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(11) **EP 1 577 433 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
21.09.2005 Bulletin 2005/38

(51) Int Cl.7: **D06F 25/00**, D06F 58/24,
D06F 58/28

(21) Application number: **05250882.7**

(22) Date of filing: **16.02.2005**

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IS IT LI LT LU MC NL PL PT RO SE SI SK TR**
Designated Extension States:
AL BA HR LV MK YU

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(30) Priority: **17.02.2004 KR 2004010412 P**
17.02.2004 KR 2004010413 P

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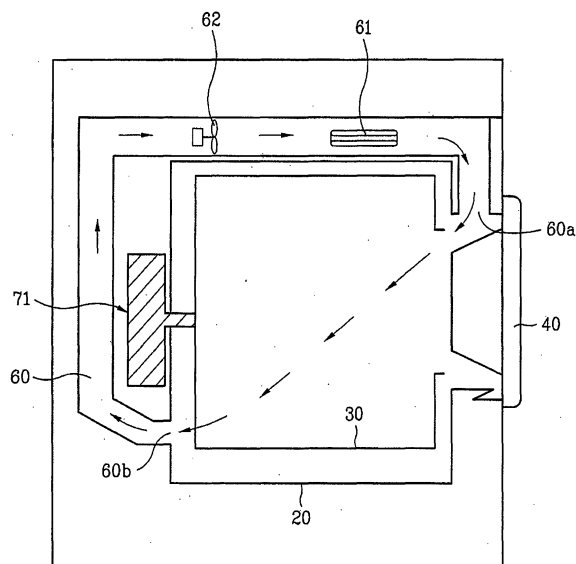
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(54) **Structure for supplying hot air for drying clothes in drum type washing machine and operation control method thereof**

(57) Structure for supplying hot air to a drum washing machine, and operation control method thereof, in which uniform introduction of hot air deep into an inside of a drum is made possible for enhancing drying capability and efficiency.

For this, a drum washing machine includes a tub (20) for holding washing water, a drum (30) rotatably mounted in the tub, for introducing laundry therein, a drying heater (61) for heating air being supplied to an inside of the drum, a drying duct (60) forming a flow passage for supplying hot air heated by the drying heater to the inside of the drum, a fan (62) for forced supply of the hot air heated by the drying heater to the inside of the drum, a hot air inlet (60a) at a front side of the drum for supplying the hot air to the inside of the drum, and a humid air recovery opening (60b) at a rear side of the drum for recovering humid air from the inside of the drum, and the operation control method of a drum washing machine includes the step of supplying hot air to an inside of the drum while rotating the drum at a speed equal to, or higher than a speed enough to keep the laundry in the drum attached to, and not fall off from, the inside surface of the drum in progressing a drying cycle.

FIG. 4



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Description

Field of the Invention

[0001] The present invention relates to drum type washing machines, and more particularly, to a structure for supplying hot air, in which uniform introduction of hot air deep into an inside of a drum is made possible for enhancing drying capability and efficiency; and an operation control method thereof.

Discussion of the Related Art

[0002] In general, in the washing machines, there are a pulsator type washing machine of a top loading type, and a drum type washing machine (in general called as a drum washing machine) having a drum laid down in a horizontal direction, substantially.

[0003] As described before, since the drum is laid down in a horizontal direction, the drum washing machine performs the washing by a method in which laundry introduced into an inside of the drum is lifted and dropped during rotation of the drum.

[0004] Moreover, recently even demands on washing and drying machines increase gradually, which has not only washing and water extraction functions, but also a drying function.

[0005] Even in the drum washing machine, there are a drum washing machine of a type the drum thereof is laid down in a horizontal direction fully, and a tilted type drum washing machine of which drum is tilted at an angle from a horizontal plane, and, depending on a direction of introduction/taking out of laundry into/from the drum, there are a front loading type, and a top loading type drum washing machines.

[0006] FIGS. 1 and 2 illustrate basic exemplary structures of above washing and drying machines, schematically.

[0007] That is, the washing and drying machine is provided with a body 10, a tub 20 mounted on an inside of the body 10, a drum 30 rotatably mounted on an inside of the tub 20, washing water supply pipes 51 for guiding flow of the washing water, a driving unit for driving the drum 30, and a drying device for supplying heated air to an inside of the tub 20.

[0008] On a front of the body 10, there is an opening for introduction of laundry, with a door 40 thereon for opening/closing the opening. Between the front of the body 10 and the tub 20, there is a gasket 11.

[0009] The tub 20 is supported, and mounted in the body 10. There may be a washing water drying heater 80 on a bottom of an inside of the tub 20, for controlling a temperature of the washing water used for washing.

[0010] The drum 30 is rotatably mounted in the tub 20, and has a plurality of through holes 31 (see FIG 2) in a circumferential surface for flow in/out of the washing water.

[0011] The washing water supply pipe 51, for flow of

the washing water, guides the washing water from a service pipe to the inside of the tub 20 through a water supply valve 52. There is a detergent box 53 in the washing water supply pipe 51 for storing detergent required for washing, so that the washing water being supplied to the inside of the tub 20 carries the detergent. The detergent box 53 in an upper space of the body 10 is designed to enable introduction of the detergent.

[0012] The washing water supply pipe 51 has an end connected to a front of an upper portion of the tub 20 for filling up the tub 20 with the washing water from a bottom thereof by free falling of the washing water.

[0013] The driving unit is provided with a drum driving motor 71, and a belt 72 for transmission of a driving power from the drum driving motor 71 to the drum 30. Recently, instead of the driving unit, a direct coupling type BLDC motor is used, which is mounted on a rear wall of the tub for direct transmission of the driving power from the motor to the drum.

[0014] The drying device is provided with a drying duct 60 for flow of air, a drying heater 61 in the drying duct 60, and a fan 62 for forced circulation of air. The drying duct 60 has one end connected to the tub 20 at a lower portion of a front side of an outside circumference thereof and the other end connected to the gasket 11, for circulation of air through the inside of the tub 20.

[0015] Connected to the drying duct 60, there is a cooling water supply pipe 54 for supplying cooling water to the air flowing along the drying duct 60 toward the drying heater after drying laundry to condense moisture therein. By removing the moisture from the air, the cooling water prevents drop of performance of the fan 62, and drop of efficiency of the drying heater 61.

[0016] The cooling water supply pipe 54 is connected to the water supply valve 52 for supplying washing water. The water supply valve 52 is operated such that only a very low rate of water is supplied to the drying duct 60 compared to a rate of the washing water supply to the drum 30 through the washing water supply pipe 51, if water supply to the drying duct 60 through the cooling water supply pipe 54 is required for condensing.

[0017] In the meantime, while the related art drum washing machine progresses drying by rotating the drum 30 at a low speed (about 20 ~ 30 rpm) after washing, and spinning, the hot air, heated and dried by the drying heater, is introduced into the inside of the drum through, in general, a connection portion to the gasket 11 on the front of the drum 30, converted into humid air by the drying action, and escapes through a lower side of a front of the drum 30 again.

[0018] That is, referring to FIGS. 1 and 3, because the drying duct draws humid air from the front side of the outside circumference of the tub, the hot air fails to be introduced deep into an inside of the drum 30, but circulates only on an entrance side and is directly discharged to a lower side of the front of the drum 30.

[0019] Therefore, since the hot air escapes the drum 30 before the hot air can be used fully for drying in the

drum 30, the drying performance, and efficiency are impaired, and input of unnecessary energy is required, resulting in waste of energy.

[0020] In short, with regard to a main flow path of the hot air in the related art drum washing machine, because the hot air fails to reach to the laundry located far from a hot air inlet fully, failing to dry the laundry uniformly to impair the drying performance, to require drying for a long time, the drying efficiency is also reduced.

[0021] Accordingly, the present invention is directed to a structure for supplying hot air in a drum washing machine and an operation control method thereof that substantially obviates one or more problems due to limitations and disadvantages of the related art.

[0022] An object of embodiments of the present invention is to provide a structure for supplying hot air in a drum washing machine and an operation control method thereof, in which hot air can be blown deep into an inside of the drum, to introduce the hot air into an inside space of the drum uniformly for drying the laundry. That is, an object of embodiments of the present invention is to provide a structure for supplying hot air and an operation control method thereof, which enables full use of the hot air introduced into the inside of the drum for enhancing the drying performance, and efficiency.

[0023] Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objectives and other advantages of the invention may be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[0024] According to the present invention there is provided a drum washing machine includes a tub for holding washing water, a drum rotatably mounted in the tub, for introducing laundry therein, a drying heater for heating air being supplied to an inside of the drum, a drying duct forming a flow passage for supplying hot air heated by the drying heater to the inside of the drum, a fan for forced supply of the hot air heated by the drying heater to the inside of the drum, a hot air inlet at a front side of the drum for supplying the hot air to the inside of the drum, and a humid air recovery opening at a rear side of the drum for recovering humid air from the inside of the drum.

[0025] In another aspect of the present invention, a drum washing machine includes a tub for holding washing water, a drum rotatably mounted in the tub, for introducing laundry therein, a drying heater for heating air being supplied to an inside of the drum, a drying duct forming a flow passage for supplying hot air heated by the drying heater to the inside of the drum, a fan for forced supply of the hot air heated by the drying heater to the inside of the drum, a hot air inlet at a rear side of the drum for supplying the hot air to the inside of the drum, and a humid air recovery opening at a front side

of the drum for recovering humid air from the inside of the drum.

[0026] In another aspect of the present invention, a method for controlling operation of a horizontal or tilt type drum washing machine including a tub for holding washing water, a drum rotatably mounted in the tub, for introducing laundry therein, a drum driving motor for providing driving force to rotate the drum, a drying heater for heating air being supplied to an inside of the drum, a drying duct forming a flow passage for supplying hot air heated by the drying heater to the inside of the drum, and a fan for forced supply of the hot air heated by the drying heater to the inside of the drum, the method including the step of supplying the hot air to an inside of the drum while rotating the drum at a speed equal to, or higher than a speed enough to keep the laundry in the drum to be attached to, and not to fall off from, an inside surface of the drum in progressing of a drying cycle.

[0027] In another aspect of the present invention, a method for controlling operation of a horizontal or tilt type drum washing machine including a tub for holding washing water, a drum rotatably mounted in the tub, for introducing laundry therein, a drum driving motor for providing driving force to rotate the drum, a drying heater for heating air being supplied to an inside of the drum, a drying duct forming a flow passage for supplying hot air heated by the drying heater to the inside of the drum, and a fan for forced supply of the hot air heated by the drying heater to the inside of the drum, the method including the steps of turning off the drum driving motor as spinning is finished, turning on the drying heater and the fan, and supplying the hot air to an inside of the drum while a rotation speed of the drum is maintained at a speed enough to keep the laundry to be attached to, and not fall off from an inside circumferential surface of the drum by turning on the drum driving motor again before the laundry attached to the inside circumferential surface of the drum in the spinning falls off therefrom.

[0028] In another aspect of the present invention, a method for controlling a drying cycle of a horizontal or tilt type drum washing machine including a tub for holding washing water, a drum rotatably mounted in the tub, for introducing laundry therein, a drying heater for heating air being supplied to an inside of the drum, a drying duct forming a flow passage for supplying hot air heated by the drying heater to the inside of the drum, a fan for forced supply of the hot air heated by the drying heater to the inside of the drum, and means for determining dryness of the laundry in the drum, the method including the steps of measuring dryness of the laundry in the drum in a state the drum is stationary after finish of spinning, supplying hot air while rotating the drum at a speed equal to or higher than a speed enough to keep the laundry to be attached to, and not to fall off from, an inside surface of the drum by raising the rotating speed of the drum, if measured dryness is below preset dryness, and supplying the hot air to an inside of the drum while rotating the drum at a speed below a speed enough to

keep the laundry to be attached to, and not to fall off from the inside surface of the drum, for progressing drying, if the measured dryness is higher than the preset dryness.

[0029] In another aspect of the present invention, a method for controlling operation of a horizontal or tilt type drum washing machine including a tub for holding washing water, a drum rotatably mounted in the tub, for introducing laundry therein, a drying heater for heating air being supplied to an inside of the drum, a drying duct forming a flow passage for supplying hot air heated by the drying heater to the inside of the drum, a fan for forced supply of the hot air heated by the drying heater to the inside of the drum, and means for determining dryness of the laundry in the drum, the method including the steps of after spinning, supplying the hot air to the inside of the drum while rotating the drum at a speed to maintain a state in which the laundry is kept to be attached to, and not to fall off from, but not to be attached closely to, an inside surface of the drum, detecting the dryness in the middle of above step, to progress drying while maintaining a speed to maintain a state in which the laundry is kept to be attached to, and not to fall off from, but not to be attached closely to, the inside surface of the drum, if the dryness is below a preset dryness, and progressing the drying after reducing the rotation speed of the drum to a low speed at which the laundry is unable to be attached to, but fall off from the inside surface of the drum, if the dryness is higher than the preset dryness.

[0030] In another aspect of the present invention, a method for controlling operation of a horizontal or tilt type drum washing machine including a tub for holding washing water, a drum rotatably mounted in the tub, for introducing laundry therein, a drying heater for heating air being supplied to an inside of the drum, a drying duct forming a flow passage for supplying hot air heated by the drying heater to the inside of the drum, and a fan for forced supply of the hot air heated by the drying heater to the inside of the drum, and a hot air supply structure in which a hot air inlet of the drying duct is positioned at a front side or a rear side of the drum, and a humid air recovery opening of the drying duct is positioned at the rear side or the front side of the drum opposite to the hot air inlet, the method including the steps of, in progressing a drying cycle, supplying hot air to an inside of the drum through the hot air inlet positioned at a front, or a rear of the drum, and, at the same time with this, rotating the drum at a speed enough to keep the laundry attached to, and not fall off from, but not to be attached closely to, an inside surface of the drum, for progressing drying.

[0031] Embodiments of the invention will now be described by way of example only with reference to the accompanying drawings in which:-

[0032] FIG 1 illustrates a side section of a related art washing and drying machine, schematically;

[0033] FIG 2 illustrates a front section of the washing

and drying machine in FIG 1;

[0034] FIG. 3 illustrates a diagram showing a main flow path of hot air on an entrance side of a drum in a related art drum washing machine, for reference;

[0035] FIG. 4 illustrates a drum washing machine embodying the present invention showing a hot air circulating structure;

[0036] FIG 5 illustrates a drum washing machine embodying the present invention showing another hot air circulating structure;

[0037] FIG 6 illustrates a front view of a rear wall portion of a tub cut along a I-I line in FIG 5 for showing a through hole structure in the tub;

[0038] FIG. 7 illustrates a flow chart showing the steps of a first method for controlling operation of a drum washing machine embodying the present invention;

[0039] FIG 8 illustrates a flow chart showing the steps of a second method for controlling operation of a drum washing machine embodying the present invention;

[0040] FIG 9 illustrates a flow chart showing the steps of a third method for controlling operation of a drum washing machine embodying the present invention;

[0041] FIG 10 illustrates a flow chart showing the steps of a fourth method for controlling operation of a drum washing machine embodying the present invention; and

[0042] FIG 11 illustrates a graph showing a rotation speed of a motor for driving the drum, and turn on/off states of drying heater and fan while drying.

[0043] In the various figures, like reference figures indicate like parts.

[0044] Referring to FIG 4, a drum washing machine includes a tub 20 for holding washing water, a drum 30 rotatably mounted on an inside of the tub 20, for introducing laundry therein, a drying heater 61 for heating air being supplied to the inside of the drum 30, a drying duct 60 forming a flow passage for supplying hot air heated by the drying heater 61, and fan 62 for forced supply of the hot air heated by the drying heater 61 to the inside of the drum 30, wherein a hot air inlet 60a is positioned at a front of the drum 30, and a humid air recovery opening 60b is positioned at a rear of the drum 30.

[0045] More specifically, the hot air inlet 60a is positioned at upper side of the front of the drum 30, and the humid air opening 60b is positioned at a lower side of the rear of the drum 30.

[0046] Even though FIG. 4 illustrates a horizontal type drum washing machine, of course, the hot air supply and exhaust structure is also applicable to the tilt type drum washing machine.

[0047] A hot air circulating structure of the drum washing machine will be described.

[0048] Referring to FIG. 4, in drying, the hot air is introduced into the inside of the drum through an upper portion of the front of the drum 30 by the forced air blow action of the fan 62, flows from the front to a rear of the drum along a direction of the arrow, passes a lower por-

tion of a rear side of the drum, and is introduced into the drying duct 60 through the humid air recovery opening 60b in the rear wall of the tub 20.

[0049] Referring now to FIG 5, a drum washing machine includes a tub 20 for holding washing water, a drum 30 rotatably mounted on an inside of the tub 20, for introducing laundry therein, a drying heater 61 for heating air being supplied to the inside of the drum 30, a drying duct 60 forming a flow passage for supplying hot air heated by the drying heater 61, and fan 62 for forced supply of the hot air heated by the drying heater 61 to the inside of the drum 30, wherein a hot air inlet 60a is positioned at a rear of the drum 30, and a humid air recovery opening 60b is positioned at a front of the drum 30.

[0050] More specifically, the hot air inlet 60a is positioned at an upper side of the rear of the drum 30, and the humid air opening 60b is positioned at a lower side of the front of the drum 30.

[0051] It is preferable that there is a guide flow passage 21 at the lower side of the tub 20 for guiding humid air from the humid air recovery opening 60b at the lower side of the front of the drum 30 to the drying duct 60.

[0052] Meanwhile, even though FIG. 5 illustrates a tilt type drum washing machine, of course, the hot air supply and exhaust structure is also applicable to the horizontal type drum washing machine.

[0053] A hot air circulating structure of the drum washing machine will be described.

[0054] Referring to FIG 5, in drying, the hot air is introduced into the inside of the drum through an upper portion of the rear of the drum 30 by the forced air blow action of the fan 62, flows from the rear to a front of the drum along a direction of the arrow, passes a lower portion of a front side of the drum, and flows toward the humid air recovery opening 60b of the drying duct 60 along the guide flow passage 21 in the lower side of the tub 20.

[0055] In the meantime, the drum type washing machine in accordance with a second preferred embodiment of the present invention, the tub 20 is formed of stainless steel, or plastic. Regardless of material of the tub 20, in the rear wall of the tub, there are the hot air inlet 60a for supplying hot air, and a hot air outlet 60c for discharge of the hot air (see FIG 6).

[0056] It is favorable that the hot air inlet 60a and the hot air outlet 60c each has a shape of slot, especially in a shape of an arc in view of strength of the tub rear wall, and connected to the drying duct 60, directly.

[0057] Meanwhile, alike the related art drum, the drum of the present invention has a plurality of pass through holes in an outside circumferential surface of the drum, which are not shown in the drawings.

[0058] Next, the steps of an operation control method in accordance with embodiments of the present invention will be described with reference to FIGS. 7 ~ 11. First, referring to FIG 7, first operation control method will be described.

[0059] In a drying cycle, while rotating the drum at a speed equal to or higher than a speed (for an example, 100rpm) enough to keep the laundry to be attached to, and not to fall from, but not to be attached closely to, the inside surface of the drum, the hot air is supplied to an inside of the drum, for progressing drying.

[0060] The speed enough to keep the laundry to be attached to, and not to fall off from, but not to be attached closely to the inside surface of the drum, is a speed at which an outward acceleration acting on a point of an inside circumferential surface of the drum in a radial direction of the drum is equal to an acceleration of the gravity.

[0061] In the meantime, the hot air supplied to the inside of the drum flows in a direction along a driving shaft of the drum. That is, the hot air flows from the hot air inlet 60a (see FIG. 4) in the front of the drum to the rear of the drum, or from the hot air inlet 60a (see FIG 5) to the front of the drum. For this, it is preferable that the hot air is supplied from the upper side of the front of the drum to the lower side of the rear of the drum, or from the upper side of the rear of the drum to the lower side of the front of the drum.

[0062] According to this, in the embodiment, if the hot air is supplied in the driving shaft direction of the drum in a state the drum rotates at the speed enough to keep the laundry to be attached to, and not to fall off from an inside surface of the drum, the hot air progresses along the driving shaft direction while swirling along the inside circumferential surface of the drum.

[0063] That is, the hot air progresses in a form of a swirl starting from the front side of the drum to the rear side of the drum until the hot air escapes therefrom, or the hot air progresses in a form of a swirl starting from the rear side of the drum to the front side of the drum until the hot air escapes therefrom. According to this, contact of the hot air with the laundry on the inside circumferential surface of the drum increases, to enhance the drying performance, and efficiency.

[0064] In the meantime, it is preferable that the drying cycle progressed thus includes an acceleration section in which the motor for driving the drum is turned on, to accelerate a rotation speed of the drum until the rotation speed reaches to a preset speed which is equal to, or higher than a speed enough to keep the laundry in the drum to be attached to, and not to fall off from the inside surface of the drum, a section for maintaining the rotation speed at the preset speed, and a section in which the rotation speed of the drum is reduced to a low speed (about 20 - 30rpm) at which the laundry in the drum is unable to be attached to, but to fall from the inside surface of the drum, for progressing drying.

[0065] It is more preferable that above acceleration, maintained speed, and low speed sections are performed at least once repeatedly before finish of the drying. This is for enhancing the drying efficiency by keeping exposing portions of the laundry that are not dried yet by changing positions of the laundry.

[0066] It is meantime, it is preferable that a rotation direction of the drum is alternated in the section drying is progressed in a low speed state in which the laundry falls from the inside surface of the drum.

[0067] Next, referring to FIG. 8, a second operation control method will be described.

[0068] The method for controlling drying laundry in a horizontal, or tilted type drum washing machine in accordance with the second preferred embodiment of the present invention includes the steps of turning off a drum driving motor as spinning is finished, turning on a drying heater and a fan, and turning on the drum driving motor again before the laundry kept attached to an inside circumferential surface of the drum at the time of spinning falls to maintain a threshold speed enough to keep the laundry to be attached to the inside circumferential surface of the drum and supplying heated air into an inside of the drum, to progress drying.

[0069] That is, in the embodiment, after turning off the driving motor, hot air is supplied while maintaining the drum at a speed higher than the threshold speed at which the laundry kept attached to the inside circumferential surface of the drum does not fall by turning on the drum driving motor again before the speed of the drum rotating by inertia drops to a speed at which the laundry kept attached to the inside circumferential surface of the drum falls.

[0070] In this instance, the drying heater and the fan may be turned on at the same time with turning off the drum driving motor when the spinning is finished, or the drying heater and the fan may be turned on after a predetermined time period is passed from the turning off of the drum driving motor. In this instance, no braking force is applied to the drum, so that the drum spinning in a state the drum driving motor is turned off as the spinning is finished rotates freely by the inertia. The drying heater and the fan may, or may not be turned on at the same time.

[0071] The hot air flows along a direction of a drum driving shaft line in the drum, for which it is preferable that the hot air is supplied from a front to a rear of the drum, or vice versa, like the first embodiment.

[0072] Alike the first embodiment, the dry progressing step may include a section in which the rotation speed of the drum is maintained at a speed equal to, or higher than a speed (for an example, 100rpm) enough to keep the laundry in the drum to be attached to, and not to fall off from, but not to be attached closely to, the inside circumferential surface of the drum, and a section in which the rotation speed of the drum is reduced to a low speed (about 20 - 30rpm) at which the laundry in the drum is unable to be attached to the inside circumferential surface of the drum.

[0073] Thus, the embodiment enables to reduce a drying time period as the drying heater and the fan are turned on starting from the inertial rotation of the drum following finishing of spinning to supply hot air, and drying laundry starting from right after the finishing of spin-

ning, and to improve drying efficiency and performance as the rotation speed of the drum is maintained at a speed higher than the speed enough to keep the laundry in the drum to be attached to the inside circumferential surface of the drum, to make the hot air to progress in a form of a swirl like the first embodiment.

[0074] Next, a third method for controlling operation of a drum washing machine will be described with reference to FIG. 9.

[0075] If the drum washing machine of the first or second embodiment is further provided with means in the drum 30 for determining dryness (for an example, an electrode sensor: not shown) of the laundry, the following operation control method is also viable.

[0076] That is, a method for controlling operation of a horizontal or tilt drum washing machine in accordance with a third preferred embodiment of the present invention includes the steps of measuring dryness of laundry in the drum in a state the drum is stationary after finish of spinning, supplying hot air to an inside of the drum while rotating the drum at a speed equal to or higher than a speed at which an outward acceleration acting on a point of an inside circumferential surface of the drum in a radial direction of the drum is equal to an acceleration of the gravity if the dryness measured in above step is below a preset dryness, and supplying hot air to an inside of the drum while rotating the drum at a reduced speed at which the laundry is unable to be attached to the inside surface of the drum if the dryness measured in above step is higher than the preset dryness, for drying.

[0077] Meanwhile, though it is preferable that the measurement of dryness is performed in a state the drum is stopped fully after the finish of spinning, the dryness may be measured in a state before the drum is stopped fully after the finish of spinning.

[0078] Moreover, in the embodiment too, the hot air flows in a direction the same or substantially same with a drum driving shaft in the drum. Especially, it is preferable that the hot air flows from a front to a rear of the drum, or vice versa.

[0079] Alike embodiments described before, in the embodiment too, it is preferable that a rotation direction of the drum is alternated in the section drying is progressed in a reduced speed state to a speed (about 20 ~ 30rpm) at which the laundry falls from the inside surface of the drum.

[0080] Next, a fourth method for controlling operation of a drum washing machine will be described, with reference to FIG. 10.

[0081] A method for controlling drying operation of a horizontal, or tilt type drum washing machine in accordance with a fourth preferred embodiment of the present invention includes the steps of, after finish of spinning, supplying hot air to an inside of the drum while rotating the drum at a speed equal to, or higher than a speed (for an example, 100rpm) enough to keep the laundry to be attached to, and not to be fall off from an inside

surface of the drum, and progressing the drying while maintaining a threshold speed which is a speed enough to keep the laundry to be attached to, and not to fall off from, an inside surface of the drum if the dryness detected in the middle of above step is below preset dryness, and progressing the drying in a reduced speed state to a speed (about 20 ~ 30rpm) at which the laundry falls off from the inside surface of the drum if the dryness is higher than the preset dryness.

[0082] That is, in the embodiment, the dryness is measured in a state the drum is rotated at a speed higher than a speed enough to keep the laundry to be attached to the inside circumferential surface of the drum, and the speed of the drum is controlled to maintain, or reduce according to a result of the measurement. This is because an accurate measurement of dryness is possible the same with a case when the drum is stationary as there is no position change of the laundry at the speed at which the laundry does not fall off from, but is kept attached to, the inside circumferential surface of the drum.

[0083] In the meantime, in the embodiment too, the hot air flows in a direction the same with a drum driving shaft in a drum. Especially, alike foregoing embodiments, it is preferable that the hot air flows from a front to a rear of the drum, or vice versa.

[0084] Alike the foregoing embodiments, a rotation direction of the drum is alternated in the section the drying is progress in a reduced speed state to a speed (about 20 - 30rpm) at which the laundry in the drum falls off the inside surface of the drum.

[0085] Thus, the embodiment enables to reduce a drying time period as the hot air is supplied to an inside of the drum starting from the inertial rotation of the drum following finishing of spinning, to progress drying, and to improve drying performance and efficiency as the rotation speed of the drum is maintained at a speed equal to, or higher than a speed enough to keep laundry not to fall off from the inside circumferential surface of the drum so that the hot air progresses while swirling at a dryness below a preset dryness.

[0086] If the measured dryness is higher than the preset dryness, the rotation speed of the drum is reduced, to change positions of the laundry, in which the a rotation direction of the drum is alternated, for changing positions of the laundry. According to this, portions of laundry dried less than other portions are exposed newly, to which the hot air comes into contact, to dry the less dried portions.

[0087] In the meantime, after the reduced speed state is over, the rotation speed of the drum rises again until the laundry is attached to the inside circumferential surface of the drum, when the dryness is detected again. According to this, above drying control process is repeated.

[0088] In the method for controlling drying operation in accordance with any one embodiments of the present invention, a portion of the clothes is liable to be inserted

in the holes in the wall of the drum if the rotation speed of the drum is high excessively. Moreover, the clothes is liable be inserted in the holes in the wall of the drum, to make circulation of the clothes difficult if the drying time period is long excessively even if the rotation speed of the drum is not so high excessively, but only is maintained at a speed (for an example; 100rpm) enough to keep the laundry to be attached to an inside of the drum.

[0089] Therefore, in each of the embodiments, it can be known it is preferable in view of clothes circulation that a section for progressing drying at a speed in which the laundry can not be attached to, but fall off from the inside surface of the drum in a state the drying heater and the fan are turned on, a section in which the drum driving motor is turned on to accelerate the drum to a speed higher than a speed enough to keep the laundry to be attached to, and not to fall off from the inside surface of the drum, and a section in which the rotation speed of the drum is maintained at a speed enough to keep the laundry to be attached to, and not to fall off from the inside surface of the drum, are mixed.

[0090] In the method for controlling drying operation in accordance with the third or fourth preferred embodiment of the present invention, a drying finish time point can be determined as follows.

[0091] The finish of drying may be simply set to finish the drying at the time the set time is reached. Or alternatively, the drying may be finished by setting a drying time period, measuring the dryness when the set drying time period is reached, and extending the drying time period according to the measured dryness. Or alternatively, regardless of a set drying time period, the finish of drying may be determined with reference to a preset dryness which is different from the set dryness in the third or fourth embodiment.

[0092] FIG 11 illustrates a graph showing a rotation speed of a motor for driving the drum, and turn on/off states of drying heater and fan while drying.

[0093] Referring to FIG 8, it can be known that a section for progressing drying at a speed in which the laundry can not be attached to, but fall off from the inside surface of the drum in a state the drying heater and the fan are turned on, a section in which the drum driving motor is turned on to accelerate the drum to a speed higher than a speed enough to keep the laundry to be attached to, and not to fall off from the inside surface of the drum, and a section in which the rotation speed of the drum is maintained at a speed enough to keep the laundry to be attached to, and not to fall off from the inside surface of the drum, are mixed.

[0094] Of course, a rotation direction of the drum can be alternated in the section in which the rotation speed of the drum is low (about 20 - 30rpm).

[0095] As has been described, the structure for supplying hot air in a drum washing machine and operation control method thereof has the following advantages.

[0096] The uniform introduction of hot air into the inside of the drum through out the drum enhances drying

performance and efficiency.

[0097] That is, the introduction of hot air starting from a front to a rear or vice versa deep into the drum improves drying efficiency and performance. Especially, because the rotation speed of the drum is maintained at a speed enough to keep laundry not to fall off from the inside circumferential surface of the drum, such that the hot air comes into contact with the laundry while progressing in swirl, the drying performance and efficiency is improved.

[0098] The supply of hot air to the inside of the drum starting from the inertial rotation of the drum following finish of spinning enables to shorten a drying time period.

[0099] The alternation of the rotation direction of the drum in the section the dry is progressed at a low speed, to keep surfaces in contact with the hot air changing, permits to improve the drying efficiency, and the swirling of the hot air further improves the drying performance owing to the position changes of the laundry.

[0100] It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the scope of the invention. Thus, it is intended that the present invention covers modifications and variations of this invention provided they come within the scope of the appended claims.

Claims

1. A drum washing machine comprising:

a tub for holding washing water;
a drum rotatably mounted in the tub, for introducing laundry therein;
a drying heater for heating air being supplied to an inside of the drum;
a drying duct forming a flow passage for supplying hot air heated by the drying heater to the inside of the drum;
a fan for forced supply of the hot air heated by the drying heater to the inside of the drum;
a hot air inlet at a front side of the drum for supplying the hot air to the inside of the drum; and
a humid air recovery opening at a rear side of the drum for recovering humid air from the inside of the drum.

2. The drum washing machine as claimed in claim 1, wherein the hot air inlet of the drying duct is positioned at an upper portion of the front side of the drum, and the humid air recovery opening of the drying duct is positioned at a lower portion of the rear side of the drum.

3. The drum washing machine as claimed in claim 1, wherein the humid air recovery opening is connect-

ed to a rear wall of the tub at the rear side of the drum, directly.

4. A drum washing machine comprising:

a tub for holding washing water;
a drum rotatably mounted in the tub, for introducing laundry therein;
a drying heater for heating air being supplied to an inside of the drum;
a drying duct forming a flow passage for supplying hot air heated by the drying heater to the inside of the drum;
a fan for forced supply of the hot air heated by the drying heater to the inside of the drum;
a hot air inlet at a rear side of the drum for supplying the hot air to the inside of the drum; and
a humid air recovery opening at a front side of the drum for recovering humid air from the inside of the drum.

5. The drum washing machine as claimed in claim 4, wherein the hot air inlet is positioned at an upper portion of a rear side of the drum, and the humid air recovery opening is positioned at a lower portion of a front side of the drum.

6. The drum washing machine as claimed in claim 4, wherein the hot air inlet is connected to a rear wall of the tub on a rear side of the drum.

7. The drum washing machine as claimed in claim 3 or 4, wherein the rear wall of the tub is formed of stainless steel or plastic, and has an opening for recovery of humid air in a surface thereof.

8. The drum washing machine as claimed in claim 7, wherein the opening has a shape of a slot.

9. A method for controlling operation of a horizontal or tilt type drum washing machine comprising a tub for holding washing water, a drum rotatably mounted in the tub, for introducing laundry therein, a drum driving motor for providing driving force to rotate the drum, a drying heater for heating air being supplied to an inside of the drum, a drying duct forming a flow passage for supplying hot air heated by the drying heater to the inside of the drum, and a fan for forced supply of the hot air heated by the drying heater to the inside of the drum,

the method comprising the step of supplying the hot air to an inside of the drum while rotating the drum at a speed equal to, or higher than a speed enough to keep the laundry in the drum to be attached to, and not to fall off from, an inside surface of the drum in progressing of a drying cycle.

10. The method as claimed in claim 9, wherein the hot

air supplied to an inside of the drum is supplied from an upper side of a front of the drum to a lower side of a rear of the drum, or from an upper side of a rear of the drum to a lower side of a front of the drum.

11. The method as claimed in claim 9, wherein the drying cycle includes at least one time of;

a section for turning on the drum driving motor, to accelerate a rotation speed of the drum until the rotation speed reaches to a preset speed equal to or higher than a speed enough to keep the laundry in the drum to be attached to, and not to fall off from the inside surface of the drum, and

a section for maintaining the rotation speed at the preset speed.

12. The method as claimed in claim 11, wherein the drying cycle further includes a section for reducing the rotation speed of the drum to a low speed at which the laundry in the drum is unable to be attached to, but to fall off from the inside surface of the drum, for progressing drying.

13. A method for controlling operation of a horizontal or tilt type drum washing machine comprising a tub for holding washing water, a drum rotatably mounted in the tub, for introducing laundry therein, a drum driving motor for providing driving force to rotate the drum, a drying heater for heating air being supplied to an inside of the drum, a drying duct forming a flow passage for supplying hot air heated by the drying heater to the inside of the drum, and a fan for forced supply of the hot air heated by the drying heater to the inside of the drum,

the method comprising the steps of:

turning off the drum driving motor as spinning is finished;
turning on the drying heater and the fan; and
supplying the hot air to an inside of the drum while a rotation speed of the drum is maintained at a speed enough to keep the laundry to be attached to, and not fall off from an inside circumferential surface of the drum by turning on the drum driving motor again before the laundry attached to the inside circumferential surface of the drum in the spinning falls off therefrom.

14. The method as claimed in claim 13, wherein the drying heater and the fan are turned on at once as the spinning is finished.

15. The method as claimed in claim 13, wherein the drying heater and the fan are turned on after a preset time period is passed from a time when the drum driving motor is turned off.

16. The method as claimed in claim 13, further compris-

ing:

a section for maintaining a rotation speed of the drum at a speed enough to keep the laundry to be attached to, and not fall off from an inside circumferential surface of the drum; and
a section for reducing the rotation speed of the drum to a speed at which the laundry in the drum is unable to be attached to, but to fall from the inside surface of the drum.

17. A method for controlling a drying cycle of a horizontal or tilt type drum washing machine comprising a tub for holding washing water, a drum rotatably mounted in the tub, for introducing laundry therein, a drying heater for heating air being supplied to an inside of the drum, a drying duct forming a flow passage for supplying hot air heated by the drying heater to the inside of the drum, a fan for forced supply of the hot air heated by the drying heater to the inside of the drum, and means for determining dryness of the laundry in the drum,

the method comprising the steps of:

measuring dryness of the laundry in the drum in a state the drum is stationary after finish of spinning;

supplying hot air while rotating the drum at a speed equal to or higher than a speed enough to keep the laundry to be attached to, and not to fall off from, an inside surface of the drum by raising the rotating speed of the drum, if measured dryness is below preset dryness; and
supplying the hot air to an inside of the drum while rotating the drum at a speed below a speed enough to keep the laundry to be attached to, and not to fall off from the inside surface of the drum, for progressing drying, if the measured dryness is higher than the preset dryness.

18. The method as claimed in claim 17, wherein the step of supplying the hot air to an inside of the drum while rotating the drum at a speed below a speed enough to keep the laundry to be attached to, and not to fall off from the inside surface of the drum, for progressing drying includes the step of alternating a rotating direction of the drum.

19. A method for controlling operation of a horizontal or tilt type drum washing machine comprising a tub for holding washing water, a drum rotatably mounted in the tub, for introducing laundry therein, a drying heater for heating air being supplied to an inside of the drum, a drying duct forming a flow passage for supplying hot air heated by the drying heater to the inside of the drum, a fan for forced supply of the hot air heated by the drying heater to the inside of the

drum, and means for determining dryness of the laundry in the drum,

the method comprising the steps of:

after spinning, supplying the hot air to the inside 5
of the drum while rotating the drum at a speed to maintain a state in which the laundry is kept to be attached to, and not to fall off from, but not to be attached closely to, an inside surface of the drum;
detecting the dryness in the middle of above 10
step, to progress drying while maintaining a speed to maintain a state in which the laundry is kept to be attached to, and not to fall off from, but not to be attached closely to, the inside surface of the drum, if the dryness is below a preset dryness; and 15
progressing the drying after reducing the rotation speed of the drum to a low speed at which the laundry is unable to be attached to, but fall 20
off from the inside surface of the drum, if the dryness is higher than the preset dryness.

20. The drum washing machine of claim 9 or 13, or the method as claimed in claim 17 or 19, wherein the hot air supplied to the inside of the drum is supplied in a direction the same with, or substantially the same with, a drum driving shaft. 25
21. The drum washing machine of claim 8 or 13, or the method as claimed in claim 17 or 19, wherein the hot air supplied to the inside of the drum is supplied from a front to a rear of the drum, or vice versa. 30
22. The method as claimed in claim 19, wherein the step of progressing the drying after reducing the rotation speed of the drum to a low speed at which the laundry is unable to be attached to, but fall off from the inside surface of the drum includes the step of alternating a rotating direction of the drum. 35 40
23. A method for controlling operation of a horizontal or tilt type drum washing machine comprising a tub for holding washing water, a drum rotatably mounted in the tub, for introducing laundry therein, a drying heater for heating air being supplied to an inside of the drum, a drying duct forming a flow passage for supplying hot air heated by the drying heater to the inside of the drum, and a fan for forced supply of the hot air heated by the drying heater to the inside of the drum, and a hot air supply structure in which a hot air inlet of the drying duct is positioned at a front side or a rear side of the drum, and a humid air recovery opening of the drying duct is positioned at the rear side or the front side of the drum opposite to the hot air inlet, 45 50 55

the method comprising the steps of:

in progressing a drying cycle, supplying hot air to an inside of the drum through the hot air inlet positioned at a front, or a rear of the drum, and, at the same time with this, rotating the drum at a speed enough to keep the laundry attached to, and not fall off from, but not to be attached closely to, an inside surface of the drum, for progressing drying.

24. The method as claimed in claim 23, wherein the hot air supplied to an inside of the drum is supplied from an upper portion of a front side of the drum to a lower portion of a rear side of the drum, or an upper portion of a rear side of the drum to a lower portion of a front side of the drum.

25. The method as claimed in claim 22, further comprising at least one time of:

a section for turning on a drum driving motor to accelerate a rotation speed of the drum to a speed equal to, or higher than a speed enough to keep the laundry in the drum attached to, and not fall off from, the inside surface of the drum; a section for maintaining the rotating speed of the drum at a speed equal to, or higher than a speed enough to keep the laundry in the drum attached to, and not fall off from, the inside surface of the drum; and
a section for reducing the rotating speed of the drum to a low speed at which the laundry in the drum is unable to be attached to, but to fall off from, the inside surface of the drum, for progressing drying.

26. The method as claimed in claim 25, wherein the section for reducing the rotating speed of the drum to a low speed at which the laundry in the drum is unable to be attached to, but to fall off from, the inside surface of the drum, for progressing drying includes the step of alternating a rotating direction of the drum.

27. The method as claimed in claim 23, further comprising the step of measuring dryness of the laundry in the drum in the middle of progressing a drying cycle.

28. The method as claimed in claim 27, wherein the dryness is measure in a state the drum is stationary, or the rotation speed of the drum is enough to keep the laundry attached to, and not fall off from, the inside circumferential surface of the drum.

29. The method as claimed in claim 28, depending on a result of measurement of the dryness, further comprising the steps of:

raising the rotating speed of the drum to main-

tain a speed enough to keep the laundry attached to, and not fall off from, the inside surface of the drum for progressing drying, if measured dryness is below a preset dryness; and reducing the rotating speed of the drum to a low speed at which the laundry is unable to be attached to, but fall off from, the inside surface of the drum, for progressing drying, if measured dryness is higher than the preset dryness.

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FIG. 1

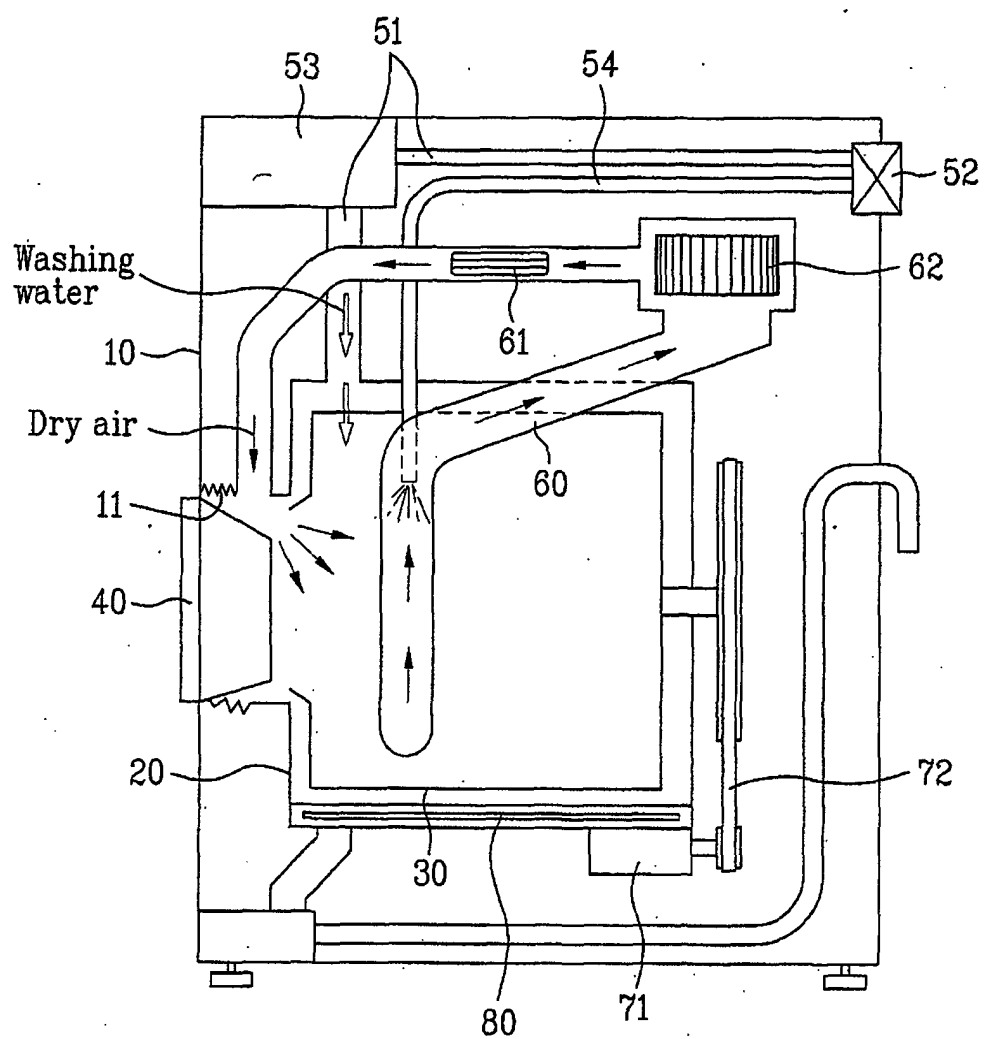


FIG. 2

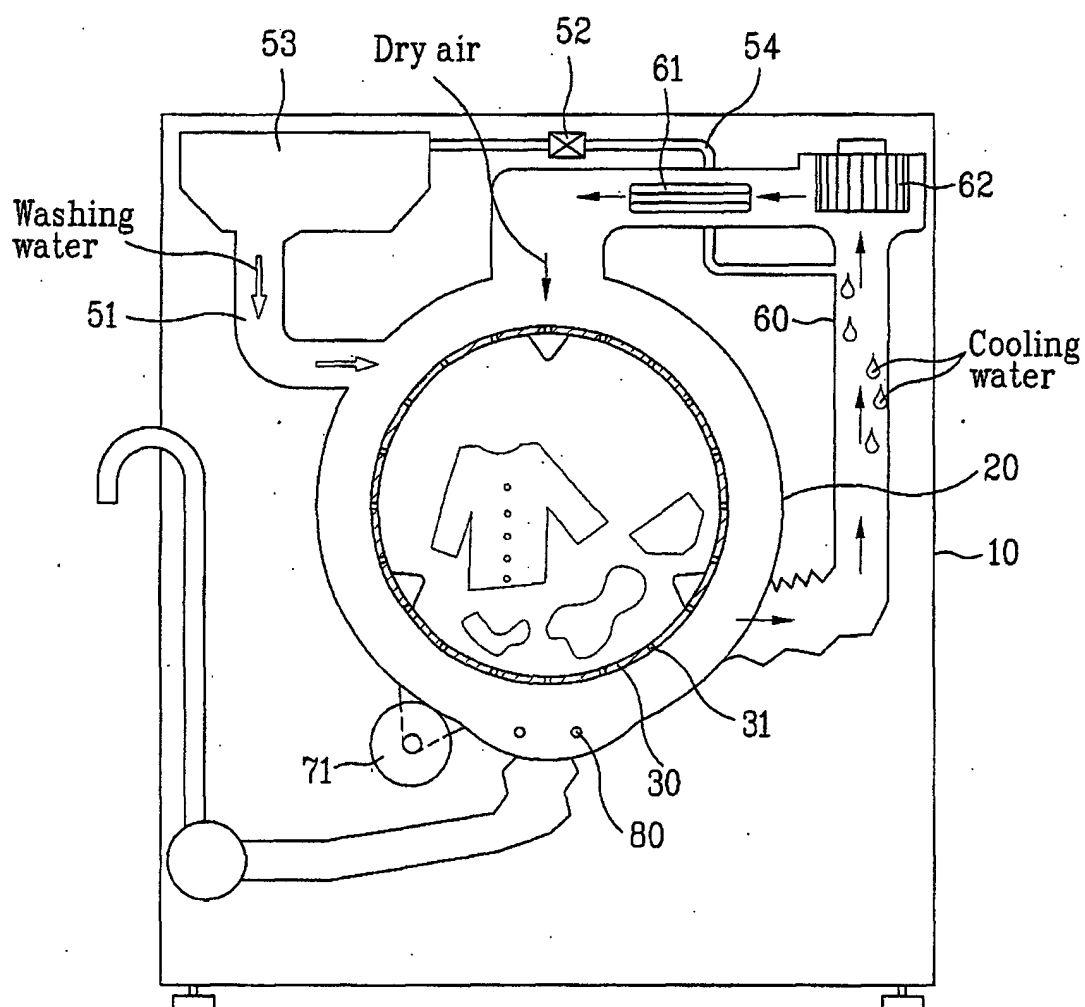


FIG. 3

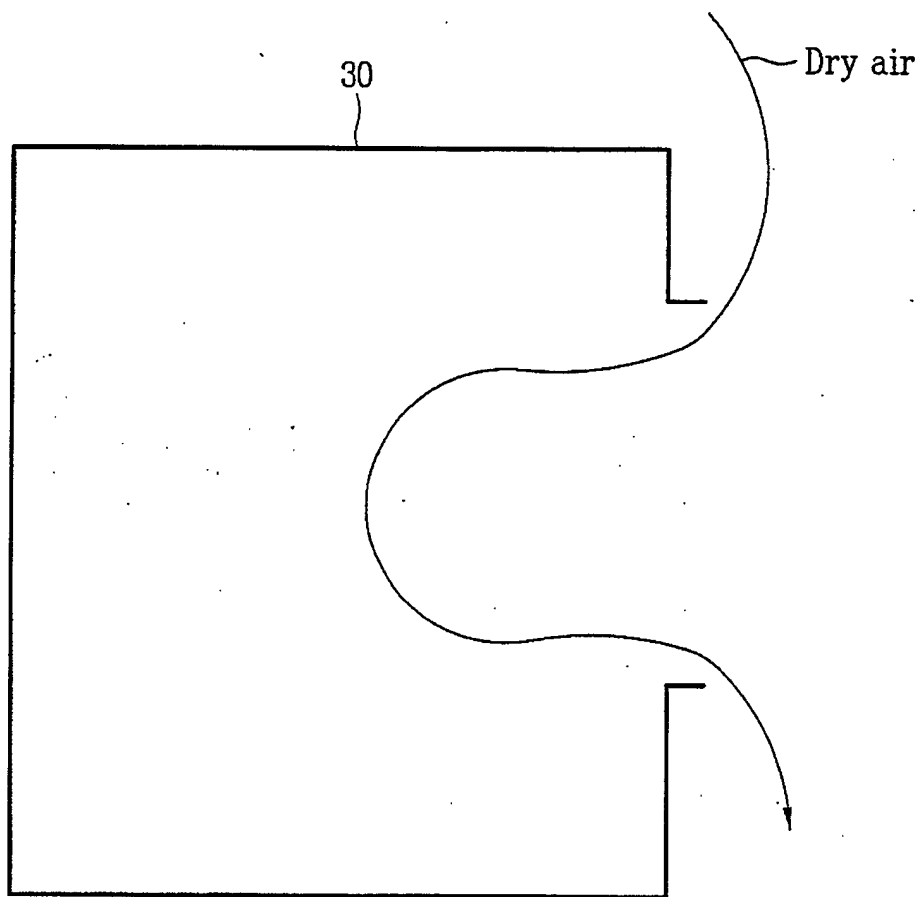


FIG. 4

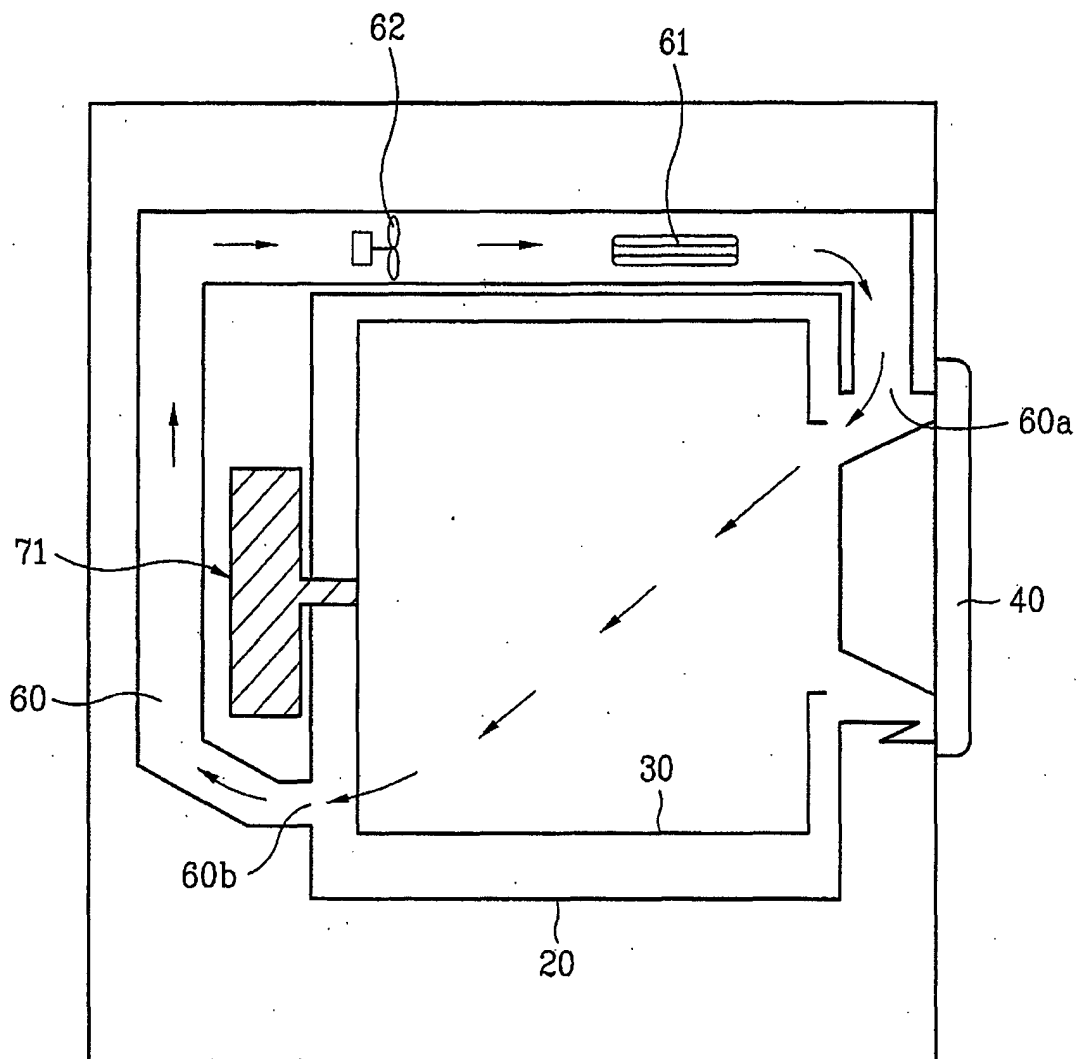


FIG. 5

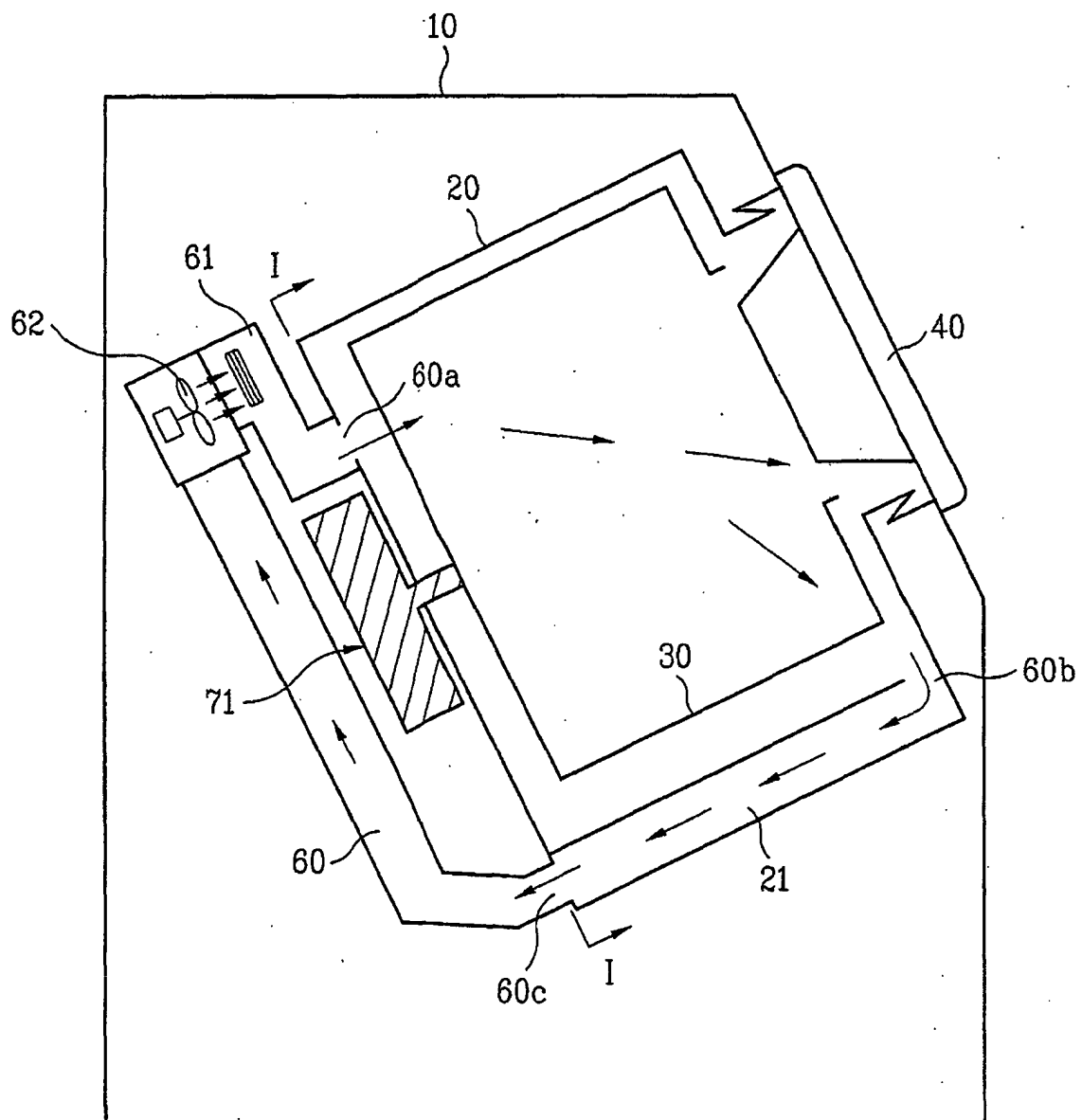


FIG. 6

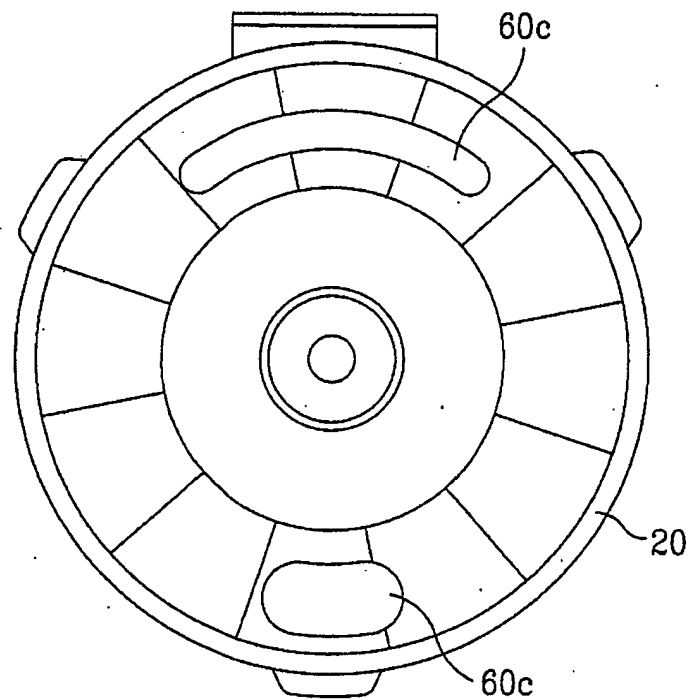


FIG. 7

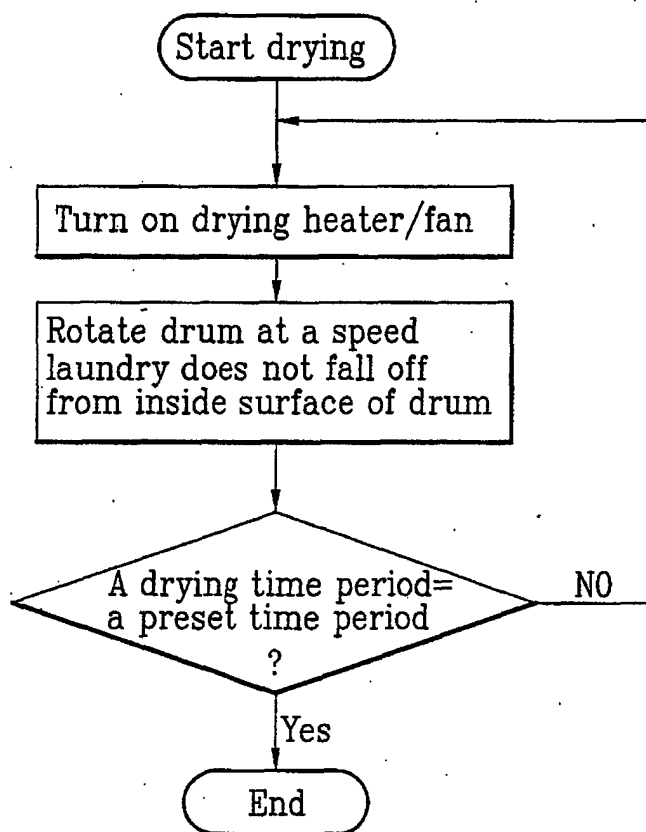


FIG. 8

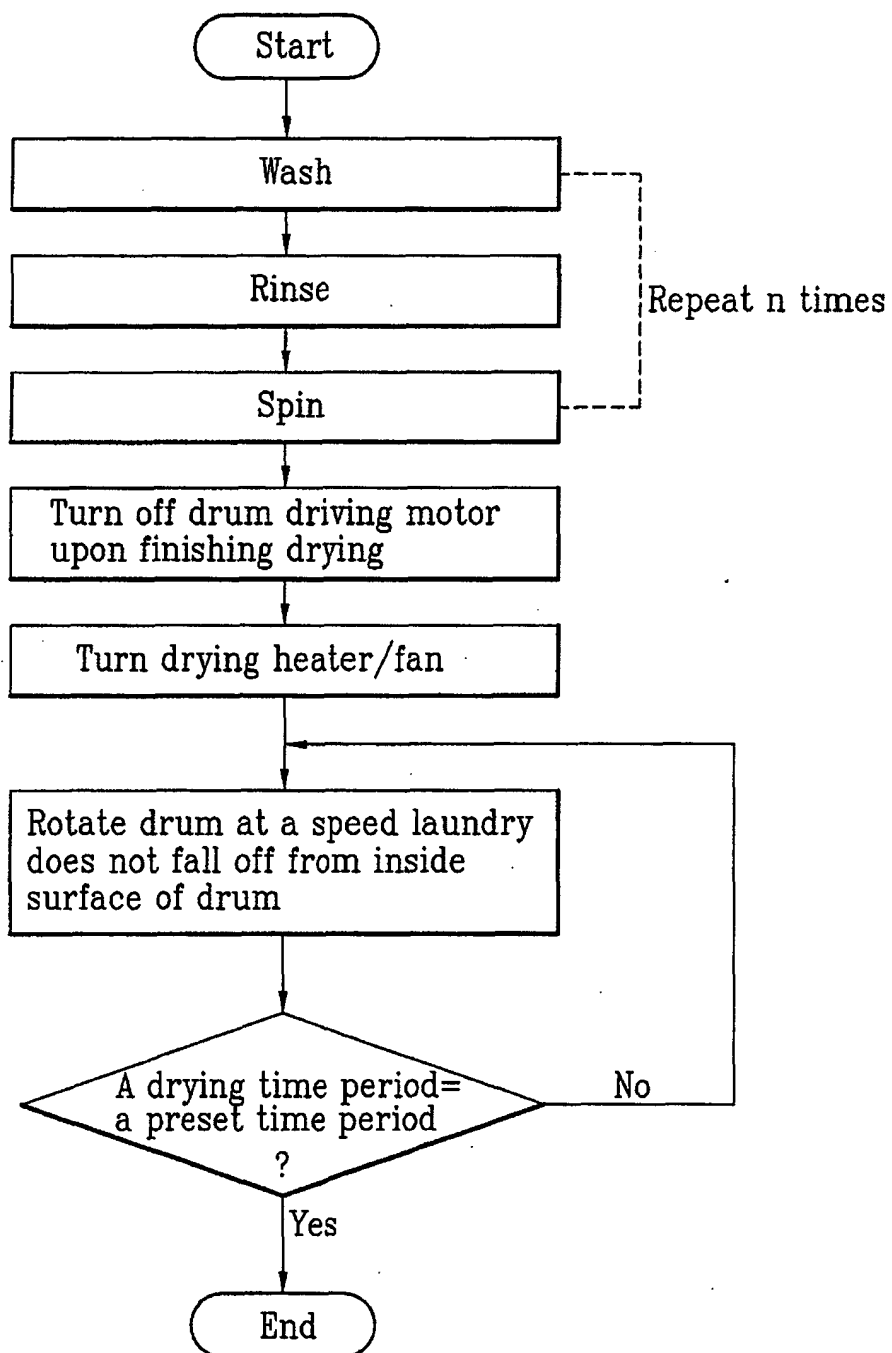


FIG. 9

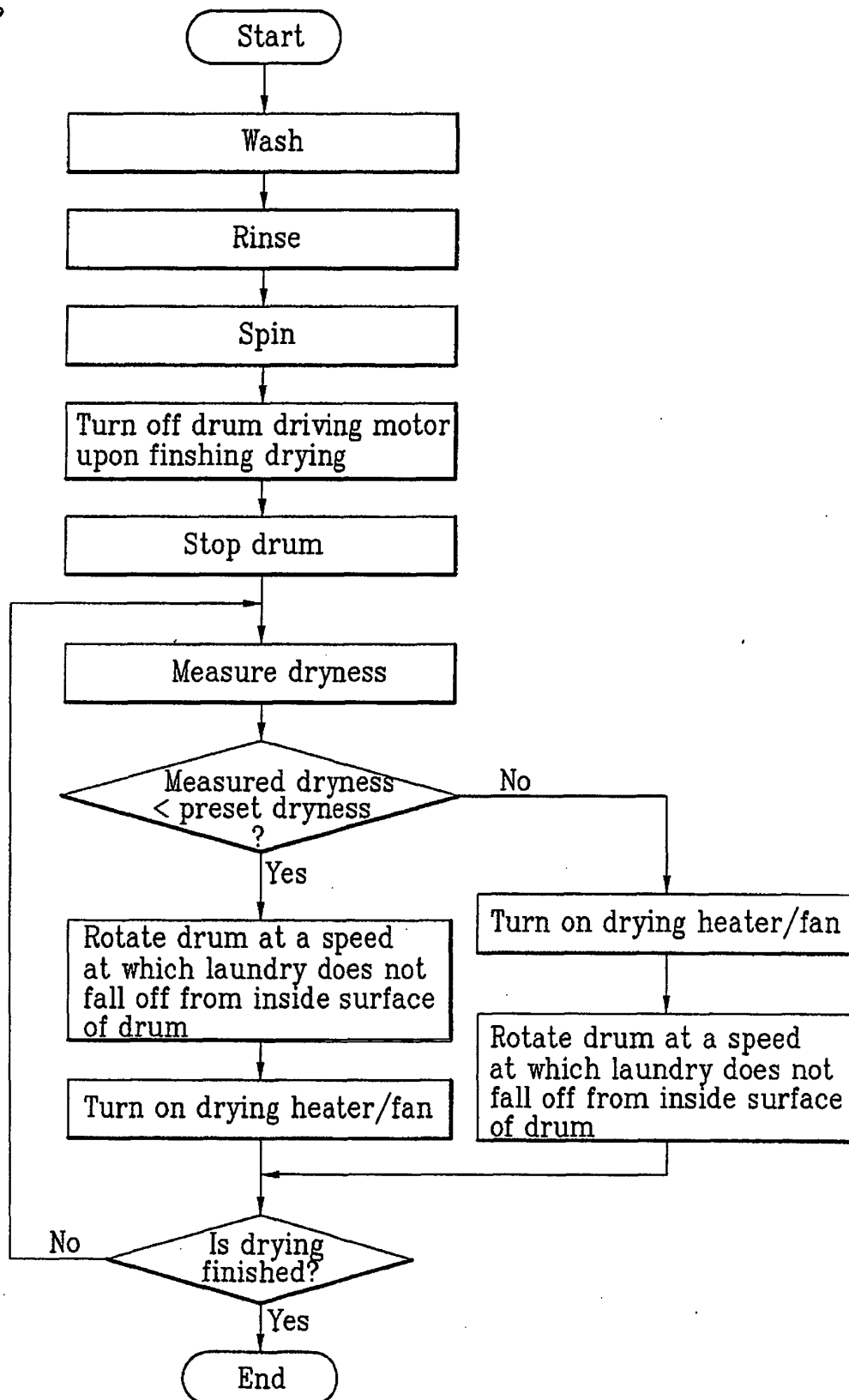


FIG. 10

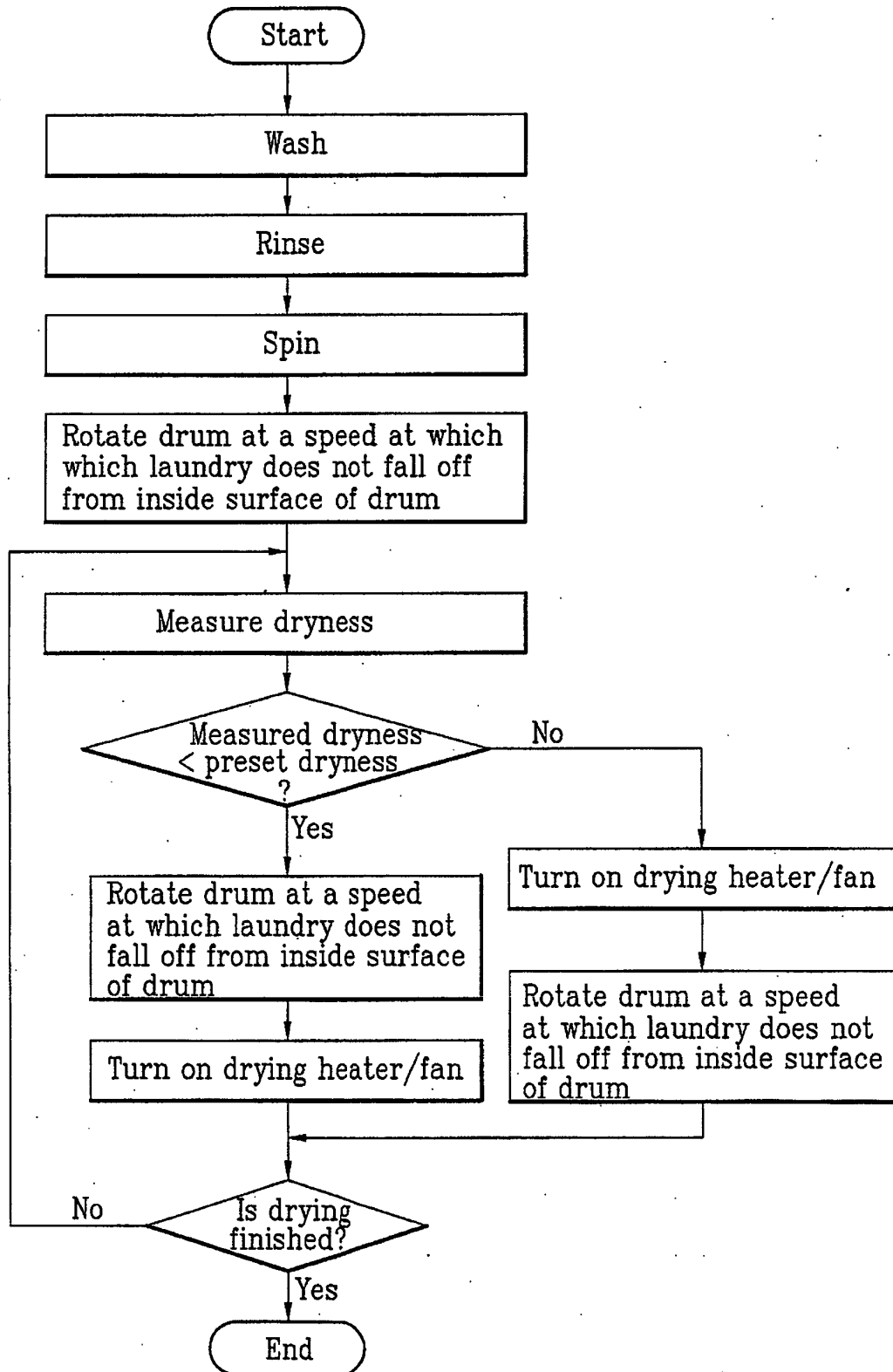


FIG. 11

