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DRUM TYPE WASHING AND DRYING MACHINE

Field of the Invention

5 The present invention relates to a drum type washing and drying machine having a rotary drum disposed in a water tub such that its rotational axis is declined toward the rear portion of the washing and drying machine.

10 Background of the Invention

 Fig. 7 shows a conventional drum type washing machine. As shown therein, housing 67 of the washing machine includes water tub 63, and rotary drum 61 is disposed in water tub 63
15 such that the direction of its rotational axis is horizontally oriented. By opening door 64, which is installed at the front portion of housing 67, laundry is loaded into rotary drum 61 through laundry loading/unloading opening 68 formed at the front portion of water tub 63,
20 facing door 64. Then, when rotary drum 61 is driven to rotate by drum driving motor 65, the laundry in rotary drum 61 is lifted up by agitation blades 66 disposed on the inner cylindrical surface of rotary drum 61 and drops down upon reaching a specific height, thereby undergoing pounding
25 motions (see Japanese Patent Laid-Open Application No. 09-215894, pp. 2 to 6, Fig. 1).



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By adding a drying function to the drum type washing machine having the above-described configuration, a drum type washing and drying machine capable of drying laundry after a water-extracting process or wet clothes can be obtained. Specifically, by forming an air circulation channel for exhausting damp air in rotary drum 61 into water tub 63 through drum perforations 62 formed on the cylindrical surface of rotary drum 61, directing thus exhausted damp air through a dehumidification unit to remove moisture in the damp air, heating thus dehumidified air by a heating unit and re-circulating thus heated air back into water tub 63, the washing machine can also have the drying function for laundry or wet clothes accommodated in rotary drum 61.

However, given that the rotary drum of the conventional drum type washing machine or drum type washing and drying machine is oriented horizontally, user has to bend down considerably to load and unload laundry into or out of the rotary drum through an opening provided at the front surface of the washing machine; this is not only inconvenient for the user but also unsuitable for a small place without sufficient clearance space before the opening. To solve the problems, it has been proposed to have the rotational axis of the rotary drum slanted so that the opening of the rotary drum would face up, thereby facilitating loading and unloading of laundry and allowing

the drum type washing and drying machine to be used even in a limited space (see Japanese Patent Laid-Open Application No. 2003-053087, pp. 3 to 5, Fig. 2).

5 However, if the rotary drum is slanted with respect to the horizontal direction, laundry in the rotary drum having a bottom surface would slide toward the lowest point, which is the rear bottom portion of the cylindrical rotary drum. This tendency of laundry to gather in the rear area is further augmented by the rotation of the rotary drum in a
10 manner such that laundry first lifted up in the circumferential direction by the agitation blades, which are disposed on the inner cylindrical surface of the rotary drum, would drop in the rear portion of the rotary drum by the rotation of the rotary drum. As a result, the slanted
15 rotary drum model has not been able to achieve a satisfying degree of washing or drying evenly and uniformly for every part of laundry articles.

Particularly, although it is necessary that warm air reaches every part of individual laundry articles to
20 facilitate uniform drying, the tendency of laundry to gather in the rear area of the rotary drum becomes worse during the drying process, given that laundry is no longer submerged in wash water, the movement of which facilitates the displacement of laundry in the rotary drum as well. Further,
25 since laundry becomes progressively lighter during the drying process, it becomes also difficult to agitate laundry

by the agitation blades provided on the inner cylindrical surface of the rotary drum. As a result of the problem of having laundry in the rear region of the rotary drum, it is difficult to achieve uniform drying and wrinkles tend to form on the laundry.

Summary of the Invention

It is, therefore, an object of the present invention to provide a drum type washing and drying machine capable of sufficiently agitating laundry in a rotary drum even though the rotary drum of the washing and drying machine is slantingly oriented.

In accordance with a preferred embodiment of the present invention, there is provided a drum type washing and drying machine including a water tub having a rear portion and a front portion; a cylindrical rotary drum having a bottom surface and an opening and disposed in the water tub such that a rotational axis thereof is slanted toward the rear portion of the water tub opposite to the front portion where the opening of the rotary drum is formed; and a drum driving motor for rotating the rotary drum, wherein the washing and drying machine performs washing, rinsing and water-extracting processes by controlling water supply into and drain out of the water tub and by controlling the rotation of the drum driving motor, and performs a drying

process by controlling an air circulation and the rotation of the drum driving motor such that damp air in the rotary drum is discharged and returned to the rotary drum after being dehumidified and heated, the drying process having at least a reference drying control process for controlling the rotation of the drum driving motor such that at least three kinds of rotation control modes are repeated for predetermined time periods, respectively, the respective rotation control modes having a different rotational speed of the rotary drum capable of producing different displacement movement of laundry in the rotary drum by the rotation of the rotary drum, and each rotation control mode having a rotating period and an idle period of the rotary drum for each rotational direction with respect to each rotational speed.

In the above configuration, since at least three kinds of rotation control modes that cause different displacement motions of laundry accommodated in the rotary drum are set, the laundry is subject to the different motions repeatedly over a predetermined time period. By setting multiple rotation control modes such as one to obtain the effects of alternating the position of laundry in the rotary drum with respect to the left and right or in the top and bottom locations, another to unfold them, and another to uniformly expose the laundry to warm air, not only drying of the laundry is facilitated, it is also possible to dry it

uniformly without the formation of wrinkles.

In the above configuration, in addition to the reference drying control process, an initial drying control process can be provided for controlling the rotation of the drum driving motor such that multiple rotation control modes are repeated for a predetermined time period, in the initial stage of the drying process. As a result, a drying control scheme for laundry with high water content can be provided.

Further, in addition to the reference drying control process, it is also possible to set a final drying control process for controlling the rotation of the drum driving motor such that multiple rotation control modes are repeated for a predetermined time period, for controlling the heating of circulation air in the final stage of the drying process. As a result, a drying control scheme for dried laundry with low water content can be performed. Further, by continuing the drying process by blowing air without heating, the temperature of laundry can be lowered when the drying process is finished.

Moreover, in addition to the reference drying control process, it is also possible to combine the initial and final control processes discussed above in the following manner: providing an initial drying control process for controlling the rotation of the drum driving motor such that multiple rotation control modes are repeated for a predetermined time period, and a final drying control

process for controlling the rotation of the drum driving motor such that multiple rotation control modes are repeated for a predetermined time period while also including a process for controlling the heating of circulation air in the final stage of the drying process. As a result, a drying control scheme capable of handling laundry with different water contents can be obtained, namely, from wet to almost dry laundry.

Further, the transition to the next process among the initial drying control process, the reference drying control process and the final drying control process may be controlled based on the elapsed time of the drying process. Each drying control process can be performed by estimating a time period necessary for a certain degree of drying to be completed.

Further, the transition to the next process among the initial drying control process, the reference drying control process and the final drying control process may be controlled based on the detection of the water content of laundry, i.e., the degree of dryness of laundry. As a result, each drying control process corresponding to the detected dryness of laundry can be performed, thereby resulting in more efficient overall drying control processes.

In addition, based on the amount of laundry accommodated in the rotary drum, by setting a rotational speed of each rotation control mode, a rotating or idle

period of time for each rotational direction and a repetition time, rotation control modes corresponding to the load exerted on the drum driving motor can be obtained.

5 Brief Description of the Drawings

The above and other objects and features of the present invention will become apparent from the following description of preferred embodiments given in conjunction
10 with the accompanying drawing, in which:

Fig. 1 is a cross sectional view illustrating the configuration of main components of a drum type washing and drying machine in accordance with a preferred embodiment of the present invention;

15 Fig. 2 shows a perspective view illustrating an external appearance of the drum type washing and drying machine in accordance with the preferred embodiment of the present invention;

20 Fig. 3 shows a cross sectional view illustrating a drying process and relevant components of the drum type washing and drying machine in accordance with the preferred embodiment of the present invention;

Fig. 4 shows a plan view of a heating duct which is one of the components used in the drying process;

25 Figs. 5A and 5B show a flow chart illustrating a rotation control for a rotary drum;

Figs. 6A to 6D show process charts with different combinations of multiple drying control processes; and

Fig. 7 is a cross sectional view illustrating the configuration of a conventional drum type washing and drying machine.

Detailed Description of the Preferred Embodiments

Fig. 1 shows a configuration of major components of drum type washing and drying machine 1 in accordance with a preferred embodiment of the present invention. Housing 2 has therein water tub 3 supported on a suspension structure (not shown), and cylindrical rotary drum 5 having a bottom surface is disposed in water tub 3. Specifically, water tub 3 and rotary drum 5 are disposed such that their openings are located at the front portion of housing 2 while the bottom surfaces of water tub 3 and rotary drum 5 are disposed at the rear portion of housing 2. Further, rotary drum 5 is slanted such that its rotational axis R is declined toward the rear portion of housing 2 at a specific angle θ with respect to the horizontal direction H. Rotary drum 5 is driven to rotate by drum driving motor 4 installed at the rear portion of water tub 3.

Water tub 3 includes cylindrical main body 3a having a base and lid 3b connected to main body 3a, wherein lid 3b of the water tub 3 extends inward (i.e., toward the center) to

provide laundry loading/unloading opening 11 through which laundry is loaded into or unloaded from rotary drum 5. Further, door 8 is installed at inclined surface 2a formed at the front surface portion of housing 2 such that it faces laundry loading/unloading opening 11. Laundry can be loaded into or unloaded from rotary drum 5 after door 8 is opened. Further, by forming door 8 partially or entirely with a transparent material, the inside of rotary drum 5 can be viewed from outside. Moreover, bellows 13, which is made of a flexible elastic body, is disposed around laundry loading/unloading opening 11. Accordingly, when door 8 is closed, the inner surface of door 8 makes a pressurized contact with an end of bellows 13, to thereby prevent splashed water by the rotation of rotary drum 5 from escaping water tub 3. Although lid 3b and main body 3a of water tub 3 are described as separate components in this embodiment, it is also possible to form lid 3b and main body 3a as one unit. For instance, when lid 3b and main body 3a are formed of, e.g., plastic material, they can be molded as one body. When a metallic material is used instead, they can be manufactured as one body.

As described above, by having rotary drum 5 slanted and installing door 8 at housing 2 to face the opening of rotary drum 5, door 8 is raised to face a user's face when he/she stands in front of drum type washing and drying machine 1, and loading and unloading of laundry can be

performed without the user having to bend down considerably. Further, installation of drum type washing and drying machine 1 in a small space, e.g., bathroom, where a conventional vertical washing machine is typically installed, becomes easier because having a large clearance space in front of washing machine 1 is no longer required. Therefore, drum type washing and drying machine 1 can be configured to be suitable even for small houses with limited space.

With regard to laundry loading/unloading opening 11 location, it is formed such that its center lies above the rotational axis R of rotary drum 5. Further, door 8 is disposed to be substantially concentric with laundry loading/unloading opening 11. If laundry loading/unloading opening 11 and door 8 are installed such that their centers are positioned above the rotational axis of rotary drum 5 as described above, the blind spot area is made smaller when the inside of rotary drum 5 is looked into through laundry loading/unloading opening 11 after opening door 8. Thus, laundry accommodated in rotary drum 5 can be observed without being hidden from view. Therefore, it becomes highly unlikely that a user would miss any laundry inside rotary drum 5 thereby failing to take it out. Particularly, by slanting rotary drum 5 and installing door 8 at inclined surface 2a formed to correspond to the angle of inclination of rotary drum 5 as in drum type washing and drying machine 1 in accordance with the preferred embodiment of the present

invention, the inside of rotary drum 5 can be viewed more extensively.

Inventors of the present invention conducted extensive research to find an optimum angle θ of inclination of rotary drum 5, and it was found that the preferable angle is about 30 $\pm$ 5 degrees. By slanting rotary drum 5 at the angle θ of about 30 $\pm$ 5 degrees, preferably, any users, whether they are children (not infants), adults or people using a wheelchair, can load and unload laundry conveniently regardless of their height. Further, by disposing laundry loading/unloading opening 11 and door 8 such that their centers are positioned above the rotational axis R of rotary drum 5 while having rotary drum 5 slanted, loading/unloading of laundry becomes easier, and a user can easily inspect each washing operation step through transparent door 8.

Figs. 3 and 4 illustrate a drying function provided by drum type washing and drying machine 1. Dehumidification duct 16 and air flow duct 18 are formed as one body on the peripheral surface of water tub 3. Further, as shown in Fig. 4, air heating duct 19 is installed on the rear portion of water tub 3. By the rotation of blower 15 disposed in air heating duct 19, damp air in rotary drum 5 is blown into water tub 3 through drum perforations 12 formed on the cylindrical surface thereof and is directed into dehumidification duct 16. Disposed in dehumidification duct 16 is dehumidification unit 38 including heat exchanger 51

and water supply nozzle 52. When water supply valve 53 is opened, water is sprayed onto heat exchanger 51 via water supply nozzle 52, whereby heat exchanger 51 is cooled down. Thus, the damp air introduced into dehumidification duct 16 via air outlet 21 is cooled by heat exchanger 51 and dehumidified as moisture contained therein is condensed. Water used to cool heat exchanger 51 or produced from the condensation of moisture flows into water tub 3 as indicated by dashed arrows in Fig. 3 and is discharged externally via drain passage 10.

Since dehumidification duct 16 and air flow duct 18 are connected to each other via connection duct 32 at the front portion of water tub 3, the dehumidified air is directed to air heating duct 19 installed on the rear portion of water tub 3 through connection duct 32, lint trap filter 17 and air flow duct 18, respectively, as shown by solid arrows in Fig. 3.

Air heating duct 19 includes lower piping 23 and upper piping 24 joined to each other. Fig. 4 shows the configuration of air heating duct 19 from which lower piping 23 is separated to illustrate the inside of air heating duct 19. Disposed in air heating duct 19 is heater 20, and the dehumidified air blown through air flow duct 18 is heated by heater 20. Thus heated warm air with a preset temperature is blown into water tub 3 from air inlet 22 and is introduced into rotary drum 5 through air circulation holes

39 formed at the rear side of rotary drum 5 along the circumference thereof. As a result, the moisture in laundry in rotary drum 5 is evaporated by the warm air, and drying of laundry is therefore facilitated. Then, damp air
5 containing the moisture extracted from the laundry is exhausted into dehumidification duct 16 again, and by repeating such air circulation process which includes dehumidification and heating processes, the laundry is dried.

If rotary drum 5 is slanted as in the above
10 configuration, laundry accommodated in rotary drum 5 tends to slide down toward the rear portion of rotary drum 5, and this laundry's tendency to gather in the rear area is further augmented by rotation of rotary drum 5. The problem, however, can be solved in drum type washing and drying
15 machine 1 in accordance with the preferred embodiment of the present invention by controlling the rotation of rotary drum 5 and by using agitation blades 9 provided on the inner cylindrical surface of rotary drum 5. Since, however, there is no water in rotary drum 5 during the drying process and
20 the moisture content in laundry decreases throughout the drying process of laundry, the effect of agitation on laundry by agitation blades 9 and laundry's displacement movements in response to change in the rotational speed of rotary drum 5 become different from those in a washing or a
25 rinsing process. Accordingly, it is necessary to perform a drying control process for preventing laundry from being

gathered at the rear area of rotary drum 5 during a drying process, so that laundry can be efficiently dried by allowing drying air to reach every part of laundry articles. Hereinafter, the drying control process will be described in accordance with the preferred embodiment of the present invention with reference to Figs. 5A and 5B, wherein reference numerals S1 to S21 represent a control sequence.

The displacement of laundry accommodated in rotary drum 5 which is to be dried is affected by the rotational speed or reversing of the rotational direction of rotary drum 5. Therefore, by controlling the rotation of rotary drum 5 such that displacements of laundry in various manners are obtained, laundry in slanted rotary drum 5 can be made to move in various directions in the rotary drum 5 adequately for the drying process, so that more efficient drying process can be performed, compared to a case where laundry keeps moving uniformly. Further, since the laundry's displacement in the rotary drum 5 changes depending on the amount of laundry accommodated in rotary drum 5, the control operation needs to be performed to reflect the amount of laundry being handled. In this case, by controlling drum driving motor 4, three different rotation control modes employing three different rotational speeds of rotary drum 5 are repeated in predetermined time intervals, thereby causing laundry to displace differently in the rotary drum 5. In each of the control modes, a time

period for rotating rotary drum 5 in each of two different rotational directions and an idle time period for stopping the rotation of rotary drum 5 are determined based on the amount of laundry accommodated in rotary drum 5.

5 With reference to Figs. 5A and 5B, the amount of laundry accommodated in rotary drum 5 is detected (S1). The laundry amount detection can be performed by, for example, calculating a laundry amount from a load exerted on drum driving motor 4. Then, a time period for each of a first to
10 a third rotation control mode is set based on the detected laundry amount (S2). Specifically, a rotational speed of rotary drum 5, a time period for rotating rotary drum 5 forwardly at the rotational speed, an idle time period for
15 stopping rotary drum 5 in order to reverse the rotational direction thereof and a time period for rotating rotary drum 5 reversibly at the rotational speed are determined with regard to each of the first to the third rotation control modes.

 First, the first rotation control mode is executed and
20 drum driving motor 4 is set to rotate rotary drum 5 at a first rotational speed (S3). Subsequently, rotary drum 5 is forwardly rotated at the first rotational speed for a first rotating period of time (S4) and then is stopped for a first idle period of time (S5). Thereafter, rotary drum 5 is
25 rotated reversibly at the first rotational speed for the first rotating period of time (S6) and then is stopped for

the first idle period of time (S7). With regard to rotary drum 5 having a diameter of about 500 ± 50 mm, the first rotational speed is set at, for example, 80 to 120 rpm; the first rotating period of time is set at, for example, 2
5 seconds; and the first idle period of time is set at, for example, 1 second. As a result of performing the above-described first rotation control mode, laundry stuck on the inner cylindrical surface of rotary drum 5 gets dispersed due to the impact of sudden change of rotational direction
10 of rotary drum 5. As a result, reversing the rotation of rotary drum 5 is accompanied by rearrangement of the positions of laundry articles with respect to the rotational axis thereof. The first rotation control mode is repeatedly performed for a predetermined period of time (for example, 3
15 minutes) set in step S2 (S8).

Next, the second rotation control mode is performed, and drum driving motor 4 is set to rotate rotary drum 5 at a second rotational speed (S9). Subsequently, rotary drum 5 is forwardly rotated at the second rotational speed for a
20 second rotating period of time (S10) and then is stopped for a second idle period of time (S11). Thereafter, rotary drum 5 is rotated reversibly at the second rotational speed for the second rotating period of time (S12) and then is stopped for the second idle period of time (S13). With regard to
25 rotary drum 5 having a diameter of about 500 ± 50 mm, the second rotational speed is set at, for example, 20 to 25

rpm; the second rotating period of time is set at, for example, 60 seconds; and the second idle period of time is set at, for example, 2 seconds. As a result of performing the second rotation control mode for rotating rotary drum 5 forwardly and reversibly at the low rotational speed, the effect of lifting up laundry in the rotational direction of rotary drum 5 is not obtained, but instead laundry's movement of rolling in the lower portion of rotary drum 5 while being agitated in left/right and to-and-fro direction is obtained. As a result, the laundry is heated uniformly by warm air blown from the lower rear portion of rotary drum 5. The second rotation control mode is performed for a preset period of time (for example, 5 minutes) set in step S2 (S14).

Subsequently, the third rotation control mode is performed, and drum driving motor 4 is set to rotate rotary drum 5 at a third rotational speed (S15). Subsequently, rotary drum 5 is forwardly rotated at the third rotational speed for a third rotating period of time (S16) and then is stopped for a third idle period of time (S17). Thereafter, rotary drum 5 is rotated reversibly at the third rotational speed for the third rotating period of time (S18) and then is stopped for the third idle period of time (S19). With regard to rotary drum 5 having a diameter of about 500 ± 50 mm, the third rotational speed is set at, for example, 35 to 45 rpm; the third rotating period of time is set at, for

example, 60 seconds; and the third idle period of time is set at, for example, 2 seconds. As a result of performing the third rotation control mode, laundry is lifted up in the rotational direction of rotary drum 5 and is dropped upon reaching a height where the weight of the laundry gets greater than the inertia or centrifugal force, so that position change of the laundry occurs vertically and the laundry is uniformly exposed to warm air blown into rotary drum 5, thereby facilitating the drying process. The third rotation control mode is repeatedly conducted for a predetermined period of time (for example, 5 minutes) set in step S2 (S20).

The first to the third rotation control mode are repeated for the predetermined time periods during the drying process (S21). Further, the sequence for performing the first to the third rotation control mode is not limited to the example illustrated in Figs. 5A and 5B, but can be changed if necessary. Furthermore, it is preferable to prepare at least three different rotation control modes, and more than three is more preferable.

As described above, the drying process is performed through the first rotation control mode in which laundry is stuck on the inner cylindrical surface of rotary drum 5 and then is dispersed while undergoing position changes in the direction of rotational axis of rotary drum 5 in the first, the second rotation control mode in which the laundry is

rolled in rotary drum 5 while undergoing agitation in the left/right and to-and-fro direction, and the third rotation control mode in which the laundry is uniformly exposed to the warm air blown thereto, thereby being effectively dried.

5 Although it is preferable only to perform the rotation control of rotary drum 5 according to the above-described control sequence during a drying process as shown in Fig. 6A, it is also possible to perform an initial drying control process (B) and/or a final drying control process (C) before
10 and after the above-described rotation control (A), which is to be referred to as a reference drying control process (A) hereinafter, as shown in Figs. 6B to 6D. Specifically, it is possible to divide the drying process into multiple stages and perform several rotation control modes according
15 to the control sequence described in Figs. 5A and 5B in each stage, wherein a rotational speed, a time period for rotating rotary drum 5 forwardly, an idle time period for stopping the rotation of rotary drum 5, a time period for rotating rotary drum 5 reversibly, and a time period for
20 repeating each control mode are set to correspond to the current dryness state of laundry in each rotation control mode. The progressive drying of laundry can be estimated based on the detection of the time elapsed or the degree of dryness of laundry. Although the degree of dryness of
25 laundry can be detected by using a dryness sensor, it is also possible to detect the degree of dryness of laundry

based on detection outputs from cooling water temperature sensor 57 as shown in Fig. 3, for detecting the temperature of water flowing in drain passage 10 after being used to cool heat exchanger 51 and air temperature sensor 56 as shown in Fig. 4, for detecting the temperature of air blown into air heating duct 19.

Fig. 6B illustrates a control example of performing the initial drying control process (B) before the reference drying control process (A). The initial drying control process (B) will now be described with reference to 5A and 5B. In the initial drying control process, a first initial rotational speed is set at 20 to 25 rpm (S3), and a series of stages of rotating rotary drum 5 forwardly for a first initial rotating period time (e.g., 30 seconds) (S4); stopping rotary drum 5 for a first initial idle period of time (e.g., 2 seconds) (S5); rotating rotary drum 5 reversibly for the first initial rotating period of time (S6); and then stopping rotary drum 5 for the first initial idle period of time (S7) are performed. By repeating such series of control steps from S4 to S7 for a time period (for example, 10 minutes) set for the first initial rotation control mode (S8), the effect of lifting up laundry in the rotational direction of rotary drum 5 is not obtained because rotary drum 5 is rotated at the low speed. Instead, laundry is agitated in left and right direction in the lower region of rotary drum 5, thereby uniformly heating the

laundry by warm air blown from the lower rear portion of rotary drum 5.

After completion of the first initial rotation control mode, a second initial rotational speed is set at 80 to 12 rpm (S9). Then, rotary drum 5 is rotated forwardly for a second initial rotating period of time (e.g., 2 seconds) (S10) and then is stopped for a second initial idle period of time (e.g., 1 second) (S11). Subsequently, rotary drum 5 is rotated reversibly for the second initial rotating period of time (S12) and then is stopped for the second initial idle period of time (S13). By repeating the series of control steps from S10 to S13 for a time period (e.g., 1 minute) set for the second initial rotation control mode (S14), laundry stuck on the inner cylindrical surface of rotary drum 5 by being rotated at the second initial rotational speed gets dispersed due to the impact of sudden reversal of rotational direction. As a result, the effect of changing laundry's position in the direction of the rotational axis of rotary drum 5 is obtained.

As described above, the initial drying control process is performed for the purpose of changing the position of laundry in rotary drum 5 in the rotational direction thereof by performing the first initial rotation control mode and the second initial rotation control mode, given that the laundry is wet and, thus, it is unlikely to be wrinkled.

After repeating the initial drying control process (B)

for a preset period of time or until the desired dryness of laundry is detected, the above-described reference drying control process (A) is performed.

Furthermore, as shown in Fig. 6C, the final drying control process (C) may be performed after completing the reference drying control process (A). The final drying control process (C) is an air cooling process carried out by stopping the heating of dry air by heater 20 and performing the drying process by means of only the circulation of air blown by blower 15, to thereby reduce the temperature of laundry already substantially dried. Since excessive drying of laundry is not preferable for, e.g., clothes condition and excessive power-consumption, a control for transmitting the air cooling operation only using the air blown by blower 15 while stopping the heating of laundry by heater 20 is conducted when a detection is made as to a preset level of dryness has been reached. The final drying control process (C) can be conducted according to the control sequence identical to that illustrated in Figs. 5A and 5B, and the rotation control scheme and time period control scheme identical to those described in the reference drying control process (A) can be employed.

As described above, the final drying control process is conducted to facilitate the position change of laundry in rotary drum 5 in the direction of the rotational axis of rotary drum 5 while preventing the formation of wrinkles on

the laundry. Therefore, the final drying control process is performed through a first final rotation control mode in which laundry is first allowed to be stuck on the inner cylindrical surface of rotary drum 5 and then is dispersed while changing its position in the direction of the rotational axis of rotary drum 5; a second final rotation control mode in which the laundry is rolled in rotary drum 5 to be agitated in the left-right and to-and-fro direction; and a third final rotation control mode in which the laundry is uniformly exposed to cool air, while undergoing the air cooling operation for reducing the temperature thereof.

Furthermore, if the initial drying control process (B), the reference drying control process (A) and the final drying control process (C) are executed according to the above-described control sequence of each rotation control mode as shown in Fig. 6D, a better drying result can be obtained.

In accordance with the preferred embodiment of the present invention, there is prepared a structure for facilitating the movement of laundry in rotary drum 5 in addition to the above-described rotation control scheme. As shown in Fig. 1, back filter 30 for preventing laundry from escaping into water tub 3 through the multiple air circulation holes 39 provided on the rear portion of rotary drum 5 is formed to have a spherical surface with a gentle arc. Back filter 30 serves to slide the laundry being

agitated by the rotation of rotary drum 5 toward the front portion of rotary drum 5. Back filter 30 is provided with multiple densely arranged small holes that allow the warm air blown through air circulation holes 39 to enter rotary drum 5 easily. The surface of back filter 30 that faces the inside of rotary drum 5 is formed as a smoothing surface that is capable of facilitating the sliding of laundry. Though it is possible to form back filter 30 to have the smoothing surface by using a material such as metal or resin, it is more preferable to use a material having a small coefficient of friction such as fluorine based resin or polyacetal or to use such a material to coat the surface thereof.

Moreover, as shown in Fig. 1, corner cover 31 is disposed around the corner portion of rotary drum 5 such that the inner cylindrical surface of rotary drum 5 and the rear surface thereof is connected by a curved surface or a sloped surface. The inner peripheral surface of corner cover 31 is formed as an arc-shaped surface or a curved surface serving as a smoothing surface having a high level of slippage. By the presence of corner cover 31, the laundry which is dropped from the upper portion of rotary drum 5 due to the agitation by the rotation of rotary drum 5 and the laundry which is glided on back filter 30 can be readily moved to the front portion of rotary drum 5. Although it is also possible to form the corner portion of

rotary drum 5 which connects the inner cylindrical surface to the rear surface in a round shape or a "C" shape instead of installing corner cover 31 in the corner portion, installation of corner cover 31, which can be easily
5 fabricated by a resin molding, would be considered more preferable because ring-shaped balancers 34, which are disposed at the opening portion and the rear portion of rotary drum 5 in order to suppress vibration caused by the rotation of rotary drum 5, are manufactured by a resin
10 molding as well.

In accordance with the present invention described so far, the problem of laundry gathering at the lower region of the rotary drum, which is slanted to facilitate the loading and unloading of laundry, while resulting in non-uniform
15 drying of laundry during a drying process can be solved by setting multiple rotation control modes capable of obtaining different movements of the laundry. Through the various rotation control modes, the laundry can be sufficiently agitated while changing its position in the rotary drum and
20 the effect of unfolding the laundry to minimize wrinkles can also be obtained. As a result, any laundry does not remain in a certain area in the rotary drum, so that non-uniform drying can be avoided and the laundry can be efficiently dried.

25 While the invention has been shown and described with respect to the preferred embodiment, it will be understood

by those skilled in the art that various changes and modifications may be made without departing from the spirit and scope of the invention as defined in the following claims.

What is claimed is:

1. A drum type washing and drying machine comprising:

a water tub having a rear portion and a front portion;

5 a cylindrical rotary drum having a bottom surface and an opening and disposed in the water tub such that a rotational axis thereof is slanted toward the rear portion of the water tub opposite to the front portion where the opening of the rotary drum is formed; and

10 a drum driving motor for rotating the rotary drum,

wherein the washing and drying machine performs washing, rinsing and water-extracting processes by controlling water supply into and drain out of the water tub and by controlling the rotation of the drum driving motor, and performs a drying process by controlling an air circulation and the rotation of the drum driving motor such that damp air in the rotary drum is discharged and returned to the rotary drum after being dehumidified and heated, the drying process having at least a reference drying control

20 process for controlling the rotation of the drum driving motor such that at least three kinds of rotation control modes are repeated for predetermined time periods, respectively, the respective rotation control modes having a different rotational speed of the rotary drum capable of producing different displacement movement of laundry in the rotary drum by the rotation of the rotary drum, and each

rotation control mode having a rotating period and an idle period of the rotary drum for each rotational direction with respect to each rotational speed.

5 2. The washing and drying machine of claim 1, wherein the drying process further has an initial drying control process for controlling the rotation of the drum driving motor in an initial stage of the drying process, and wherein the initial drying control process has a plurality of rotation control
10 modes which are repeatedly executed for preset time periods, respectively.

3. The washing and drying machine of claim 1, wherein the drying process further has a final drying control process
15 for controlling the rotation of the drum driving motor such that a multiplicity of rotation control modes are repeated for preset time periods, respectively and for controlling the heating of circulation air, and wherein the final drying control process is repeatedly executed in a final stage of
20 the drying process.

4. The washing and drying machine of claim 1, wherein the drying process further has an initial drying control process for controlling the rotation of the drum driving motor such
25 that a plurality of rotation control modes are repeated for preset time periods, respectively, and a final drying

control process for controlling the rotation of the drum driving motor such that a multiple number of rotation control modes are repeated for a predetermined time, respectively and for controlling the heating of circulation air, the initial and the final drying control processes being performed in an initial state and a final stage of the drying process, respectively.

5. The washing and drying machine of any one of claims 2 to 4, wherein a transition from a drying control process to a next drying control process is controlled based on elapsed time of the drying process.

6. The washing and drying machine of any one of claims 2 to 4, wherein a transition from a drying control process to a next drying control process is controlled based on a detection of the degree of dryness of the laundry.

7. The washing and drying machine of any one of claims 1 to 6, wherein a rotational speed of each rotation control mode, a rotating period of time and an idle period of time for each rotation control mode for each rotational direction, and a repetition time are set based on the amount of the laundry accommodated in the rotary drum.