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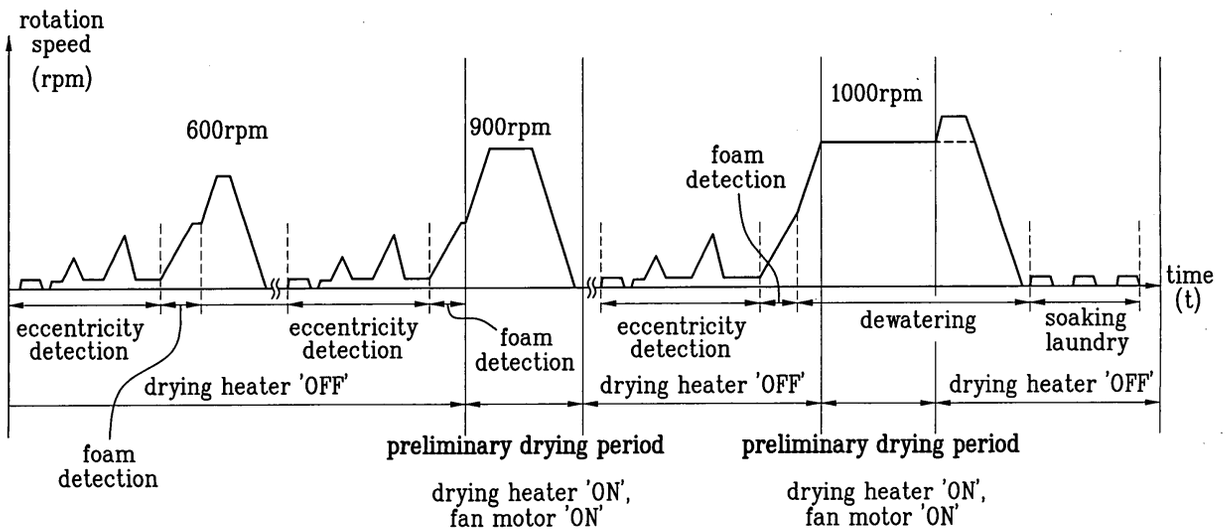
(54) Washing machine and control method thereof

(57) The present invention provides a washing machine and control method thereof, by which a laundry can be dried more effectively, by which a drying cycle time can be shortened, and by which stability and reliance can be enhanced. The present invention includes the step of performing dewatering and preliminary drying simultaneously during a dewatering cycle. And, The present invention supplies cooling water for condensing hot and humid air during the dewatering cycle.

FIG. 3



EP 1 526 210 A2

Description

[0001] The present invention relates to a washing machine and control method thereof.

[0002] Generally, a drum type washing machine adopts a washing system using a friction between a laundry and a drum rotated by receiving a drive force of a motor while a detergent, water, and laundry are held within the drum. The drum type washing machine is advantageous in causing less damage to the laundry, preventing the laundry from being raveled, and providing washing effects of beating and rubbing.

[0003] Meanwhile, in order to cope with the functional improvement and high-quality trend of the drum type washing machine, a laundry-drying function is provided to the drum type washing machine as well as the conventional washing and dewatering functions. Accordingly, the demand for a drum type washier/dryer tends to rise.

[0004] The drum type washer/dryer dries a laundry within a drum in a manner of sucking to heat an external air using a fan and heater provided outside a tub and blowing the heated air into the tub.

[0005] FIG. 1 and FIG. 2 are cross-sectional diagrams of a drum type washing machine equipped with a drying function (washer/dryer) according to a related art.

[0006] Referring to FIG. 1 and FIG. 2, a cylindrical tub 2 is provided within a cabinet 1 and a cylindrical drum 3 is provided within the tub 2. A drive shaft 4 is installed at a rear part of the drum 3 to be connected to a motor 5. A drive power of the motor 5 is transferred to the drum 3 to rotate. And, a multitude of perforated holes (not shown in the drawings) are formed on an outer circumference of the drum 3 so that air or water can pass through the perforated holes.

[0007] In order to perform a drying cycle of the drum type washing machine, a circulation duct 6 is provided outside the tub 2 to form a circulation path of heated air. Specifically, both ends of the circulation duct 6 communicate with lower and upper parts of the tub 2, respectively. And, a blower fan 7 for forcibly blowing air to circulate and a heater 8 for heating the blown air are installed within the circulation duct 6.

[0008] A cooling water inlet pipe 9 for supplying cooling water from outside for the condensation of air flowing in the circulation duct 6 is connected to an upper part of the circulation duct 6. A tub temperature sensor 'B' sensing a temperature within the tub 2 is installed within the tub 2, and a duct temperature sensor 'A' sensing a temperature of a circulating air is installed inside the circulation duct 6.

[0009] A method of controlling a drying cycle in the drum type washing machine equipped with the drying function according to a related art is explained as follows.

[0010] Once a drying cycle is initiated after completion of a dewatering cycle, the blower fan 7 is driven to suck air into the circulation duct 6. The air blown to flow in the circulation duct 6 is passed through the heater 8 to be heated at a high temperature and then flows in the drum 3 to exchange heat with a laundry within the drum 3 for drying the laundry.

[0011] Meanwhile, the humid air resulting from the heat exchange with the laundry within the tub 2 flows in the circulation duct 6 again by the operation of the blower fan 7. If the hot and humid air is supplied to the heater 8 via the blower fan 7, performance of the blower fan 7 is reduced and efficiency of the heater 8 is considerably lowered. Hence, the cooling water is supplied via the cooling water inlet pipe 9 to condense the hot and humid air flowing from the tub 2. Thus, humidity of the corresponding air is lowered.

[0012] The humidity-lowered air is passed through the heater 8 to be heated at a high temperature and then flows in the tub 2 again, whereby a circulation process of drying the laundry is repeated.

[0013] In case of circulating the hot air at the high temperature into the tub 2 during the drying cycle, the motor 5 rotates the drum 3 at a low rotational speed of about 50RPM so that the hot air can evenly come into contact with the laundry.

[0014] In the drum type washing machine equipped with the drying function according to the related art, if a difference (TA-TB=TC) between a temperature TA sensed by the duct temperature sensor 'A' and a temperature TB sensed by the tub temperature sensor 'B' is equal to or greater than a first setup value in each drying cycle mode, if the temperature TA sensed by the duct temperature sensor 'A' or the temperature TB sensed by the tub temperature sensor 'B' is equal to or greater than a second setup value, or if a predetermined time expires from the initiation of the drying cycle, the heater 8 stops being driven but the blower fan 7 is operated during a period of time to perform a cool air drying. Alternatively, the drying cycle is further performed during an additional period of time and is then terminated.

[0015] However, in the related art drum type washing machine equipped with the drying function (washer/dryer), the dewatering cycle is carried out for the dewatering only. After the dewatering cycle has been completed, the drying cycle is entered to initiate the corresponding drying. Hence, the drying time is inevitably elongated.

[0016] Namely, the drying cycle adopted by the related art drum type washing machine is purely carried out for the dewatering only during the dewatering cycle but never performs a bit of the drying function. Thus, the drying time is elongated, whereby the related art fails to meet the latest trend or demand for the high drying performance.

[0017] Accordingly, the present invention is directed to a washing machine and control method thereof that substantially obviates one or more of the problems due to limitations and disadvantages of the related art.

[0018] An object of the present invention, which has been devised to solve the foregoing problem, lies in pro-

viding a washing machine and control method thereof, by which a laundry can be dried more effectively.

[0019] It is another object of the present invention to provide a washing machine and control method thereof, by which a drying cycle time can be shortened.

[0020] It is a further object of the present invention to provide a washing machine and control method thereof, by which stability and reliance can be enhanced.

[0021] Additional features and advantages of the invention will be set forth in the description which follows, and in part will be apparent to those having ordinary skill in the art upon examination of the following or may be learned from a practice of the invention. The objectives and other advantages of the invention will be realized and attained by the subject matter particularly pointed out in the specification and claims hereof as well as in the appended drawings.

[0022] For these objects of the present invention, the present invention includes at least one or more preliminary drying periods during a dewatering cycle.

[0023] In at least one or each of the preliminary drying periods, a drying heater may be turned on during a predetermined time, or a time to be determined during operation, to be operative in dewatering and drying the laundry simultaneously. And, cooling water for condensing hot and humid air may be supplied during at least one period of the dewatering cycle.

[0024] To achieve these objects and other advantages in accordance with the present invention, as embodied and broadly described herein, there is provided a method of controlling a washing machine, the washing machine including a drum holding a laundry therein, the method including the steps of executing a dewatering cycle and at least one preliminary drying for drying the laundry during the dewatering cycle and in particular condensing hot and humid air produced from the drum during at least one portion of the dewatering cycle.

[0025] In another aspect of the present invention, there is provided a method of controlling a washing machine, the washing machine including a drum holding a laundry therein, the method including the step of performing a dewatering cycle by rotating the drum at a plurality of different rotational speeds, the dewatering cycle including a plurality of first periods for detecting both eccentricities and foams by rotating the drum at a low dewatering speed selected from a plurality of the different rotational speeds, respectively, a plurality of second periods lying between a plurality of the first periods to rotate the drum at normal dewatering speeds selected from a plurality of the different rotational speeds and simultaneously to perform preliminary drying if the eccentricities and foams detected through the first periods are decided as normal, respectively, a third period lying behind the second periods to finally rotate the drum at a high dewatering speed selected from a plurality of the different rotational speeds, and a fourth period lying next to the third period to perform an unraveling process of the laundry.

[0026] In a further aspect of the present invention, there is provided a washing machine including a drum holding a laundry therein, a heater heating air to produce hot air, an air supply path leading the hot air to the drum, a blower fan forcibly supplying the hot air to the drum via the air supply path, and a control unit executing a dewatering cycle sub-routine wherein the dewatering cycle sub-routine comprises at least one preliminary drying step of drying the laundry by driving the heater and the blower fan during a dewatering cycle.

[0027] Preferably, the dewatering cycle sub-routine further includes the step of condensing hot and humid air produced from the drum during at least one portion of the dewatering cycle.

[0028] Preferably, the washing machine further includes a cooling water inlet pipe supplying a cooling water to condense hot and humid air flowing via the air supply path.

[0029] It is to be understood that both the foregoing explanation and the following detailed description of the present invention are exemplary and illustrative and are intended to provide further explanation of the invention as claimed.

[0030] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention and together with the description serve to explain the principle of the invention. In the drawings:

FIG. 1 is a cross-sectional diagram of a drum type washing machine equipped with a drying function according to a related art;

FIG. 2 is another cross-sectional diagram of a drum type washing machine equipped with a drying function according to a related art; and

FIG. 3 is a graph of explaining a method of controlling a washing machine according to the present invention.

[0031] Reference will now be made in detail to the preferred embodiment(s) of the present invention, examples of which are illustrated in the accompanying drawings. Throughout the drawings, like elements are indicated using the same or similar reference designations where possible.

[0032] For the understanding of the present invention, the following description of the present invention refers to the configuration of the related art drum type washing machine in FIG. 1 and FIG. 2 without appended explanations since the configuration and function of a drum type washing machine according to the present invention are similar to those of the related art drum type washing machine except a function of a control unit.

[0033] The preferred embodiment of the present invention is explained in detail by referring to FIGs. 1 to 3

as follows.

[0034] First of all, a drum type washing machine according to the present invention includes a drying heater 8 heating air to provide hot air, a blower fan 7 forcibly supplying the hot air to a drum 3 via air supply path, a circulation duct 6 forming the air supply path, a cooling water inlet pipe 9 connected to the circulation duct 6 to supply a cooling water for condensing hot and humid air flowing via the circulation duct 6, and a control unit. And, the control unit sequentially executes a washing cycle sub-routine, a rinsing cycle sub-routine, a dewatering cycle sub-routine, and a drying cycle sub-routine.

[0035] During a dewatering cycle executed prior to a normal drying cycle, the control unit turns on the drying heater 8 at least one or more time during a prescribed period of time each to dewater a laundry and simultaneously to execute a preliminary drying period for drying the laundry. In executing the dewatering cycle subroutine, the control unit supplies the cooling water to an inside of the circulation duct 6 via the cooling water inlet pipe 9 to condense the hot and humid air flowing through the circulation duct 6.

[0036] A control method of a washing machine according to the present invention is explained in detail by referring to FIG. 3 as follows.

[0037] FIG. 3 is a graph of explaining a method of controlling a washing machine according to the present invention.

[0038] Referring to FIG. 3, a dewatering cycle is carried out to dewater a laundry in a manner of rotating the drum at a plurality of different rotational speeds. The dewatering cycle includes a plurality of first periods for detecting both eccentricities and foams by rotating the drum at a low dewatering speed selected from a plurality of the different rotational speeds, respectively, a plurality of second periods lying between a plurality of the first periods to rotate the drum at normal dewatering speeds selected from a plurality of the different rotational speeds and simultaneously to perform preliminary drying if the eccentricities and foams detected through the first periods are decided as normal, respectively, a third period lying behind the second periods to finally rotate the drum at a high dewatering speed selected from a plurality of the different rotational speeds, and a fourth period lying next to the third period to perform a process of unraveling the laundry.

[0039] In the embodiment of the present invention, the low dewatering speed is 600 rpm, the normal dewatering speeds are 900 rpm to 1,000 rpm, and the high dewatering speed is 1,400 rpm. Meanwhile, the preliminary drying is carried out in a manner of driving the heater heating the air and the blower fan forcibly supplying the heated air to the drum. In doing so, the drum 3 is rotated by the motor and the dewatering speeds are substantially the rotational speeds of the motor, respectively.

[0040] A plurality of preliminary drying periods exist between a plurality of the second periods for rotating the drum 3 at the low dewatering speed exceeding 600 rpm. Namely, a plurality of the preliminary drying periods substantially correspond to the second periods for rotating the drum 3 at the normal dewatering speeds of 900 rpm or 1000 rpm, respectively.

[0041] Meanwhile, each of the preliminary drying periods exists after the detected laundry eccentricity and foam have been decided as normal. In this case, the eccentricity corresponds to a distance between a central axis of the drum and a gravity center of the laundry.

[0042] The control unit enables to execute a step of condensing the hot and humid air produced from the drum during at least one period of the dewatering cycle. As mentioned in the foregoing description, in order to condense the hot and humid air flowing through the circulation duct 6 as the air supply path, the cooling water can be supplied to the circulation duct 6 via the cooling water inlet pipe 9.

[0043] And, the control unit enables to keep supplying the cooling water to the circulation duct 6 during the entire periods of the dewatering cycle. Alternatively, the control unit can periodically supplies the cooling water to the circulation duct 6.

[0044] Moreover, the control unit may keep supplying the cooling water to the circulation duct 6 during the preliminary drying periods only. Alternatively, the control unit may periodically keep supplying the cooling water to the circulation duct 6 during the preliminary drying periods only.

[0045] Besides, the cooling water is supplied to the circulation duct 6 by about 0.5 liter per minute in the embodiment of the present invention.

[0046] A process of controlling the cycles by the control unit of the drum type washing machine according to the present invention is explained as follows.

[0047] First of all, a user puts a laundry in the drum 3 and selects a specific washing course. The control unit then performs the dewatering cycle after completion of the washing and rinsing cycles.

[0048] In each of the first periods of the dewatering cycle, the drum 3 is rotated at a rotational speed below 600 rpm to dewater the laundry. In doing so, the control unit detects the eccentricity and foam to decide whether the detected eccentricity and foam are normal. And, the control unit turns off the drying heater 8 and the blower fan 7 not to execute the preliminary drying during each of the first periods.

[0049] While making the drum 3 be rotated at the rotational speed below 600 rpm, the control unit detects the eccentricity and foam to decide whether the detected eccentricity and foam are normal. The control unit then rotates the drum 3 in a manner of raising the dewatering speed up to the low dewatering speed of 600 rpm and then lowering the dewatering speed down to a basic rpm.

[0050] Subsequently, the control unit re-detects the eccentricity in the period where the drum 3 is rotated at a speed equal to or smaller than the low dewatering

speed of 600 rpm. And, the control unit regards the re-detected eccentricity as a real eccentricity.

[0051] If deciding that the re-detected (secondly detected) eccentricity, i.e., the real eccentricity, is normal, the control unit raises the dewatering speed up to 900 rpm of the first normal dewatering speed corresponding to the second period to rotate the drum 3. Hence, the laundry can be stably dewatered without the eccentricity during the period having the normal dewatering speed of 900 rpm.

[0052] As mentioned in the foregoing description, when the laundry is dewatered without the eccentricity, the control unit turns on the drying heater 8 and the blower fan 7 to execute the preliminary drying.

[0053] After the dewatering and the preliminary drying have been performed on the laundry during a first one of a plurality of the second periods, the control unit stops rotating the drum 3. In doing so, the control unit turns off the drying heater 8 and the blower fan 7 as well.

[0054] Subsequently, the control unit finally detects the eccentricity and foam and then decides whether the finally detected eccentricity and foam are normal. If deciding the finally detected eccentricity and foam are normal, the control unit raises the dewatering speed up to 1,000 rpm of the second normal dewatering speed and rotates the drum 3 during a prescribed time to dewater the laundry within the drum 3. In the second period for rotating the drum 3 at the second normal dewatering speed of 1,000 rpm, the control unit turns on the drying heater 8 and the blower fan 7 again for the preliminary drying.

[0055] Meanwhile, after having performed the dewatering and preliminary drying during the prescribed time by rotating the drum 3 at the second normal dewatering speed of 1,000 rpm, the control unit raises the dewatering speed up to the high dewatering speed of 1,400 rpm to dewater the laundry by rotating the drum 3 during a prescribed time. The control unit then reduces the dewatering speed to 'zero' . In this case, the period for rotating the drum 3 at the high dewatering speed of 1,400 rpm corresponds to the third period.

[0056] Subsequently, the control unit executes the fourth period for unraveling the laundry. The unraveling process of the laundry is the last period of the dewatering cycle.

[0057] In each of the preliminary periods, the control unit controls the drying heater 8 so that a temperature of the heated air within the circulation duct can lie within a prescribed temperature range. In this case, the prescribed temperature range is previously determined so as not to overheat the air and not to lower the drying performance. In the embodiment of the present invention, the control unit turns off the drying heater 8 if the temperature of the heated air is 90°C. And, the control unit turns on the drying heater 8 if the temperature of the heated air is 87°C.

[0058] Meanwhile, as mentioned in the foregoing description, in performing the dewatering cycle, the control unit enables the cooling water to be continuously or periodically supplied to the circulation duct 8 via the cooling water inlet pipe 9. In doing so, the cooling water is supplied to prevent the steam, which is generated from the heat exchange between the laundry and the heated air within the drum 3 during the preliminary drying periods, from escaping via a grip of a detergent box.

[0059] After completion of the above-explained dewatering cycle, the control unit executes the drying cycle for the drying only. Compared to the conventional dewatering cycle for performing the dewatering function only, the dewatering cycle according to the embodiment of the present invention is carried out in a manner of turning on the drying heater 8 and the blower fan 7 during the prescribed periods to perform both of the dewatering and the drying on the laundry. As mentioned in the foregoing description, the drying periods of the dewatering cycle are named 'preliminary drying periods', respectively. Besides, the cooling water supply enables to prevent the steam from being discharged via the detergent box.

[0060] Meanwhile, the drum type washing machine is exemplarily used in the embodiment of the present invention for the application thereto. Yet, it is apparent to those skilled in the art that the embodiment of the present invention be applicable to the pulsator type washing machines and other washing machines provided with the dewatering and drying functions.

[0061] As explained in the foregoing description of the present invention, the preliminary drying function is executed during the dewatering cycle proceeding prior to the normal drying cycle as well as the dewatering function.

[0062] Accordingly, the present invention enables to reduce the drying cycle time after completion of the dewatering cycle. And, the present invention enables to shorten the overall washing process from the washing cycle to the drying cycle.

[0063] Moreover, the present invention prevents the steam from being discharged to the detergent box during the respective preliminary drying periods, thereby enabling to enhance the stability and reliance on the product.

[0064] Summarized, the present invention provides a washing machine and control method thereof, by which a laundry can be dried more effectively, by which a drying cycle time can be shortened, and by which stability and reliance can be enhanced. The present invention includes the step of performing dewatering and preliminary drying simultaneously during a dewatering cycle. And, The present invention supplies cooling water for condensing hot and humid air during the dewatering cycle.

[0065] 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 spirit or scope of the invention. Thus, it is intended that the present invention cover such modifications and varia-

tions, provided they come within the scope of the appended claims and their equivalents.

Claims

1. A method of controlling a washing machine, the washing machine including a drum (3) holding a laundry therein, the method comprising the step of performing a dewatering cycle wherein the dewatering cycle comprises at least one preliminary drying period for drying the laundry.

2. The method of claim 1, wherein a heater (8) heating air and a blower fan (7) forcibly supplying the heated air to the drum (3) are provided to the at least one preliminary drying period.

3. The method of claim 2, wherein the heater (8) is controlled to leave a temperature of the heated air within a prescribed range during the at least one preliminary drying period.

4. The method of claim 3, wherein the heater (8) is turned off if the temperature of the heated air is 90°C and wherein the heater is turned on if the temperature of the heated air is 87°C.

5. The method of one of claims 1 to 4, wherein the at least one preliminary drying period is inserted between a plurality of dewatering periods where the drum (3) is rotated at a plurality of normal dewatering speeds, respectively.

6. The method of claim 5, wherein a plurality of the normal dewatering speeds are 900 rpm and 1,000 rpm, respectively.

7. The method of one of claims 1 to 6, wherein the at least one preliminary drying period exists behind each corresponding period detecting an eccentricity corresponding to a distance between a central axis of the drum (3) and a gravity center of the laundry and a foam of the laundry.

8. A method of controlling a washing machine, in particular in combination with the method of one of claims 1 to 7, the washing machine including a drum (3) holding a laundry therein, the method comprising the steps of:

   executing a dewatering cycle and at least one preliminary drying for drying the laundry during the dewatering cycle; and

   condensing hot and humid air produced from the drum (3) during at least one portion of the dewatering cycle.

9. The method of claim 8, wherein the condensing step is continuously performed during the dewatering cycle.

10. The method of claim 8, wherein the condensing step is periodically performed during the dewatering cycle.

11. The method of claim 8, wherein the condensing step is continuously performed during the dewatering cycle during the preliminary drying only.

12. The method of claim 8, wherein the condensing step is periodically performed during the dewatering cycle during the preliminary drying only.

13. A method of controlling a washing machine, in particular in combination with the method of one of claims 1 to 12, the washing machine including a drum (3) holding a laundry therein, the method comprising the step of performing a dewatering cycle by rotating the drum (3) at a plurality of different rotational speeds, the dewatering cycle comprising:

   a plurality of first periods for detecting both eccentricities and foams by rotating the drum (3) at a low dewatering speed selected from a plurality of the different rotational speeds, respectively;

   a plurality of second periods lying between a plurality of the first periods to rotate the drum (3) at normal dewatering speeds selected from a plurality of the different rotational speeds and simultaneously to perform preliminary drying if the eccentricities and foams detected through the first periods are decided as normal, respectively;

   a third period lying behind the second periods to finally rotate the drum (3) at a high dewatering speed selected from a plurality of the different rotational speeds; and

   a fourth period lying next to the third period to perform an unraveling process of the laundry.

14. The method of claim 13, wherein the low dewatering speed is 600 rpm, each of the normal dewatering speeds is 900 rpm to 1,000 rpm, and the high dewatering speed is 1,400 rpm.

15. The method of claim 13 or 14, wherein the preliminary drying is performed by driving a heater (8) heating air and a blower fan (7) forcibly supplying the heated air to the drum (3).

16. A washing machine, in particular a washing ma-

chine controllable by the method of one of claims 1 to 15, the method comprising:

a drum (3) holding a laundry therein;

a heater (8) heating air to produce hot air;

an air supply path leading the hot air to the drum (3);

a blower fan (7) forcibly supplying the hot air to the drum (3) via the air supply path; and

a control unit executing a dewatering cycle sub-routine wherein the dewatering cycle sub-routine comprises at least one preliminary drying step of drying the laundry by driving the heater and the blower fan during a dewatering cycle.

17. The washing machine of claim 16, wherein the air supply path is a circulation duct.

18. The washing machine of claim 16 or 17, wherein the dewatering cycle sub-routine further comprises the step of condensing hot and humid air produced from the drum during at least one portion of the dewatering cycle.

19. The washing machine of one of claims 16 to 18, further comprising a cooling water inlet pipe (9) supplying a cooling water to condense hot and humid air flowing via the air supply path.

20. The washing machine of claim 19, wherein the cooling water is continuously supplied to the air supply path during the dewatering cycle.

21. The washing machine of claim 19, wherein the cooling water is periodically supplied to the air supply path during the dewatering cycle.

22. The washing machine of claim 19, wherein the cooling water is continuously supplied to the air supply path during a preliminary drying period for the at least one preliminary drying step only.

23. The washing machine of claim 19, wherein the cooling water is periodically supplied to the air supply path during a preliminary drying period for the at least one preliminary drying step only.

24. The washing machine of claim 19, wherein the cooling water is supplied about 0.5 liter per minute.

25. The washing machine of one of claims 16 to 25, wherein the heater is controlled to leave a temperature of the heated air within a prescribed range during a preliminary drying period for the at least one preliminary drying step.

26. The washing machine of one of claims 16 to 25, wherein the heater is turned off if the temperature of the heated air is 90°C and wherein the heater is turned on if the temperature of the heated air is 87°C.

FIG. 1
Background Art

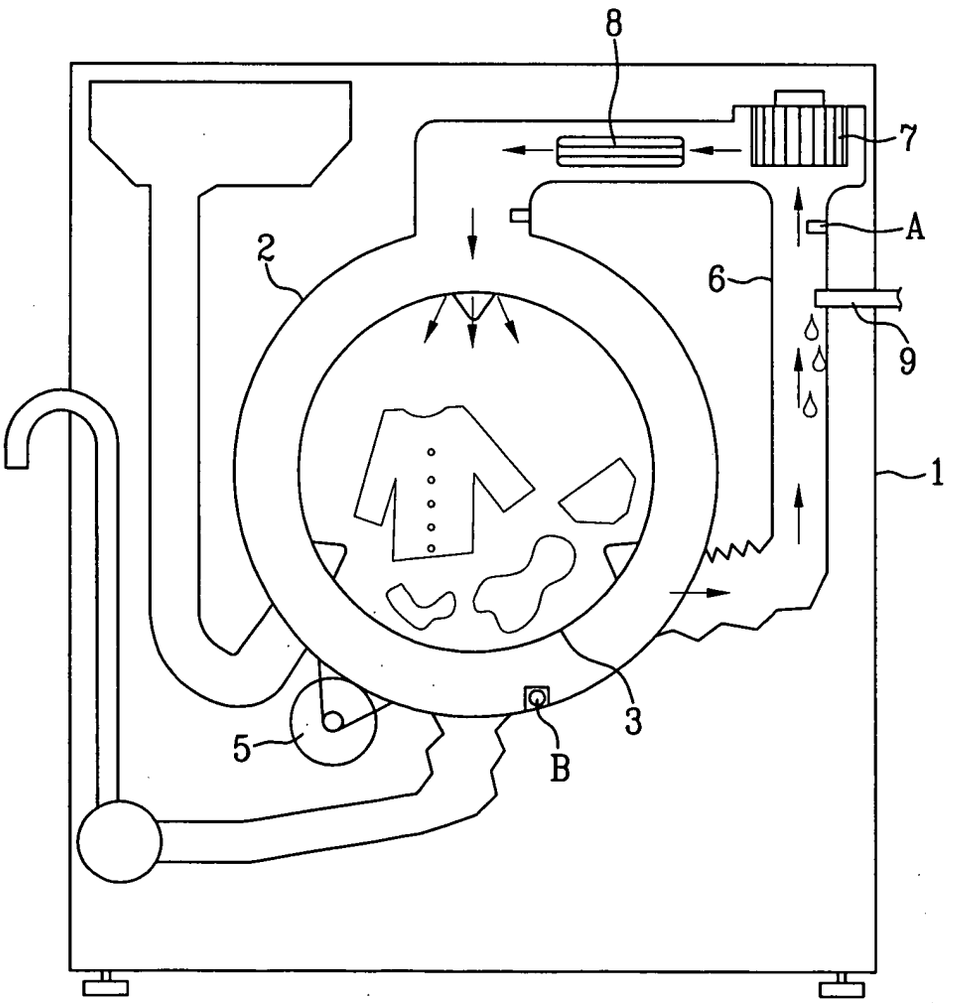


FIG. 2
Background Art

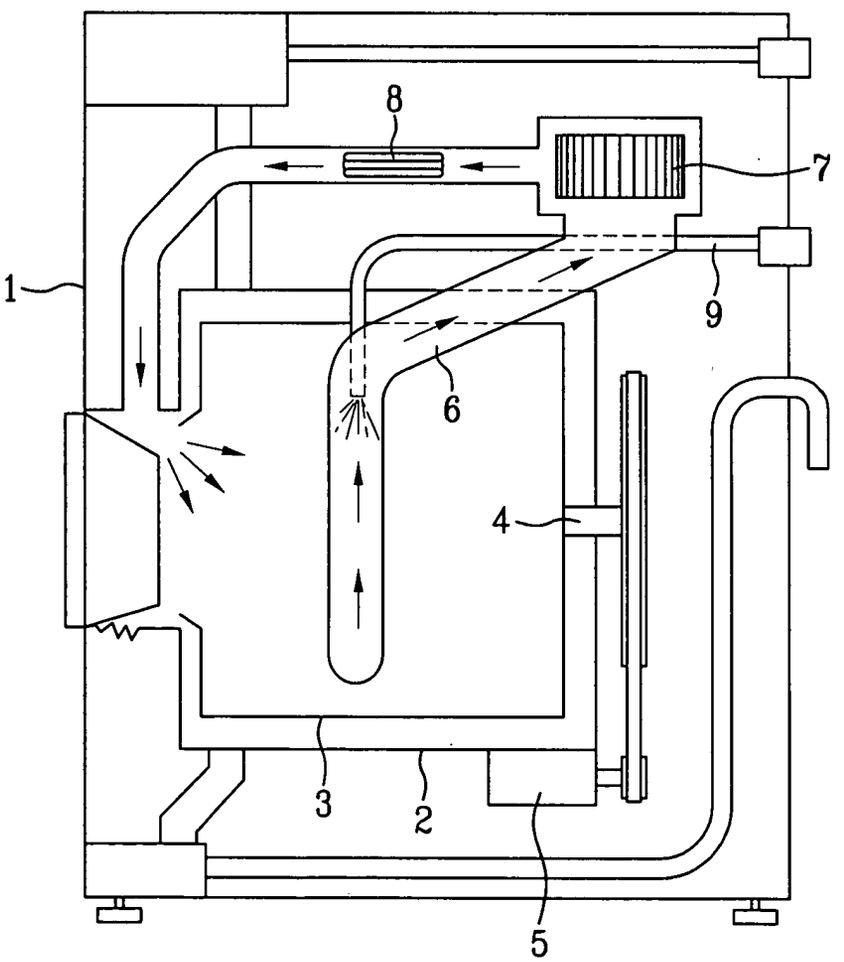
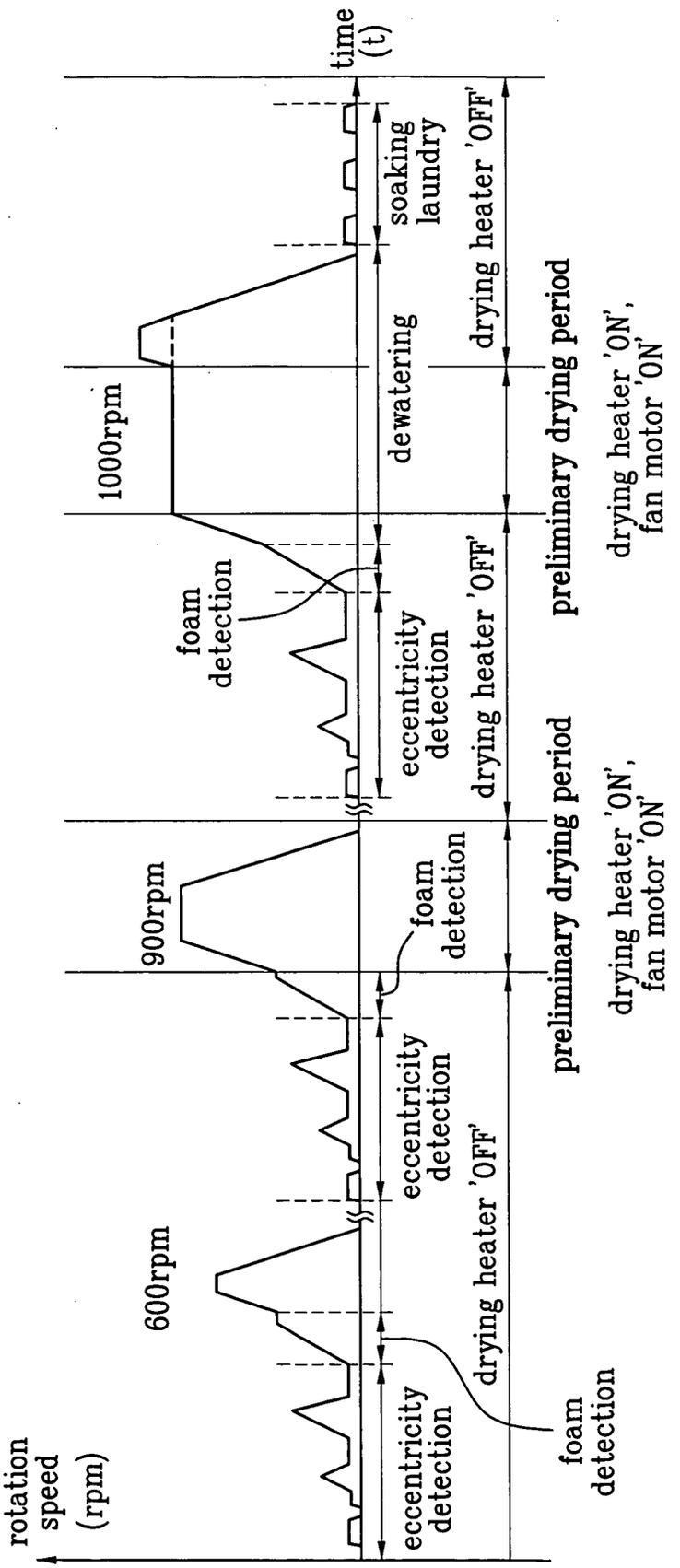


FIG. 3


rotation speed (rpm)
time (t)
600rpm
900rpm
1000rpm
eccentricity detection
foam detection
drying heater 'OFF'
drying heater 'ON', fan motor 'ON'
preliminary drying period
dewatering
soaking laundry
drying heater 'OFF'