

[54] **METHOD AND APPARATUS FOR CONTROLLING THE DRYING OPERATION IN AN APPLIANCE SUCH AS A DRYER, WASHER-DRYER OR THE LIKE**

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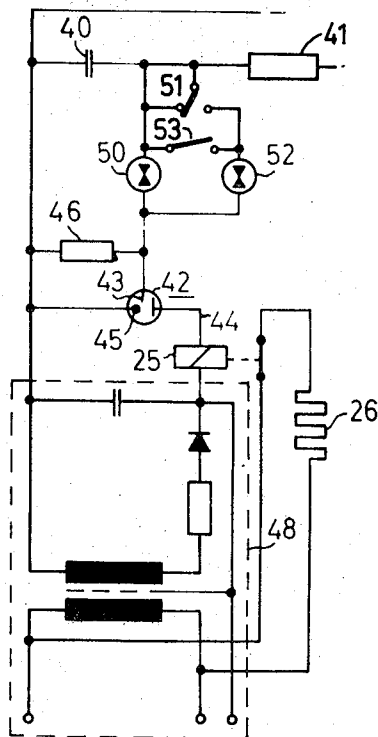
[57] **ABSTRACT**

A method of controlling the drying operation of laundry in dependence upon the moisture content thereof in an appliance such as a dryer, washer-dryer or the

like is disclosed. The appliance has a program control device and is of the tumbler type wherein an electrostatic charge occurs on the laundry when the laundry becomes dry. The method includes sensing the electrostatic charge occurring on the laundry when the laundry becomes dry to provide an electrical signal indicative of the field intensity developed by the electrostatic charge, and then transmitting the electrical signal to an operational amplifier connected to the program control device whereby the operational amplifier operates on the control device in response to the voltage signal.

An apparatus for carrying out the above method is also disclosed and includes a structure arranged in the appliance so as to be in contact with the laundry tumbled during the drying operation; this structure thus receives an electrostatic charge thereon in response to the electrostatic charge occurring on the laundry when the laundry becomes dry. An electrically conductive sensing member is connected to the structure for sensing the electrostatic charge collected thereon to provide a voltage signal indicative of the electric field intensity developed by the electrostatic charges on the laundry and the structure. An electronic operational amplifier having an input control electrode is also provided and a glow discharge device is connected between the sensing member and the control electrode. The glow discharge device transmits the voltage signal to the control electrode after the voltage signal has attained a predetermined value corresponding to the laundry in the appliance. The operational amplifier is connected to the program control device of the appliance whereby the operational amplifier operates on the program control device in response to the voltage signal of pre-determined value.

**8 Claims, 3 Drawing Figures**



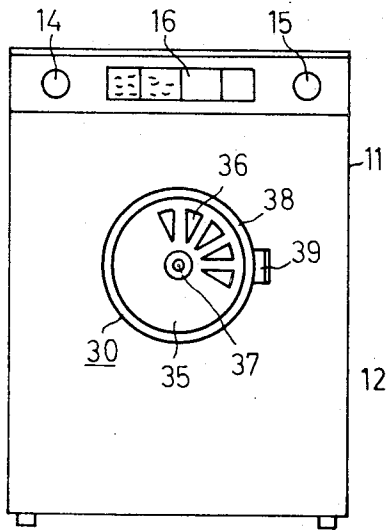


Fig. 1

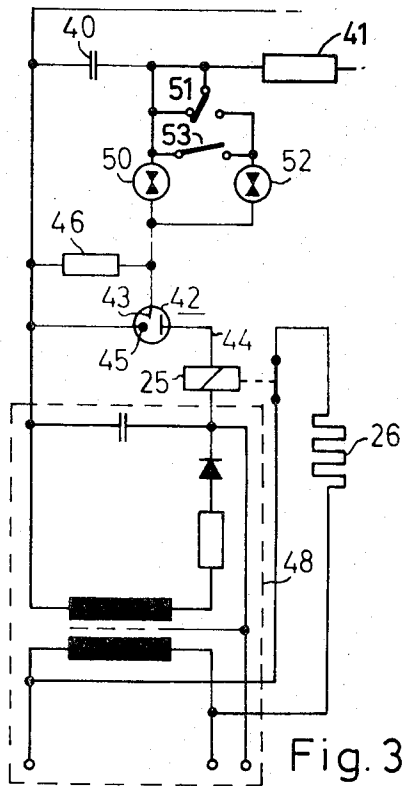


Fig. 3

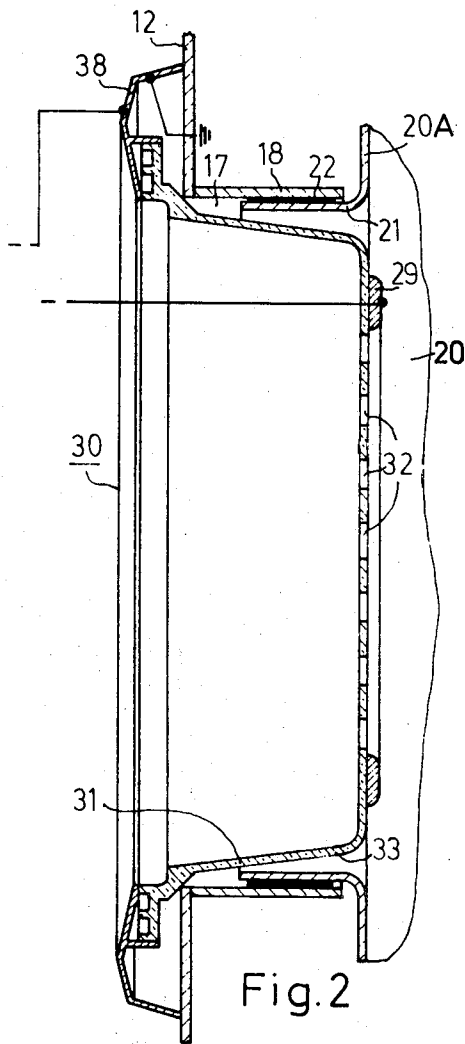


Fig. 2

**METHOD AND APPARATUS FOR CONTROLLING  
THE DRYING OPERATION IN AN APPLIANCE  
SUCH AS A DRYER, WASHER-DRYER OR THE  
LIKE**

**BACKGROUND OF THE INVENTION**

The invention relates to a method and apparatus for controlling the drying process of laundry in dependence upon the moisture content thereof in an appliance such as a dryer, washer-dryer or the like which operates according to the tumbler principle.

Most laundry dryers intended for household use are provided with a timer by means of which the duration of the drying period can be set. Such a control method, the desired degree of drying can be achieved only through much experience under approximately constant conditions.

To be able to define the duration of the process and thereby, the degree of dryness more specifically, several methods are known in which the degree of dryness is monitored as a function of condition. Thus, one automatic switch-off device for a hot-air dryer, for example, operates with temperature-sensitive and/or humidity-sensitive resistors as sensors for sensing the degree of dryness. In other known dryer controls, the degree of dryness of the laundry is determined by measuring its conductivity and/or its resistance.

The control methods mentioned above, however, are only capable of monitoring the degree of dryness up to a moisture content of about 20 percent with any accuracy. However, if a batch of laundry is to be dried to the extent that it is ready for placement in the laundry closet, that is, dried to a moisture content of 0 percent, purely time-dependent control elements are used in the known dryers for this last drying phase.

**SUMMARY OF THE INVENTION**

It is an object of the invention to provide a method of controlling the drying operation of laundry in an appliance such as a dryer, washer-dryer or the like which affords a substantial improvement over the methods described above wherein the drying time is monitored in dependence upon the moisture content of the laundry. Subsidiary to this object, it is an object of the invention to provide such a method wherein a purely condition dependent control down to moisture content of 0 percent is made possible.

It is another object of the invention to provide an apparatus for performing the foregoing object methods.

The method of the invention is performed in an appliance such as a dryer, washer-dryer or the like which is equipped with a program control device. The appliance is of the tumbler type wherein an electrostatic charge occurs on the laundry when the laundry becomes dry. The invention involves applying an electrical quantity to an operational amplifier which is indicative of the field intensity developed by the electrostatic charging. The amplifier then in turn operates on the program control device.

The method includes as a feature the step of sensing the electrostatic charge occurring on the laundry when the laundry becomes dry to provide an electrical signal indicative of the field intensity developed by the electrostatic charge, and then transmitting the electrical signal to an operational amplifier connected to the pro-

gram control device whereby the operational amplifier operates on the control device in response to the voltage signal.

The invention is based on the observation that completely dry laundry which is moved in a dryer operating according to the tumbler principle is electrostatically charged. This becomes apparent when it is considered that in the laundry drums of dryers of modern configuration, plastic parts are generally used, for example, as the driver or the coarse screen. In some cases, the entire drum is made of plastic. It is on the basis of these observations that the new method functions; this method affords the advantage that it can determine without any difficulty the drying point at a moisture content of the laundry of 0 percent.

The apparatus for carrying out the above method includes as a feature a structure arranged in the appliance so as to be in contact with the laundry tumbled during the drying operation; this structure thus receives an electrostatic charge thereon in response to the electrostatic charge occurring on the laundry when the laundry becomes dry. An electrically conductive sensing member is connected to the structure for sensing the electrostatic charge collected thereon to provide a voltage signal indicative of the electric field intensity developed by the respective electrostatic charges on the laundry and the structure. An electronic operational amplifier having an input control electrode is also provided and glow discharge means in the form of a glow discharge device is connected between the sensing member and the control electrode. The glow discharge device transmits the voltage signal to the control electrode after the voltage signal has attained a predetermined value corresponding to the laundry in the appliance. The operational amplifier is connectable to the program control device of the appliance whereby the operational amplifier operates on the program control device in response to the voltage signal of the predetermined value.

The appliance wherein the apparatus of the invention is arranged has a housing. The housing is preferably provided with a door in the front wall thereof through which the appliance is loaded with laundry. According to another feature of the invention, the structure can be a part of this door and located so as to be in contact with the laundry tumbled during the drying operation.

The foregoing is based on the following consideration. For switching a dryer, an amount of energy of the order of one-tenth of a watt-second is required. The electrostatic energy produced in the drying process in a laundry dryer, however, is only about several thousandths of a watt-second. In order to use the very small amount of charge that can be conducted away for the control of the dryer, the charge that occurs on the pieces of laundry and on the drum of the dryer must be collected in suitable form. It has been found particularly advantageous in this connection, to provide an overvoltage arrester between the voltage sensor and the control electrode of the amplifier. This configuration of the circuit arrangement makes it possible to use the very small amount of charge for the control of the dryer. Thus, according to still another feature of the invention, the glow discharge device can be an overvoltage arrester of the glow discharge type. The operational amplifier can be a cold-cathode tube as well as

a transistor flip-flop which is connected in shunt with the capacitor of an RC circuit member.

Because the overvoltage arrester between the voltage sensor at the dryer and the control electrode must be optimally matched to the peak voltage occurring in each case, it is recommended to arrange different overvoltage arresters in parallel so as to be switchable into and out of the circuit so that a match can be provided to the peak voltages of different height which occur with different kinds of laundry. According to another embodiment of the invention, the glow discharge means can then be a plurality of overvoltage arresters of the glow discharge type connected so as to be switchable into the circuit between the sensing member and the operational amplifier. Switching means are then provided for selectively switching any one of the overvoltage arresters into the circuit. Additional means for switching at least one of the remainder of the overvoltage arresters into the circuit in parallel with the one overvoltage arrester already connected into the circuit can also be provided.

Although the invention is illustrated and described herein as a method and apparatus for controlling the drying operation in an appliance such as a dryer, washer-dryer or the like, it is nevertheless not intended to be limited to the details shown, since various modifications may be made therein within the scope and the range of the claims. The invention, however, together with additional objects and advantages will be best understood from the following description and in connection with the accompanying drawings.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an outline view of an appliance such as a dryer wherein the method according to the invention is performed. The appliance is also adapted to accommodate the apparatus of the invention.

FIG. 2 is an expanded section view showing the portion of the appliance pertinent to the invention; this view is taken at the door of the dryer through which the laundry is loaded.

FIG. 3 is a circuit diagram which includes an amplifier circuit and the glow discharge device of the apparatus of the invention.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

The laundry dryer of FIG. 1 operates according to the tumbler principle and includes a housing 11 wherein a drum 20 of large volume is arranged which receives the laundry. The drying air is heated with a blower (not shown) coacting with a heater and is introduced into the drum on the rear side and is blown out of the drum in the area of the charging door, as will be described in further detail below. On the front side of the housing a charging opening 17 is provided, which can be closed by the bull's eye type charging door 30. In the upper portion of the front wall 12, control devices 14 and 15 and dials 16 with setting instructions are arranged.

In the region of the charging opening 17 (FIG. 2) a tubular bearing 18 is connected with the front wall 12 of the housing on which the correspondingly shaped bearing ring 21 of the front end face 20A of the drum rests, with a strip of fabric 22 interposed. Structure means in the form of a cup-shaped body 31 made of plastic projects into the charging opening 17. The body

31 has a base portion having large air-passage holes 32 which serve as a coarse screen. The body 31 with its base portion 33 is lined up with the front end face of the drum 20. Referring to FIG. 1 on the outside of the door, a metal aperture 35 is arranged which is provided with slot-shaped cutouts 36 for the discharge of the air. The aperture and a lint filter connected therewith can be connected by means of a pushbutton 37 and a pushbutton mechanism, not shown, with the coarse screen and the other parts of the charging door 30.

The ring-shaped frame 38 is made of metal and carries the door lock 39. The frame 38 is grounded because an electrical turn-off switch is connected with the door lock; this turn-off switch interacts with the control system and shuts off the drum drive, the blower and the heater when the door is opened.

For sensing the electrostatic charge of the laundry, a sensing member in the form of a ring electrode 29 is arranged at the outer side of the base portion 33. The ring electrode 29 is connected with a control electrode 43 of the amplifier circuit as described in detail with reference to FIG. 3.

Referring now to FIG. 3, a capacitor 40 of approximately 200 pf is connected between the grounded door frame 38 and the ring electrode 29 serving as the voltage sensor. The static charge of the laundry is transmitted to the control electrode 43 of a cold-cathode tube 42 through the ring electrode 29, a high-resistance protective resistor 41 of about 20 megohm, a double-throw switch 51 and an overvoltage arrester 50 (for the position of switch 51 shown) which functions in the manner of a glow discharge device. The overvoltage arrester 50, for example, has a firing voltage of 800 to 1,200 V whereas its operating voltage is 70 to 100 V. An additional overvoltage arrester 52 with other characteristics can also be provided to provide a match to a different kind of laundry. By means of the double-throw switch 51, either overvoltage arrester 50 or 52 can be selectively connected into the circuit to provide a match for the particular kind of laundry being dried. If required, the additional switch 53 can be closed to connect the two overvoltage arresters 50 and 52 in parallel with each other to provide a match for still another kind of laundry.

The operational amplifier 42 is made up of a cold-cathode tube having a plate circuit 44. A high-impedance relay 25 of about 11 kilo-ohms is connected into the plate circuit 44 for controlling the heater 26 of the dryer. The power supply of the control device is designated with reference numeral 48. The cold-cathode tube has a firing voltage of about 140 V. The control electrode 43 is connected with the cathode 45 via a high-impedance resistor 46 of about 1 megohm.

The apparatus of the invention functions as described below:

When the laundry is dry, an electrostatic charge appears at the laundry and at the plastic parts of the dryer drum which is so high that the breakdown voltage of the overvoltage arrester 50 is reached. This causes a control pulse to arrive at the control electrode 43 thereby causing a current pulse in the plate circuit 44. The relay 25 is thereby energized and the heater 26 of the dryer is shut off.

What is claimed is:

1. In an appliance such as a dryer, washer-dryer or the like, the appliance having a program control device

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and being of the tumbler type wherein an electrostatic charge occurs on the laundry when the laundry becomes dry, an apparatus for controlling the drying operation of the laundry in dependence upon the moisture content thereof, the apparatus comprising structure means arranged in the appliance so as to be in contact with the laundry tumbled during the drying operation for receiving an electrostatic charge thereon in response to the electrostatic charge occurring on the laundry when the laundry becomes dry, an electrically conductive sensing member connected to said structure means for sensing electrostatic charge collected thereon to provide a voltage signal indicative of the electric field intensity developed by said electrostatic charge, an electronic operational amplifier having an input control electrode, and glow discharge means connected between said sensing member and said control electrode for transmitting said voltage signal to said control electrode after said voltage signal has attained a predetermined value corresponding to the laundry in the appliance, said operational amplifier being connectable to the program control device of the appliance whereby said operational amplifier operates on the program control device in response to said voltage signal of predetermined value, said glow discharge means comprising a plurality of overvoltage arresters of the glow discharge type connected so as to be switchable into the circuit between said sensing member and said control electrode of said operational amplifier, and the apparatus comprising switching means for selectively switching any one of said overvoltage arresters into said circuit, said switching means including means for switching at least one of the remainder of said overvoltage arresters into said circuit in parallel with said one overvoltage arrester.

2. In an appliance such as a dryer, washer-dryer or the like, the appliance having a program control device and being of the tumbler type wherein an electrostatic charge of a specific magnitude occurs on the laundry when the moisture content of the laundry reaches a desired value, an apparatus for controlling the drying operation of the laundry in dependence upon the moisture content thereof, the apparatus comprising a plastic structure arranged in the appliance so as to be in contact with the laundry tumbled during the drying operation for receiving an electrostatic charge thereon in response to the electrostatic charge occurring on the laundry when the laundry becomes dry, an electrically conductive sensing member connected to said plastic structure for sensing said electrostatic charge collected thereon to provide a voltage signal indicative of the electric field intensity developed by said electrostatic charge, an electronic operational amplifier having an input control electrode, and a glow discharge device

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selected for responding to a determined value of the voltage signal corresponding to said specific magnitude of the electrostatic charge, said glow discharge device being connected between said sensing member and said control electrode for transmitting said voltage signal to said control electrode after said voltage signal has attained said determined value, said operational amplifier being connectable to the program control device of the appliance whereby said operational amplifier operates on the program control device in response to said voltage signal of determined value when the moisture content of the laundry reaches said desired value.

3. The apparatus of claim 2 wherein the appliance has a housing with a door mounted on the front wall thereof through which the appliance is loaded with laundry, said plastic structure being a part of the door of the appliance and located so as to be in contact with the laundry tumbled during the drying operation, and said glow discharge device being an overvoltage arrester of the glow discharge type.

4. The apparatus of claim 3, said part of the door being made electrically insulating material.

5. The apparatus of claim 4, said material being plastic.

6. The apparatus of claim 3, said operational amplifier being a cold-cathode tube amplifier stage.

7. The apparatus of claim 1 wherein the appliance has a housing with a door mounted on the front wall thereof through which the appliance is loaded with laundry, said structure means being part of the door of the appliance and located so as to be in contact with the laundry tumbled during the drying operation.

8. A method of controlling the drying operation of laundry in an appliance such as a dryer, washer-dryer or the like so as to cause the laundry to have a moisture content of a desired value, the appliance having a program control device and being of the tumbler type wherein an electrostatic charge of a specific magnitude occurs on the laundry when the moisture content of the laundry reaches the desired value, the method comprising: sensing the electrostatic charge occurring on the laundry as the laundry becomes dry to provide an electrical signal, supplying the electrical signal to a glow-discharge device selected for responding to a determined value of the electrical signal corresponding to said specific magnitude of the electrostatic charge, and transmitting the determined value of the electrical signal from the glow-discharge device to an operational amplifier connected to the program control device whereby the operational amplifier operates on the control device when the moisture content of the laundry reaches the desired value.

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