and NTC2 are electrically and thermally connected via plate-shaped metal cooling bodies K1 provided with cooling ribs to two PTC resistors PTC1 and PTC2, or PTC3 and PTC4. The two PTC resistors PTC1 and PTC2 or PTC3 and PTC4 are electrically parallel-connected. The metal cooling bodies K2 are connected to the zero pole N of the AC voltage. The two metal cooling bodies K1 and K2 can also be connected to each other in an electrically conductive manner so that the two NTC resistors NTC1 and NTC2 are also parallel-connected. Several parallel-connected NTC resistors that are electrically and thermally connected can also be between the metal contact bodies KK and the metal cooling body/bodies K1. More than two parallel-connected PTC resistors can also be between the metal cooling bodies K1 and K2. The resistance characteristic of the overall resistance circuit can hence be optimally adapted to conditions during a cold-start and heating, and the resistance characteristic can be adapted as desired by selecting the NTC and PTC resistors with their associated characteristics.

[0016] As shown in the exemplary embodiment in Fig. 4 and 5, the circuit diagram to the overall resistance circuit 1 consisting of the NTC and PTC resistors can be varied and used to attain the desired resistance characteristics. The overall resistance heater 1 is installed in the air channel LK between sections 9 and 5. Phase L of the AC voltage is applied to a metal contact body KK. The single NTC resistor functions as a line-side NTC heater VH that has electrically an direct thermal contact with another metal contact body KK1.

[0017] There are three parallel-connected PTC resistors PT11, PTC12 and PTC13 functioning as a PTC resistance heater WH between the metal contact body KK1 and a first metal cooling body K1, while three parallel-connected PTC resistors PTC21, PTC22 and PTC23 are between the metal cooling bodies K1 and K2, and they are parallel-connected to PTC resistors PTC31, PTC32 and PTC33. Finally, there are four parallel-connected PTC resistors PTC31, PTC32, PTC33 and PTC34 between metal contact bodies K2 and Kn. The zero pole N of the alternating voltage is applied to metal cooling body Kn that can also be merely a metal contact body. The number of NTC and PTC resistors in the branches VH and WH of the series-connection of the circuit diagram in Fig. 5 can be larger or smaller to create the desired overall resistance characteristic for the overall resistance heater.

[0018] The NTC and PTC resistors are mutually heated via their thermal connection.

[0019] The geometric arrangement of the heater in Fig. 4 reduces the voltage difference between the metal contact bodies KK and KK1 as well as metal cooling bodies K1, K2, Kn and the surrounding air channel LK as can be seen from the circuit diagram in Fig. 5 in which the connecting points of resistors are provided with corresponding references.

Claims

1. A clothes dryer with a PTC resistance heater for the drying air conducted through the dryer drum by means of a blower,
   characterised in that
   a line-side NTC heater (VH) consisting of at least one NTC resistor (NTC1, NTC2, NTC) is series-connected to the PTC resistance heater (WH), and that at least one PTC resistor of the PTC resistance heater (WH) thermally contacts an NTC resistor of the line-side NTC heater (VH).

2. A clothes dryer according to claim 1,
   characterised in that
   the overall heater (1 = WH + VH) is in an air channel (9,5) through which drying air flows.

3. A clothes dryer according to claim 1 or 2,
   characterised in that
   the line-side NTC heater (VH) limits the starting current in the cold-start phase by means of its temperature-related resistance characteristic.

4. A clothes dryer according to one of claims 1 - 3,
   characterised in that
   the PTC resistance heater (WH) limits the heating current and protects against overload by means of its temperature-related resistance characteristic.

5. A clothes dryer according to one of claims 1 - 4,
   characterised that the
   PTC resistors (PTC1 - PTC4; PTC11, PTC12, PTC21, PTC22; PTC32) in the PTC resistance heater (WH) are series-connected, parallel-connected or a mixture thereof, and that the NTC resistors (NTC1, NTC2, NTC) in the inline NTC heater

(VH) are series-connected, parallel-connected or a mixture thereof.

6. A clothes dryer according to one of claims 1 - 5, **characterised in that** the PTC and NTC resistors are in the form of plates and electrically contact each other preferably by means of plate contact bodies (KK) and/or plate cooling bodies (K1, K2, Kn) provided with cooling ribs, and the contact bodies and cooling ribs in the PTC resistance heater (WH) and line-side NTC heater (VH) connect the PTC resistors and NTC resistors according to the overall heating system (Fig. 3 or Fig. 5).

7. A clothes dryer according to claim 6, **characterised in that** at least one cooling body (K1) electrically and thermally contacts a surface with at least one PTC resistor and another surface with at least one NTC resistor.

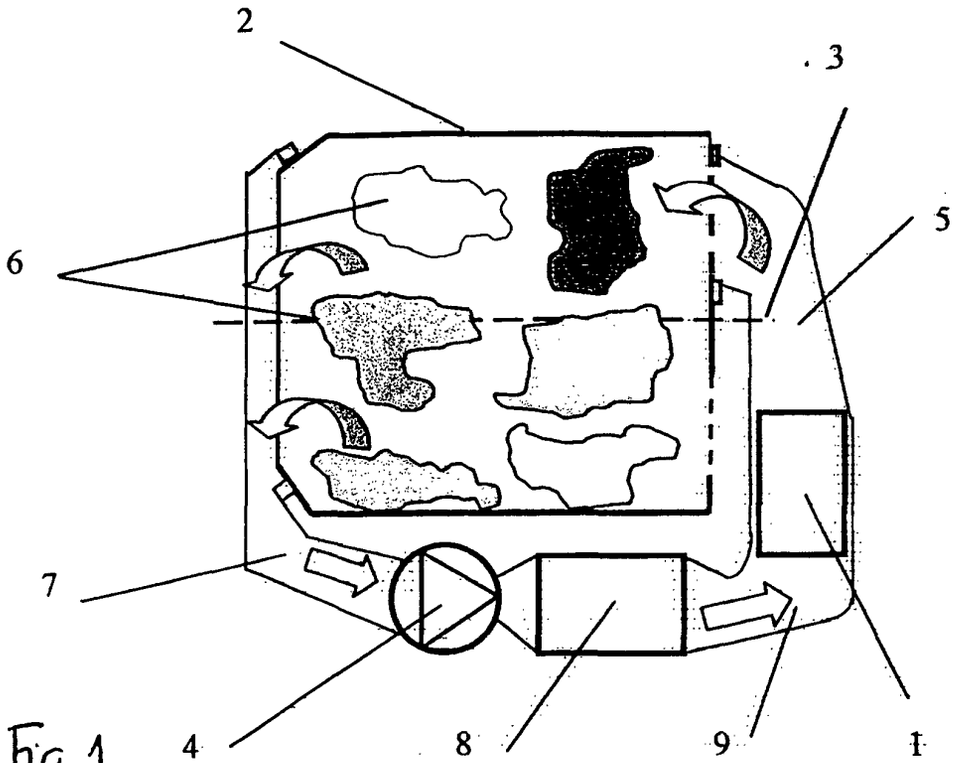

Fig. 1

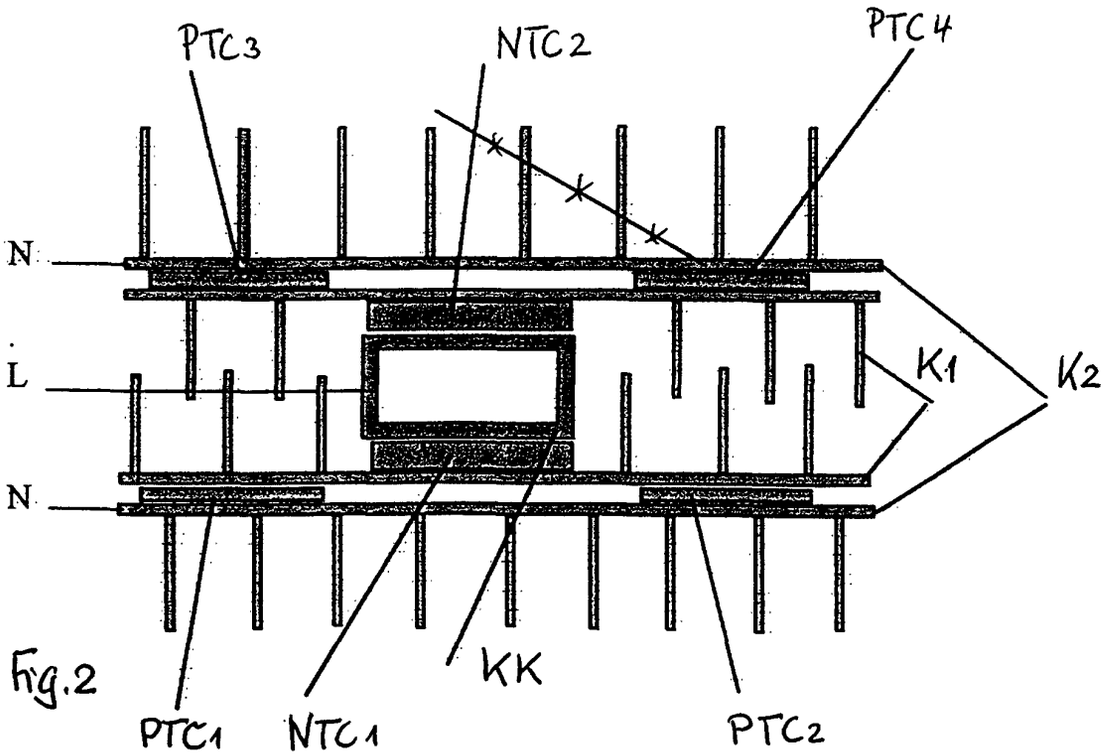

Fig. 2

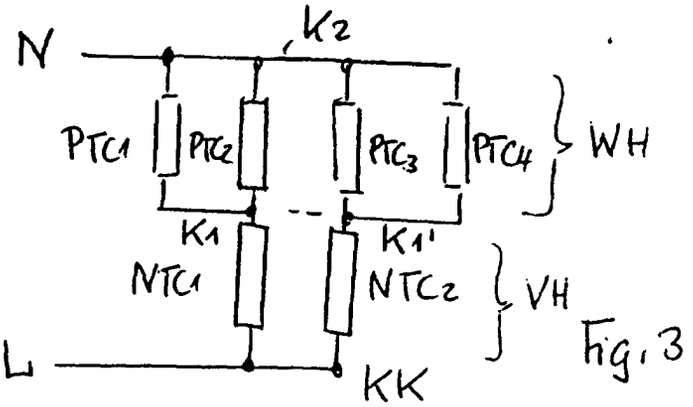

Fig. 3

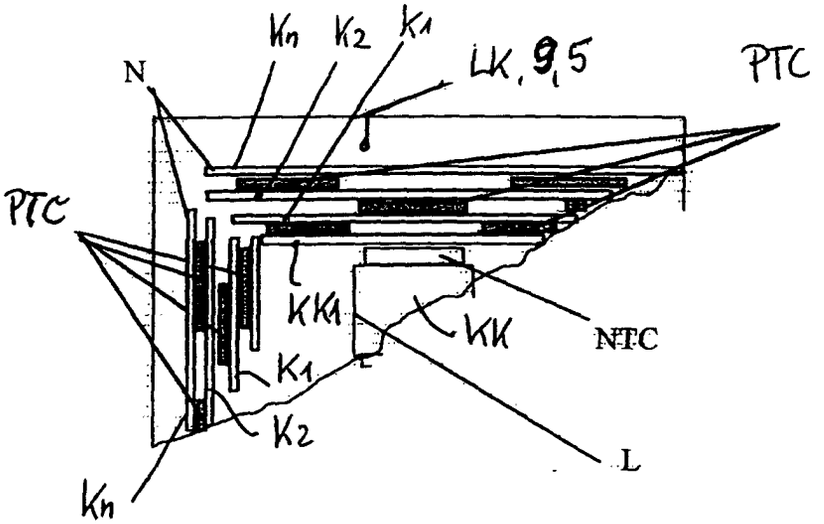

Fig. 4

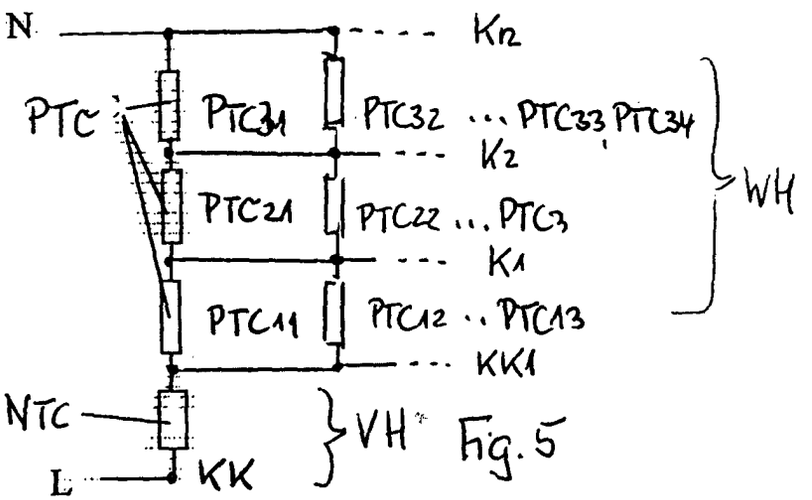

Fig. 5