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DRUM TYPE WASHING MACHINE

Field of the Invention

5 The present invention relates to a drum type washing machine; and, more particularly, to a drum type washing machine capable of executing, e.g., washing, rinsing, and dewatering processes in a rotary drum rotably installed in a water tub such that a rotational axis thereof is
10 substantially horizontal or slanted with respect to a horizontal direction.

Background of the Invention

15 Referring to Fig. 6, there is illustrated a conventional drum type washing machine. As shown therein, housing 57 of the washing machine includes water tub 53 installed via a suspension structure. Incorporated in water tub 53 is rotary drum 51 which is provided with a plurality
20 of drum perforations 52 on a peripheral surface thereof. Rotary drum 51 is driven to rotate by drum driving motor 55. Further, by opening door 54, which is installed at a front portion of housing 57, laundry articles can be loaded into or unloaded from rotary drum 51 via respective openings
25 formed at front portions of water tub 53 and rotary drum 51.

After an opening of door 54, the laundry articles and

detergent are loaded into rotary drum 51, and the operation of the washing machine is initiated. Water is fed into water tub 53 and, also, into rotary drum 51 through drum perforations 52. Then, when rotary drum 51 is driven to rotate at a predetermined rotational speed by drum driving motor 55, the laundry articles accommodated in rotary drum 51 are lifted up in a rotational direction by the action of agitation blades 56 provided on an inner peripheral surface of rotary drum 51 and are dropped when reaching a specific height, thereby undergoing pounding motions. After the completion of the washing operation, the used washing fluid is drained, and a rinsing operation is carried out by using fresh water. Then, when the rinsing operation is finished, a dewatering operation is conducted by way of rotating rotary drum 51 at a high rotational speed. The series of processes described are automatically carried out according to a preset control sequence.

The above-described washing machine has a general configuration of a drum type washing machine. In addition to the washing machine with such a basic configuration, there has been suggested, for example, a drum type washing machine employing a structure for drawing water stored in a water tub into a rotary drum in order to allow laundry articles to be sufficiently soaked by water, to thereby provide a further enhanced detergency (see Japanese Patent Laid-Open Application No. 1997-215893, pp. 3 to 5, Fig. 1).

Besides, there has been also developed a washing machine having a laundry drying function for drying laundry articles by way of blowing warm air into a rotary drum.

5 In washing machines including drum-type ones, thus has continued to exist a need to improve the cleaning efficiency while reducing an amount of water used and the period of time required for the washing process. To meet such requirements, there has been developed a technique for enhancing the cleaning efficiency by utilizing detergent
10 foams generated by dissolving a detergent in water.

Summary of the Invention

Accordingly, it is a primary object of the present
15 invention to provide a drum type washing machine having a structure for efficiently generating detergent foams.

In accordance with a preferred embodiment of the present invention, there is provided a drum type washing machine comprising: a rotary drum disposed in a water tub
20 and driven to rotate by a drum driving motor, wherein a controlled amount of water from a water supply unit is fed into the water tub; and a controller for controlling operations of each part including the water supply unit and the drum driving motor according to a control sequence in
25 each of washing, rinsing and dewatering processes, wherein a turbulent water flow generating means is provided at an

inner lower portion of the water tub in a direction intersecting a rotational direction of the rotary drum, and wherein the controller performs a water supply control operation for supplying the water into the water tub up to a
5 second water level by way of controlling the water supply unit, the second water level being lower than a first water level corresponding to an amount of laundry articles; and then performs a rotation control operation for rotating the rotary drum at a second rotational speed by way of
10 controlling the drum driving motor, the second rotational speed being greater than a first rotational speed employed in the washing process.

Under the above configuration, the rotary drum is rotated at the second rotational speed at the moment the
15 supply of water up to the second water level is started, thereby initiating the washing process. Therefore, there is developed a current in the detergent-containing water supplied into the water tub in the rotational direction of the rotary drum, and a turbulent water flow is generated
20 from the current of water by a wall portion provided in the direction intersecting the rotational direction of the rotary drum. The detergent solution in the water tub is of a high concentration because it contains the detergent in a small amount of water. By the development of the turbulent
25 water flow, detergent foams are produced from the detergent solution of the high concentration. The detergent foams so

generated are introduced into the rotary drum from the water tub via an opening of the rotary drum to thereby make contact with the laundry articles being agitated by the rotation of the rotary drum. Accordingly, the high
5 concentration of the detergent solution permeates through the laundry articles, providing an improved detergency. As a result, the cleansing efficiency of the washing operation with the supply of water up to the first water level is improved and the time period required for the washing of the
10 laundry articles is shortened.

Preferably, the controller rotates the rotary drum at the first rotational speed as soon as the supply of water is started. If the rotary drum is rotated at the first rotational speed, the laundry articles are lifted up in the
15 rotational direction of the rotary drum and is dropped when reaching a height where a weight of the laundry articles gets greater than the inertia or centrifugal force. Since the lift-up and drop movements of the laundry articles are repeated while the water is being supplied, the laundry
20 articles can be completely soaked by water, which helps the detergent solution penetrate the laundry articles when the detergent foams of the high concentration are adhered to the laundry articles. As a result, the washing of the laundry articles can be performed without causing any uneven or
25 insufficient in washing result.

Further, the first water level is set to correspond to

the amount of the laundry articles accommodated in the rotary drum. If the rotary drum is rotated while water is being supplied up to the second water level lower than the first water level, the detergent foams can be generated from the detergent solution of a high concentration, so that the detergent foams of high concentration can be efficiently produced.

Furthermore, the second rotational speed is set to be the rotational speed at which a centrifugal force can be obtained to allow the laundry articles not to drop but to cling to an inner peripheral surface of the rotary drum. By rotating the rotary drum at the second rotational speed, there is developed a fast current in the water supplied in the water tub, so that generation of detergent foams of a high concentration can be facilitated. Moreover, since the laundry articles cling to the inner peripheral surface of the rotary drum, it becomes easier to fill the central portion of the rotary drum with the detergent foams.

Preferably, the first rotational speed is set to be the rotational speed at which the laundry articles accommodated in the rotary drum are allowed to be lifted up in the rotational direction thereof and dropped when reaching a height where their weight gets greater than the inertia or centrifugal force developed by the rotation. By rotating the rotary drum at the first rotational speed, the laundry articles can be fully agitated while changing their

positions in the rotary drum, so that all of the laundry articles can undergo uniform detergency.

Further, the turbulent water flow generating portion is preferably a groove formed at an inner lower portion of the water tub. The groove may be formed in a direction intersecting the rotational direction of the rotary drum. Alternately, a sidewall of a drain groove, formed at a lowermost portion of the water tub for use in draining water, can be used as the turbulent water flow generating portion.

Still further, the turbulent water flow generating portion can be a protrusion formed at the inner lower portion of the water tub in the direction intersecting the rotational direction of the rotary drum. The turbulent water flow generating portion facilitates a development of a turbulent water flow from a water current, generated by the rotation of the rotary drum, and, thus, detergent foams can be efficiently generated.

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 with the accompanying drawings, in which:

Fig. 1 shows a configuration of main parts of a drum type washing machine in accordance with a preferred

embodiment of the present invention;

Fig. 2 provides a block diagram describing a controller for use in the drum type washing machine in accordance with the preferred embodiment of the present invention;

Fig. 3 describes a flowchart for describing a water supply control and a rotation control executed by the controller in accordance with the preferred embodiment of the present invention;

Fig. 4 presents a cross sectional view of a wall portion of a water tub;

Fig. 5 offers a cross sectional view of a wall portion of a water tub, wherein the wall portion is provided with a protrusion; and

Fig. 6 sets forth a cross sectional view of a conventional drum type washing machine.

Detailed Description of the Preferred Embodiments

Referring to Fig. 1, there is shown a configuration of main parts of a drum type washing machine in accordance with a preferred embodiment of the present invention. Water tub 3 is slantingly suspended in housing 2 via a suspension structure (not shown). Rotably installed in water tub 3 is cylindrical rotary drum 5 having a base. Rotary drum 5 is driven to rotate by drum driving motor 4, disposed at a rear

portion of water tub 3, and a rotational speed and a rotational direction of rotary drum 5 can be varied. Further, rotary drum 5 is installed in water tub 3 such that an opening thereof is disposed toward a front portion of housing 2 and the direction R of a rotational axis of rotary drum 5 is declined toward a rear portion of housing 2 at an angle of θ with respect to a horizontal direction H. Therefore, after opening door 8, which is installed at inclining surface 2a formed at a front portion of housing 2, laundry articles can be loaded into or unloaded from rotary drum 5 without a user having to bend down. Moreover, securing a space in front of drum type washing machine 1 is not needed any more, which enables the installation of drum type washing machine 1 in a small space.

Housing 2 further includes water supply unit 6 for supplying water into water tub 3; water drain unit 7 for draining the used water from the water tub; and controller 10 (see Fig. 2) for controlling washing, rinsing and dewatering processes of washing machine 1. If the operation of washing machine 1 is started after loading the articles into rotary drum 5 by opening door 8 and supplying a required amount of detergent thereinto via a detergent dispenser prepared in water supply unit 6, controller 10 controls a series of processes, to thereby automatically operate washing machine 1.

Referring to Fig. 2, there is described a

configuration of controller 10. By receiving a setup input such as a selection of an operation course from setting unit 13, control unit 11, made up of a microcomputer, outputs a control command to power switching unit 12 by using a control program stored in storage unit 15. Power switching unit 12, formed of switching devices such as SCRs, controls on-off operations of drum driving motor 4, water supply valve 26, water drain pump 27, and so forth, based on the control command provided from controller 10. Hereinafter, operation of drum type washing machine 1 using controller 10 will be described with reference to Figs. 1 to 4.

Door 8 is opened and laundry articles are loaded into rotary drum 5. Then, a specific amount of detergent is supplied into the detergent dispenser, and power switch 18 is turned on. Thereafter, an operation course is selected from setting unit 13 on a control panel provided on a surface of housing 2 depending on types of laundry articles to be washed. If an operation start input is provided, control unit 11 reads a control program corresponding to the setup input from storage unit 15 and initiates a control operation according to a control sequence. First, control unit 11 detects the amount of the laundry articles by rotating rotary drum 5. Specifically, laundry amount detector 16 calculates the amount of the laundry articles based on a load exerted on drum driving motor 4, which is varied depending on the amount of the laundry articles. The

detected laundry amount is inputted to control unit 11 and stored in storage unit 15.

First, a washing operation is started. In the washing operation, a control of water supply and a control of rotation of rotary drum 5 are executed as shown in Fig. 3, wherein reference numerals W1 to W6 represent a control sequence for controlling the water supply while reference numerals R1 to R8 describes a control sequence for controlling the rotation of rotary drum 5.

When the washing operation is started, control unit 11 outputs control commands to power switching unit 12 in order to open water supply valve 26 for the supply of water into water tub 3 and, at the same time, to rotate rotary drum 5 at a first rotational speed. By the control operations, water supply valve 26 is opened and fresh water is fed into water tub 3 from a water supply piping connected to water supply unit 6 (W1). At this time, the detergent is also supplied into water tub 3 while being mixed with the water. Further, simultaneously with the supply of the water, rotary drum 5 is set to be rotated at the first rotational speed by drum driving motor 4 (R1). Then, rotary drum 5 is rotated with its rotation direction reversed according to a predetermined reversal cycle, thereby executing forward and reverse rotations alternately (R2).

The first rotational speed is a rotational speed allowing the laundry articles accommodated in rotary drum 5

to be lifted up in the rotational direction of rotary drum 5 and dropped down on a lower inner peripheral surface thereof when reaching a height where their weight gets greater than an inertia or a centrifugal force developed by the rotation.

5 The first rotational speed is about 35 ± 5 r/min when the diameter of rotary drum 5 is about 500 ± 50 mm. By controlling the rotation of drum driving motor 4 to obtain the first rotational speed, the above-described lift-up and drop movements of the laundry articles can be obtained.

10 Provided at a plurality of locations on the inner peripheral surface of rotary drum 5 are agitation blades 9. When rotary drum 5 rotates at the first rotational speed, the laundry articles being in contact with the inner peripheral surface of rotary drum are lifted up in the rotational direction by being caught by agitation blades 9. 15 Since the laundry articles piled in rotary drum 5 are successively moved up and dropped when they reach the height where weight thereof becomes greater than the inertia or the centrifugal force, an effect of pounding motions can be obtained due to the impact from the drop movements of the 20 laundry articles at the moment their pileup state is released. With a rotational speed smaller than the first rotational speed, no such laundry lift-up movement takes place, whereas no drop movement of the laundry articles takes place with a rotational speed greater than the first 25 rotational speed, for the laundry articles are made to cling

to the inner peripheral surface of rotary drum 5 due to an increased centrifugal force.

Since the supply of the water into water tub 3 is continued while the rotation of rotary drum 5 is being executed, the water fed into water tub 3 is also introduced into rotary drum 5 through the plurality of drum perforations 17 formed on the peripheral surface of rotary drum 5. Accordingly, the laundry articles, being engaged in the repeated lift-up and drop movements by the rotation of rotation drum 5 at the first rotational speed, are completely soaked in the water.

A water level in water tub 3 is detected by water level detector 19 installed in water tub 3. When the water level reaches a second preset level (W2), which is lower than a first preset level corresponding to the amount of the laundry articles, water level detector 19 provides a detection output to control unit 11, and control unit 11 sends a control command to power switching unit 12 in order to close water supply valve 26, to thereby stop the supply of the water (W3).

When the water is supplied into water tub 3 up to the second preset level, control unit 11 outputs a control command to drum driving motor 4 to revolve rotary drum 5 at a second rotational speed, so that rotary drum 5 is rotated at the second rotation greater than the first rotational speed (R3). The second rotational speed represents a

rotational speed allowing the laundry articles not to drop but to cling to the inner peripheral surface of rotary drum 5 by the centrifugal force developed by the rotation of rotary drum 5. The second rotational speed is, for example, about 90 to 140 r/min when the diameter of rotary drum 5 is about 500 ± 50 mm. By rotating rotary drum 5 at the second rotational speed, there is developed a current in the detergent solution of a high concentration, containing the detergent dissolved in a small amount of water, and, thus, a generation of detergent foams is facilitated.

As shown in Figs. 1 and 4, drain groove 20 is formed at a bottommost portion of water tub 3 in a direction perpendicular to the rotational direction (marked by an arrow A) of rotary drum 5. Since sidewall (wall portion or turbulent water flow generating means) 20a of drain groove 20 intersects a direction of a water current (marked by an arrow B), a turbulent water flow (marked by an arrow C) occurs due to sidewall 20a, so that foams are produced from the water containing the high concentration of the detergent dissolved therein.

A detergent molecule (surfactant molecule) generally has two parts: a hydrophilic (water-soluble) group and a lipophilic (water-insoluble) group. In a detergent solution, detergent molecules align themselves at the surface (interface) of the water, and those that are not arranged at the surface exist under the water individually or forming

micelles (i.e., aggregated units of a number of detergent molecules). When the detergent molecules at the surface (herein referred to as latent molecules) are removed, the detergent molecules that have been submerged in the water immediately rise up to the surface, replenishing the removed latent molecules. If air bubbles produced by the turbulent water flow are added in the detergent solution, the air bubbles ascend to the surface, converting to detergent foams while maintaining the latent molecules on the surface thereof. Since each of the detergent foams arranges as many detergent molecules as possible on the surface thereof, the concentration of the detergent becomes very high. Further, since the detergent molecules arranged under the water move up to the surface for the replenishment of the detergent molecules taken away as the detergent foams, additional detergent foams are successively produced when air bubbles are supplied.

Then, the thus generated large quantity of detergent foams rise filling the space between water tub 3 and rotary drum 5 and are successively introduced into rotary drum 5 through opening 3a formed at the front portion of water tub 3, to thereby cling to the laundry articles therein. At this time, since the laundry articles are adhered to the inner peripheral surface of rotary drum 5, which is rotating at the second rotational speed, a central portion in rotary drum 5 is left empty and, thus, the entrance of the

detergent foams into rotary drum 5 can be facilitated. Besides, since the detergent foams are sent to the laundry articles through drum perforations 17 as well, the detergent foams can be adhered to the laundry articles efficiently.

5 Still further, since the laundry articles are thoroughly wet through the laundry lift-up and drop movements by rotary drum 5 rotating at the first rotational speed, the penetration of the detergent foams into the laundry articles is facilitated.

10 If the detergent foams reach the surfaces of the laundry articles or permeate therethrough, oily dirt and soils are taken away by being combined with the lipophilic groups. Moreover, if the detergent foams burst while passing through the laundry articles, the high-concentration

15 detergent solution permeates the laundry articles making the soils soluble, thereby providing detergency. As described, by producing detergent foams of a greater volume from the detergent solution and allowing the detergent foams to cling to or permeate the laundry articles in rotary drum 5,

20 cleaning actions of detergent components on the soils can be facilitated, and an imbalance in washing result (i.e., a phenomenon that the laundry articles are not cleaned uniformly) can be suppressed, for the uniform penetration of the high-concentration of the detergent solution is

25 facilitated. As a result, cleaning efficiency can be improved while shortening the period of time required for

washing.

After the elapse of a first preset time period during which detergent foams sufficiently enter rotary drum 5 such that the laundry articles are covered all over with the foams (R4), control unit 11 outputs a control command to power switching unit 12 to open water supply valve 26 and supply water into water tub 3. Resultantly, water supply valve 26 is opened and the supply of water is initiated (W4). In the mean time, the water level in water tub 3 is detected by water level detector 19. If the water level is found to reach a first preset level (W5), water level detector 19 sends a detection output to control unit 11. As a result, water supply valve 26 is closed by a control command from control unit 11 and the water supply is ceased (W6).

The first preset water level is an amount of water corresponding to the amount of the laundry articles involved. As described earlier, the amount of the laundry articles is first detected by laundry amount detector 16 and is stored in storage unit 15. Therefore, if water is fed up to the first preset water level corresponding to the amount of the laundry, the supply of water is stopped.

With the initiation of the supply of the water up to the first preset water level, controller 10 outputs a control command to power switching unit 12 in order to revolve rotary drum 5 at the first rotational speed again. As a result, rotary drum 5 is set to revolve at the first

rotational speed by drum driving motor 4 (R5). Then, rotary drum 5 is revolved with its rotation direction reversed according to a predetermined reversal cycle, thereby executing forward and reverse rotations alternately (R6).

5 As rotary drum 5 rotates at the first rotational speed, the laundry articles are subject to pounding motions by being lifted up and then dropped. In addition, as rotary drum 5 alternately executes the forward and reverse rotations by the predetermined time interval, the detergent foams are

10 adhered to all over the soils of all the laundry articles. Such washing operation is continued for a second preset period of time by using washing water that has reached the first water level corresponding to the amount of the laundry articles (R7). Then, after the elapse of the second preset

15 period of time, control unit 11 outputs a control command to power switching unit 12 to cease the rotation of drum driving motor 4. As a result, rotary drum 5 is stopped (R8), and the washing process is finished.

After the completion of the washing process, a rinsing

20 and a dewatering process are also carried out, and then the whole process is terminated. Since the rinsing and the dewatering processes are identical to those generally known in the art, and explanation thereof will be omitted.

In the control sequence described so far, the step for

25 revolving rotary drum 5 at the first rotational speed until the water is supplied up to the second preset water level

can be omitted. In such a case, however, the laundry articles may not be fully soaked by water in advance, resulting in a poor efficiency in making the detergent foams permeate the laundry articles.

5 Moreover, though the preferred embodiment has been described for the case of employing sidewall 20a of drain groove 20 as a means for producing the turbulent water flow for the efficient generation of the detergent foams, it is also preferred that protrusion 28 is provided at an inner
10 bottom portion of water tub 3 to intersect the rotational direction of rotary drum 5, as shown in Fig. 5. Protrusion 28 serves to develop a great deal of turbulent water flow from the current, thereby contributing to a more efficient production of detergent foams. Further, since protrusion 28
15 allows for the generation of the turbulent water flow, the detergent foams can be still produced even in case water tub 3 is configured not to have drain groove 20.

 Furthermore, though the preferred embodiment has been described for the case where washing machine is configured
20 to have rotary drum 5 slanted in housing 2, the same cleaning effect can be obtained even in case rotary drum 5 is horizontally disposed by way of changing the rotational speed of rotary drum 5.

 As described above, in accordance with the present
25 invention, the detergency of a drum type washing machine can be improved by using detergent foams generated by

controlling the supply of water and the rotation of a rotary drum, which results in a decrease of washing time and running cost of the washing machine.

Further, in accordance with the present invention, the
5 detergent foams can be efficiently produced by employing a wall portion formed in a water tub while controlling the supply of water into the water tub and the rotation of the rotary drum. Therefore, the detergency of the washing machine can be improved and a washing process thereof can be
10 efficiently performed without causing any imbalance in washing result, by which washing time and running cost of the washing machine can be decreased.

While the invention has been shown and described with respect to the preferred embodiment, it will be understood
15 by those skilled in the art that various changes and modification 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 machine comprising:

5 a rotary drum disposed in a water tub and driven to rotate by a drum driving motor, wherein a controlled amount of water from a water supply unit is fed into the water tub; and

10 a controller for controlling operations of the water supply unit and the drum driving motor according to a control sequence in each of washing, rinsing and dewatering processes,

15 wherein a turbulent water flow generating means is provided at an inner lower portion of the water tub in a direction intersecting a rotational direction of the rotary drum, and wherein the controller performs a water supply control operation for supplying the controlled amount of water into the water tub up to a second water level by way of controlling the water supply unit, the second water level being lower than a first water level corresponding to an amount of laundry articles, and then performs a rotation control operation for rotating the rotary drum at a second rotational speed by way of controlling the drum driving motor, the second rotational speed being greater than a first rotational speed employed in the washing process.

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2. The washing machine of claim 1, wherein the controller

rotates the rotary drum at the first rotational speed at the moment the supply of the water is started.

3. The washing machine of claim 1 or 2, wherein the first
5 water level corresponds to the amount of laundry articles accommodated in the rotary drum.

4. The washing machine of claim 1, wherein the second
10 rotational speed is set at a rotational speed capable of obtaining a centrifugal force allowing the laundry articles not to drop but to cling to an inner peripheral surface of the rotary drum.

5. The washing machine of claim 2, wherein the first
15 rotational speed is set at a rotational speed allowing the laundry articles accommodated in the rotary drum to be lifted up in the rotational direction of the rotary drum and dropped when reaching a height where the weight thereof gets greater than a centrifugal force.

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6. The washing machine of claim 1, wherein the turbulent water flow generating means is a groove formed at the inner lower portion of the water tub.

25 7. The washing machine of claim 6, wherein the turbulent water flow generating means is a sidewall of a drain groove

formed at a lowermost portion of the water tub.

8. The washing machine of claim 1, wherein the turbulent
water flow generating means is a protrusion formed at the
5 inner lower portion of the water tub.