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WASHING MACHINE



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Field of the Invention

5 The present invention relates to a washing machine,
which performs washing, rinsing and water-extracting
processes in a rotary drum having a central axis of rotation
in a horizontal or a slanted direction, and which removes
foreign matters, such as detergent residues or molds, stuck
10 on inner and outer surfaces of the rotary drum and an inner
wall of a water tub incorporating therein the rotary drum.

Background of the Invention

15 Conventionally, there has been proposed a method for
removing foreign matters, such as metallic soap formed by
combination of detergent components and metal ions in tap
water and black molds formed by the reaction of microscopic
organisms contained in laundry on the metallic soap, stuck
20 on an outer wall of a washer tub having its central axis of
rotation in a vertical direction or an inner wall of a outer
tub accommodating the washer tub therein (see, for example,
Reference 1: Japanese Patent Laid-Open Application No. 2002-
248295).

25 In Reference 1, water supply is performed into the
washer tub having its central axis of rotation in the

vertical direction until a water level reaches a preset level. And a cleaning agent is added to the water in the washer tub. Then, by rotating a pulsator for a preset period of time, a cleaning fluid is prepared. Subsequently, a soaking process for intermittently rotating the washer tub is performed to spread the cleaning fluid evenly on the outer wall of the washer tub and the inner wall of the outer tub. The soaking process is performed for such a period of time that the cleaning fluid is given enough time to work to remove foreign matters from the walls of the washer tub and the outer tub. Thereafter, the pulsator is rotated again to direct the cleaning fluid in the washer tub to a lint filter from a pump chamber via a circulation passage, thereby filtering out the foreign matters contained in the cleaning fluid by the lint filter.

Recently, there has been developed a rotary drum type washing machine for performing washing, rinsing and water-extracting processes in a rotary drum having a central axis of rotation in a horizontal or a slanted direction (see, for example, Reference 2: Japanese Patent Laid-Open Application No. 1998-201991).

In the washing machine having the central axis of rotation in the vertical direction as in Reference 1, the inner and outer walls of the washer tub and the inner wall of the outer tub can be almost entirely submerged in the cleaning fluid that is prepared by dissolving the cleaning

agent under the water supplied in the washer tub up to the
preset water level. Accordingly, the foreign matters stuck
on the outer wall of the washer tub and/or the inner wall of
the outer tub can be fully removed by rotating the washer
5 tub and the pulsator.

However, in case of the drum type washing machine with
the rotary drum having its central axis of rotation in the
horizontal or the slanted direction as in Reference 2, only
a part of inner and outer surfaces of the rotary drum and a
10 part of an inner wall of a water tub accommodating the
rotary drum can be submerged under the water supplied in the
water tub. There has been proposed no method for removing
the foreign matters in the washing machine of this type, and
besides, it is considered that a sufficient cleaning effect
15 cannot be obtained even if the cleaning method as employed
in Reference 1 is applied to the washing machine of this
type.

Summary of the Invention

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It is, therefore, an object of the present invention
to provide a washing machine capable of effectively flushing
out foreign matters, such as detergent residues and molds,
stuck on inner and outer surfaces of a rotary drum having
25 its central axis of rotation in a horizontal or a slanted
direction and an inner wall of a water tub accommodating the

rotary drum therein.

In accordance with the present invention, there is provided a washing machine including: a rotary drum having one of a substantially horizontal central axis of rotation and a slanted central axis of rotation; a water tub
5 elastically supported in a washing machine main body and accommodating the rotary drum therein; a motor for rotating the rotary drum; a water supply mechanism for supplying water into the water tub; an input setting unit for setting
10 an operation of the washing machine; a controller for controlling the operation of the washing machine set by the input setting unit and controlling the water supply mechanism and the motor, wherein the controller controls the water supply mechanism to feed water into the water tub to a
15 preset water level when no laundry is accommodated in the rotary drum; and then controls the motor to thereby execute a combination of a first cleaning operation, a second cleaning operation and a drum rotation stop process plural times for a predetermined time period, the first cleaning
20 operation being for rotating the rotary drum at a first preset rotational speed; the second cleaning operation being for rotating the rotary drum at a second preset rotational speed which is greater than the first preset rotational speed and which is fast enough to develop circulatory water
25 flow between an outer surface of the rotary drum and an inner wall of the water tub; and the drum rotation stop

process being for stopping the rotation of the rotary drum.

In such configuration, cleaning of the inner and outer surfaces of the rotary drum is enacted during the first cleaning operation for rotating the rotary drum at the first
5 preset rotational speed (which is low, for example 35 rpm). Further, circulatory water flow is generated between the outer surface of the rotary drum and the inner wall of the water tub by a friction and a centrifugal force developed as a result of rotating the rotary drum at the second preset
10 rotational speed (which is high, for example 140 rpm) during the second cleaning operation. The inner wall of the water tub can be cleansed by thus generated circulatory water flow. Particularly, the circulatory water flow removes detergent residues or contaminants that are often left at upper
15 portions of the rotary drum and the water tub after being scattered thereto during a washing process because wash water does not reach them. Further, by performing the drum rotation stop process, cleaning effect on the rotary drum can also be obtained owing to its immersion under the
20 cleaning fluid. Furthermore, since the rotation of the rotary drum is stopped, the effect of reducing power consumption can be achieved. Besides, by performing the combination of the first cleaning operation, the second cleaning operation and the drum rotation stop process plural
25 times during a long period of time (for example, 10 hours), the detergent residues and/or molds that are stuck to and

hardened on the inner and outer surfaces of the rotary drum and the inner wall of the water tub can be eliminated.

Preferably, the controller controls the motor to rotate the rotary drum in a forward and a reverse direction alternately at a preset time interval during the first
5 cleaning operation.

In such configuration, the inner and outer surfaces of the rotary drum can be washed by rotating the rotary drum at the first rotational speed during the first cleaning
10 operation. Further, by alternately changing the rotational direction of the rotary drum from forward to backward directions and vice versa, irregular portions on the inner and outer surfaces of the rotary drum can also be cleansed by water currents acting thereon in left and right
15 directions. Further, in case of repeating the alternation between the forward and reverse rotations of the rotary drum, turbulent water currents are produced at the moment when the rotational direction is changed, resulting in further improved cleaning effect.

20 Preferably, the controller controls the motor to rotate in a forward and a reverse direction alternately at a preset time interval during the second cleaning operation.

In such configuration, the inner wall of the water tub can be cleansed by rotating the rotary drum at the second
25 preset rotational speed during the second cleaning operation. Further, by changing the rotational direction of the rotary

drum in forward and reverse directions alternately, irregular portions on the inner wall of the water tub can also be cleansed by water currents circulating clockwise and counterclockwise. Further, in case of repeating the alternation between the forward and reverse rotations of the rotary drum, turbulent water currents are produced at the moment when the rotational direction is changed, resulting in further improved cleaning effect.

Further, the preset water level is equal to or higher than a maximum water level that can be reached during a normal laundry washing cycle.

In this configuration, soaking effect of the cleaning fluid can be improved.

Furthermore, the controller controls the water supply mechanism and the motor to execute a rinsing operation of the inner and outer surfaces of the rotary drum and the inner wall of the water tub by a combination of a water drain process, a water supply process and a rotary drum rotation process after performing a cleaning operation of the inner and outer surfaces of the rotary drum and the inner wall of the water tub by the combination of the first cleaning operation, the second cleaning operation and the drum rotation stop process.

In this configuration, the cleaning of the inner and outer surfaces of the rotary drum and the inner wall of the water tub can be performed without manually setting the

water supply process, the cleaning operation, the water drain process and the rinsing operation individually.

Preferably, the cleaning and the rinsing operation of the inner and outer surfaces of the rotary drum and the inner wall of the water tub are executed by setting the input setting unit.

In this configuration, the cleaning and rinsing operations of the inner and outer surfaces of the rotary drum and the inner wall of the water tub can be performed more easily.

Moreover, the water tub has a groove formed below the central axis of rotation of the rotary drum.

In this configuration, the groove may cause turbulences and vortices in the circulatory water flow during the second cleaning operation for rotating the rotary drum at the second preset rotational speed. As a result, further improved cleaning effect can be obtained.

Brief Description of the Drawings

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

Fig. 1 is a cross sectional view of a washing machine in accordance with a preferred embodiment of the present

invention;

Fig. 2 sets forth a partial cross sectional view of a groove in Fig. 1;

Fig. 3 presents a partial cross sectional view of a modified embodiment of the groove in Fig. 1;

Fig. 4 shows a circuit diagram of a control unit in Fig. 1;

Fig. 5 is a top view of a console including an input setting unit in Fig. 1; and

Figs. 6A and 6B provide a flow chart for describing processes included in a tub cleaning sequence of the washing machine in accordance with the preferred embodiment of the present invention.

Detailed Description of the Preferred Embodiment

Hereinafter, a preferred embodiment of the present invention will be described in detail with reference to the accompanying drawings.

Referring to Fig. 1, there is provided a cross sectional view of a washing machine in accordance with a preferred embodiment of the present invention. Cylindrical rotary drum 1 having a bottom portion and multiple drum perforations 2 on its cylindrical surface is rotatably installed in water tub 3. A central axis of rotation of rotary drum 1 is declined toward a rear portion of the

washing machine, and rotating shaft (central axis of rotation) 4 is installed at a slant and connected to rotary drum 1 in such a manner that rotating shaft 4 is aligned with the central axis of rotation of rotary drum 1. Motor 5, installed at a rear side of water tub 3, is connected to rotating shaft 4 to allow rotary drum 1 to rotate in forward and reverse directions. Further, a number of agitation blades 6 are provided on an inner wall of rotary drum 1.

An opening provided at an inclined surface of washing machine main body 9 which faces upward is opened and closed by door 7. By opening door 7, laundry can be loaded into or unloaded from rotary drum 1 through laundry loading/unloading opening 8 of water tub 3. Since door 7 is installed in the inclined surface of washing machine main body 9, the loading/unloading of the laundry can be performed without a user having to bend down unduly.

Water tub 3 is suspended in washing machine main body 9 by springs 10 and dampers 11 so that it can rock back and forth. Connected to a lower portion of water tub 3 is one end of water drain conduit 12, and the other end of water drain conduit 12 is coupled to water drain valve 13 to drain wash water from water tub 3.

Further, groove 300 is formed at the lower portion of water tub 3 along a direction of a rotational axis of rotary drum 1. Figs. 2 and 3 are partial cross sectional views showing an exemplary configuration of groove 300 and a

modification thereof, respectively. With respect to an example shown in Fig. 2, groove 300 has sidewalls 300a and lower surface 300b, wherein sidewalls 300a are formed such that they are perpendicular to lower surface 300b. Meanwhile, with respect to the modification shown in Fig. 3, groove 300 has sidewalls 300a formed at an acute angle with respect to lower surface 300b.

Grooves 300 shown in Figs. 2 and 3 are formed to attain improved cleaning efficiency by creating turbulences and/or vortices, as represented by arrows in Figs. 2 and 3, in circulatory water flow during a second cleaning operation for rotating rotary drum 1 at a second preset rotational speed (or the number of rotation(s)) of a high rotational speed in the course of executing a tub cleaning sequence for cleaning rotary drum 1 and water tub 3, as will be described later in detail.

Referring back to Fig. 1, the washing machine further includes water feed valve (water supply mechanism) 14 for feeding water into water tub 3 via water supply conduit 15; and water level detector 16 for detecting the water level in water tub 3.

Further, although rotary drum 1 connected with rotating shaft 4 aligned with the central axis of rotation of rotary drum 1 is installed such that its central axis of rotation is declined toward the rear portion of the washing machine in this preferred embodiment, rotary drum 1

connected with rotating shaft 4 aligned with the central axis of rotation of rotary drum 1 may be disposed in such a manner that its central axis of rotation is horizontally oriented.

5 In addition, though not shown in Fig. 1, the washing machine further includes fan 17 (see Fig. 4) for blowing warm air into rotary drum 1 and heater 18 (see Fig. 4) for heating air, to thereby provide a drying function for drying laundry in rotary drum 1.

10 Control unit 19 is configured as shown in Fig. 4, and includes controller 20 with a microcomputer for controlling a series of processes including washing, rinsing, water-extracting and drying processes in sequence by way of controlling the operation of motor 5, water drain valve (DV)
15 13, water feed valve (FV) 14, fan (F) 17, heater (H) 18 and so forth.

 As for controller 20, it registers an input signal from input setting unit 21 for setting, e.g., an operation course, and informs the user of the input information
20 through display unit 22. Concurrently, once an operation is set to start by input setting unit 21, controller 20 controls the operation of water drain valve 13, water feed valve 14, fan 17, heater 18 and so forth via load driving unit 23 based on input data transmitted from water level
25 detector 16 for detecting a water level in water tub 3, and so forth, thereby carrying out a washing and a drying

process.

At this time, controller 20 controls the rotation of motor 5 by controlling inverter 26 via driving circuit 25 based on data transmitted from position detecting unit 24 (including position detectors 24a to 24c), which detects the position of a rotor of motor 5. Though not shown, motor 5 is a brushless DC motor including a stator with three-phase windings and a rotor with a bipolar permanent magnet disposed in a ring shape. The stator is made up of the three-phase windings including first winding 5a, second winding 5b and third winding 5c wound around an iron core provided with slots.

Inverter 26 includes switching devices, each being made up of a parallel circuit of a power transistor (e.g., insulated gate bipolar transistor (IGBT)) and a reverse conducting diode. Specifically, inverter 26 includes a serial circuit of first and second switching devices 26a and 26b; a serial circuit of third and fourth switching devices 26c and 26d; and a serial circuit of fifth and sixth switching devices 26e and 26f, wherein the serial circuits are connected to each other in parallel.

Here, both ends of each of the serial circuits serve as input terminals and are coupled to a DC power supply. Further, respectively coupled to a junction of the two switching devices in each serial circuit are output terminals, which are in turn connected to a U terminal, a V

terminal and a W terminal of the three-phase windings, respectively. The U, V and W terminals are controlled as a positive voltage, a zero voltage and floating state, respectively, by a combination of on-off operations of the
5 two switching devices in each serial circuit.

The on-off operations of the switching devices are controlled by controller 20 based on data from three position detectors 24a to 24c, which are made up of hall IC's. Position detectors 24a to 24c are disposed at the
10 stator at an interval of an electrical angle of 120 degrees to face the permanent magnet provided in the rotor.

While the rotor makes one revolution, each of three position detectors 24a to 24c outputs a pulse at the interval of the electrical angle of 120 degrees. Controller
15 20 monitors a change in the state of signals from at least one of three position detectors 24a to 24c. When a change is detected, controller 20 changes the on-off states of the switching devices 26a to 26f based on the signals from position detectors 24a to 24c, thereby setting the U, V and
20 W terminals at a positive voltage, a zero voltage and a floating state, respectively. A magnetic field is formed by supplying thus controlled electric power to first, second and third windings 5a to 5c, thereby rotating the rotor.

Furthermore, each of switching devices 26a, 26c and
25 26e is subjected to pulse width modification (PWM), and the number of rotations of the rotor is controlled by way of,

for example, repeatedly controlling a duty ratio at a frequency of 10 kHz. Every time the state of signals from at least one of three position detectors 24a to 24c is changed, controller 20 detects the period thereof,
5 calculates the number of rotations (rotational speed) of the rotor; and then performs the PWM control of switching devices 26a, 26c and 26e such that the rotor makes as many revolutions as the set rotation number.

Current detector 27 includes resistor 28 connected to
10 an input terminal of one side of inverter 26; and current detecting circuit 29 coupled to resistor 28. Current detector 27 detects an input current of inverter 26; and inputs the output voltage to controller 20. In case motor 5 is a brushless DC motor, its torque is substantially
15 proportional to the input current. Thus, the torque of motor 5 can be detected by way of detecting the value of the input current of inverter 26 by current detecting circuit 29 connected to resistor 28.

Laundry amount detector 30 detects the amount of
20 laundry in rotary drum 1. Specifically, laundry amount detector 30 calculates the amount of laundry in rotary drum 1 based on a signal transmitted from current detector 27 when rotary drum 1 is driven to rotate at a specific rotational speed (for example, 200 rpm).

25 Commercial power source 31 is coupled to inverter 26 via a DC power converter made up of diode bridge 32, choke

coil 33, and smoothing capacitor 34. It is, however, to be noted that the configuration described above is only one example. Thus, the configurations of brushless DC motor 5 and inverter 26 are not limited thereto.

5 As shown in Fig. 5, input setting unit 21 includes washing time setting switch 21a for setting a washing time period, rinsing number setting switch 21b for setting the number of rinsing processes, water-extracting time setting switch 21c for setting a water-extracting time period,
10 drying time setting switch 21d for setting a drying time period, start/pause switch 21e, power-on switch 21f, power-off switch 21g, first course setting switch 21h, second course setting switch 21i, and so forth.

 First course setting switch 21h is for setting an
15 operation course. Each time first course setting switch 21h is pressed, the operation course is altered in order between a course for performing washing, rinsing, water-extracting and drying processes in series, a course for performing washing, rinsing and water-extracting processes in series
20 and a course for performing only a drying process.

 Second course setting switch 21i is used to select an operation course among an automatic course, a quick course, a programming course established by user preset settings, a blanket course, a tub cleaning course, and the like. Each
25 time second course setting switch 21i is pressed, one of those course options is selected in said order.

Display unit 22 includes washing time display unit 22a, rinsing number display unit 22b, water-extracting time display unit 22c, drying time display unit 22d, and course set display unit 22e for displaying a course selected by second course setting switch 21i, and so forth. Further, display unit 22 also has number display unit 22h, detergent amount indicator lamp 22f lit to indicate that the number on number display unit 22h is a detergent amount, and residual operating time indicator lamp 22g lit to indicate that the number on number display unit 22h is a residual operating time. Moreover, display unit 22 includes fluffing display unit 22i for indicating that a fluffing process for fluffing up clothes is performed after the drying process.

With regard to the washing machine having the above-described configuration, the tub cleaning sequence for removing foreign matters stuck on inner and outer surfaces of rotary drum 1 and an inner wall of water tub 3 will now be described with reference to a flowchart in Figs. 6A and 6B.

First, if the tub cleaning course is selected by using second course setting switch 21i of input setting unit 21 (step S601), controller 20 controls water supply valve 14 to feed fresh water into water tub 3 via water supply conduit 15 until the water in water tub 3 reaches a preset water level (e.g., 150 mm) equal to or higher than a maximum water level that can be reached during a normal laundry washing

cycle. After the completion of the water supply up to the preset level, the user temporarily stops the operation of the washing machine by pressing start/pause switch 21e, and supplies cleaning agent directly in the inside of rotary drum 1 by opening door 7 (step S602). The water supply up to this preset water level is for maximizing soaking effect of the cleaning fluid. Thereafter, when the user closes door 7 and presses start/pause switch 21e again, the process proceeds to subsequent step S603.

Since chlorine-based bleaching agent is contained in the cleaning agent, there is a possibility that the cleaning agent may deteriorate resin forming a detergent dispenser or stainless steel forming rotary drum 1 if the cleaning agent is directly put thereto. Therefore, it is preferable to supply the cleaning agent as illustrated above.

Then, controller 20 controls motor 5 to rotate rotary drum 1 at a rotational speed of, e.g., 30 rpm for about 5 minutes in order to prepare cleaning fluid by dissolving the cleaning agent in the water (step S603), and, then, stops the rotation of rotary drum 1 for, e.g., 4 minutes (step S604: drum rotation stop process). Thereafter, rotary drum 1 is driven to rotate at a first preset rotational speed (for example, 35 rpm) in a clockwise (forward) direction when viewed from a position in front for a predetermined period of time (for example, 20 seconds) (step S605). Subsequently, the rotational direction is reversed, so that

rotary drum 1 is rotated in a counterclockwise (reverse) direction at the first preset rotational speed for the same period of time (step S606). Steps 605 and 606 are included in a first cleaning operation. During the first cleaning
5 operation, by changing the rotational direction of rotary drum 1 in the forward and reverse directions alternately, not only the inner and outer surfaces of rotary drum 1 but also irregular portions thereon can be cleansed by water currents acting thereon in left and right directions.

10 Next, controller 20 determines whether a preset period of time A (for example, 2 minutes) has elapsed (step S607) and, if not ("No" in step S607), steps 605 and 606 are repeated. Accordingly, at the moment the rotational direction of rotary drum 1 is alternated between forward and
15 reverse directions, turbulent water currents are generated, and the cleaning effect on rotary drum 1 can be improved. On the other hand, if the preset period of time A (for example, 2 minutes) has elapsed ("Yes" in step S607), i.e., after the pair of forward rotation and reverse rotation of
20 rotary drum 1 has been repeated three times, the first cleaning operation is terminated, and a second cleaning operation is started.

During the second cleaning operation, controller 20 controls motor 5 to rotate rotary drum 1 at a second preset
25 rotational speed (for example, 140 rpm) in a clockwise (forward) direction when viewed from a position in front for

a predetermined period of time (for example, 30 seconds) (step S608). The second preset rotational speed is greater than the first rotational speed and is so high that a circulatory water flow is developed between the outer surface of rotary drum 1 and the inner wall of water tub 3. Subsequently, controller 20 reverses the rotational direction of rotary drum 1 to thereby make rotary drum 1 rotate in a counterclockwise (reverse) direction at the second preset rotational speed for the same period of time (step S609). During the second cleaning operation, the circulatory water flow is developed between the outer surface of rotary drum 1 and the inner wall of water tub 3 by the friction and the centrifugal force generated by the rotation of rotary drum 1, at which state groove 300 of water tub 3 causes turbulences and/or vortices in the circulatory water flow. Besides, by alternately rotating rotary drum 1 in the forward and reverse directions, not only the inner wall of water tub 3 but also irregular portions thereon can be washed by water currents circulating clockwise and counterclockwise.

Thereafter, controller 20 determines whether a preset period of time B (for example, 2 minutes) has elapsed (step S610). If the preset period of time B has not passed yet ("No" in step S610), steps S608 and S609 are repeated. Accordingly, at the moment the rotational direction of rotary drum 1 is changed between forward and reverse

directions, turbulent water currents are generated, and the cleaning effect on water tub 3 can be improved. On the other hand, if it is found in step S610 that the preset period of time B (for example, 2 minutes) has elapsed ("Yes" in step S610), i.e., after the pair of forward rotation and reverse rotation of rotary drum 1 has been repeated two times, step S611 is performed to determine whether a preset period of time C, a long period of time, (for example, 10 hours) has passed.

Meanwhile, if the preset period of time C has not passed yet ("No" in step S611), the drum rotation stop process as in step S604 is performed again, and, then, the first cleaning operation through steps S605 to S607 and the second cleaning operation through steps S608 to S610 are repeated. By repeatedly executing a combination of the first and second cleaning operations and the drum rotation stop process plural times for the preset period of time C, detergent residues and/or molds that are stuck on the surfaces of rotary drum 1 and the inner wall of water tub 3 can be flushed out.

After the preset period of time C ("Yes" in step S611) has elapsed, a water drain process is performed (step S612), so that water drain valve 13 is opened and the cleaning fluid containing therein foreign matters removed from the inner and outer surfaces of rotary drum 1 and the inner wall of water tub 3 is exhausted through water drain conduit 12.

Afterward, rotary drum 1 is rotated at a rotational speed (for example, 900 rpm) which is usually required in the water-extracting process for, e.g., 3 minutes (step S613: rotary drum rotation process). Subsequently, as in step 5 S602, controller 20 controls water supply valve 14 to feed fresh water into water tub 3 via water supply conduit 15 until the water in water tub 3 reaches a preset water level (for example, 150 mm) equal to or higher than a maximum water level in the normal laundry washing cycle (step S614: 10 water supply process).

Then, as in the second cleaning operation, rotary drum 1 is rotated at the second preset rotational speed (for example, 140 rpm) in a clockwise (forward) direction for a preset period of time (for example, 30 seconds) (step S615: 15 rotary drum rotation process). Thereafter, the rotational direction of rotary drum 1 is reversed and rotary drum 1 is rotated at the second preset rotational speed in a counterclockwise (backward) direction for the same period of time (step S616: rotary drum rotation process).

20 The rinsing operation including the water drain process, the water supply process and the rotary drum rotation process described above is performed as many times as a preset rinsing number (for example, four times). If the rinsing process is performed preset number of times 25 ("Yes" in step S617), a water drain process is carried out (step S618), so that the tub cleaning sequence for removing

the foreign matters stuck on the inner and outer surfaces of rotary drum 1 and the inner wall of water tub 3 is finished.

As described, the tub cleaning sequence is performed automatically by selecting the tub cleaning course by using second course setting switch 21i of input setting unit 21. Therefore, the cleaning course of rotary drum 1 and water tub 3 can be performed without manually setting water supply process, cleaning process, water drain process and rinsing process individually.

Further, although the preferred embodiment of the present invention has been described for the case that groove 300 of water tub 3 is formed to have sidewalls 300a and lower surface 300b at a right or an acute angle with respect to each other, the shape of groove 300 is not limited thereto. That is, groove 300 can be of any shape so long as it generates turbulences and/or vortices in the circulatory water flow that is developed between the outer surface of rotary drum 1 and the inner wall of water tub 3 as a result of rotating rotary drum 1 at the second preset rotational speed.

Moreover, although the preferred embodiment has been described for the case that motor 5 is a brushless DC motor, the present invention is not limited thereto. For example, although driving mechanism or method of the washing machine is changed by using a brush DC motor or an induction motor, the present invention can be applied thereto and the same

effects as obtained in the present invention can be attained.

Still further, the configurations of the washing machine and the processes of the tub cleaning sequence (including conditions on preset water levels, preset rotational speeds, preset time periods) described so far are just examples, and, therefore, can be changed or modified in various ways.

The washing machine of the present invention has a merit in that it can effectively flush out foreign matters, such as detergent residues, molds, and/or the like, that are stuck to the inner and outer surfaces of the rotary drum having a substantially horizontal or a slanted central axis of rotation or the inner wall of the water tub. Thus, the present invention is advantageous in case it is applied to a rotary drum type washing machine.

While the invention has been shown and described with respect to the preferred embodiments, 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 washing machine comprising:

5 a rotary drum having one of a substantially horizontal central axis of rotation and a slanted central axis of rotation;

a water tub elastically supported in a washing machine main body and accommodating the rotary drum therein;

a motor for rotating the rotary drum;

10 a water supply mechanism for supplying water into the water tub;

an input setting unit for setting an operation of the washing machine;

15 a controller for controlling the operation of the washing machine set by the input setting unit and controlling the water supply mechanism and the motor,

wherein the controller controls the water supply mechanism to feed water into the water tub to a preset water level when no laundry is accommodated in the rotary drum; and then controls the motor to thereby execute a combination of a first cleaning operation, a second cleaning operation and a drum rotation stop process plural times for a predetermined time period, the first cleaning operation being for rotating the rotary drum at a first preset rotational speed; the second cleaning operation being for rotating the rotary drum at a second preset rotational speed

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which is greater than the first preset rotational speed and which is fast enough to develop circulatory water flow between an outer surface of the rotary drum and an inner wall of the water tub; and the drum rotation stop process
5 being for stopping the rotation of the rotary drum.

2. The washing machine of claim 1, wherein the controller controls the motor to rotate the rotary drum in a forward and a reverse direction alternately at a preset time
10 interval during the first cleaning operation.

3. The washing machine of claim 1, wherein the controller controls the motor to rotate in a forward and a reverse direction alternately at a preset time interval during the
15 second cleaning operation.

4. The washing machine of any one of claims 1 to 3, wherein the preset water level is equal to or higher than a maximum water level that can be reached during a normal
20 laundry washing cycle.

5. The washing machine of any one of claims 1 to 3, wherein the controller controls the water supply mechanism and the motor to execute a rinsing operation of an inner and
25 the outer surface of the rotary drum and the inner wall of the water tub by a combination of a water drain process, a

water supply process and a rotary drum rotation process
after performing a cleaning operation of the inner and the
outer surface of the rotary drum and the inner wall of the
water tub by the combination of the first cleaning operation,
5 the second cleaning operation and the drum rotation stop
process.

6. The washing machine of claim 5, wherein the cleaning
and the rinsing operation of the inner and the outer surface
10 of the rotary drum and the inner wall of the water tub are
executed by setting the input setting unit.

7. The washing machine of any one of claims 1 to 6,
wherein the water tub has a groove formed below the central
15 axis of rotation of the rotary drum.