

DRUM TYPE WASHING MACHINE

Field of the Invention

5 The present invention relates to a drum type washing machine for performing wash, rinse and water-extraction cycles in a rotary drum having a substantially horizontal or a slanted rotational axis.

10 Background of the Invention

A conventional drum type washing machine will be described hereinafter.

15 Fig. 13 provides a cross sectional view of a drum type washing machine having a rotary drum whose rotational axis is horizontally oriented. Housing 101 of the drum type washing machine has therein water tub 102 supported by a suspension structure, and rotary drum 103 is rotatably installed in water tub 102 and is driven to rotate by
20 driving motor 104. By opening door 105 provided at a front surface of housing 101, laundry can be loaded into or unloaded from rotary drum 103 through opening 102a of water tub 102 and opening 103a of rotary drum 103 (see, for example, Japanese Patent Laid-open Application No. H9-
25 215894).

Below, a wash cycle of the drum type washing machine

having the above-described configuration will be explained.

If a washing machine starts to be operated after laundry being loaded into rotary drum 103 through opening door 105 and detergent being added therinto, water supply valve 106

5 is opened, so that fresh water is supplied to water tub 102 up to a predetermined water level. Thereafter, rotary drum 103 is rotated by driving motor 104 at a preset rpm, during which the laundry loaded into rotary drum 103 is lifted up in the drum's rotational direction by agitation blades 107
10 disposed on an inner peripheral surface of rotary drum 103 and dropped once reaching a specific height. Due to an impact force generated as the laundry drops, the laundry is subjected to pounding motions and is therefore washed.

After completing the wash cycle, soiled wash water is
15 drained and a rinse cycle is performed by using supplied fresh water. Then, if the rinse cycle is finished, a water-extraction cycle is conducted by spinning rotary drum 103 at a high rpm.

In the above configuration, however, since the wash
20 cycle is performed while the laundry is not fully soaked in the wash water, i.e., the laundry does not contain a sufficient amount of wash water therein. As a consequence, sufficiently strong detergency to completely remove soils from the laundry cannot be realized. Further, in order to
25 obtain a sufficiently strong level of detergency, washing time becomes longer.

As a solution to these problems, there has been proposed a technique for pumping up wash water collected in water tub 102 by a circulation pump and re-circulating it into rotary drum 103, thus allowing the laundry to be fully soaked in the wash water, resulting in an improvement of detergency (see, for example, Japanese Patent Laid-open Application No. H9-215893).

Since, however, the amount of the wash water capable of being circulated by the circulation pump depends on the size of the circulation pump, a large size of circulation pump may be required to supply the wash water to the laundry sufficiently. However, in order to meet the recent trend for favoring a compact washing machine main body, the circulation pump needs to be reduced in its size, which results in a failure in obtaining a sufficient flow rate of water circulation. Moreover, as a result of using the circulation pump, which is an additional component, the configuration of the washing machine is complicated and thus manufacturing cost increases.

Summary of the Invention

It is, therefore, an object of the present invention to provide a drum type washing machine capable of re-circulating wash water in a water tub into a rotary drum without having to use a circulation pump or the like,

thereby improving detergency and removing soils from laundry effectively, while reducing manufacturing costs for the washing machine.

5 In accordance with a preferred embodiment of the present invention, there is provided a drum type washing machine includes a housing; a cylindrical water tub, having a cylindrical body and a bottom, provided with a first opening through which a loading/unloading of laundry is performed, the water tub being accommodated in the housing; 10 and a cylindrical rotary drum, provided with a second opening corresponding to the first opening, having a bottom and a substantially horizontal or slanted rotational axis, the rotary drum being rotatably accommodated in the water tub, wherein the water tub has a water inlet port through 15 which wash water being rotated in the water tub by a rotation of the rotary drum is supplied; a water circulation passage, the water inlet port being communicated with one of two ends of the water circulation passage; and one or more water discharge openings for discharging the wash water into 20 the rotary drum therethrough, the water discharge openings being communicated with the other end of the water circulation passage.

Brief Description of the Drawings

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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 is a cross sectional view of a drum type washing machine in accordance with a first preferred embodiment of the present invention;

Fig. 2 sets forth a block diagram of a control unit of the washing machine in accordance with the first embodiment of the present invention;

Fig. 3 provides a perspective view of a water tub main body of the washing machine in accordance with the first embodiment of the present invention;

Fig. 4 depicts a perspective view of a water tub cover of the washing machine in accordance with the first embodiment of the present invention;

Figs. 5A to 5C show a front view, a plan view and a sectional side elevation view of a circulation nozzle of the washing machine in accordance with the first embodiment of the present invention;

Fig. 6 is an exterior bottom plan view of a rotary drum of the washing machine in accordance with the first embodiment of the present invention;

Fig. 7 offers a longitudinal cross sectional view of the rotary drum in accordance with the first embodiment of the present invention;

Fig. 8 provides a perspective view of a water tub main

body in accordance with a second preferred embodiment of the present invention;

Fig. 9 sets forth a longitudinal cross sectional view of a rotary drum in accordance with the second embodiment of the present invention;

Fig. 10 illustrates an exterior bottom plan view of a rotary drum in accordance with a third preferred embodiment of the present invention;

Fig. 11 presents an exterior bottom plan view of a rotary drum in accordance with a fourth preferred embodiment of the present invention;

Fig. 12 depicts an exterior bottom plan view of a rotary drum in accordance with a fifth preferred embodiment of the present invention; and

Fig. 13 is a cross sectional view of a conventional drum type washing machine.

Detailed Description of the Preferred Embodiments

Hereinafter, preferred embodiments of the present invention will be described with reference to the accompanying drawings. Here, it is to be noted that the present invention is not limited thereto.

(First preferred embodiment)

Fig. 1 illustrates a cross sectional view of a drum

type washing machine in accordance with a first preferred embodiment of the present invention. As shown in Fig. 1, cylindrical water tub 6 having a closed bottom is supported in housing 1 of the drum type washing machine by a suspension structure such that it is declined toward the rear side of housing 1. Water tub 6 includes water tub main body 2 and water tub cover 3, which are fixedly connected to each other via first packing member 4 provided at their joint portion. Further, cylindrical rotary drum 5 having a bottom is rotatably installed in water tub 6 such that its rotational axis is declined toward the rear side of housing 1.

Also, housing opening 1a through which laundry is loaded and unloaded is provided in a front surface portion of housing 1, and door 8 for opening and closing housing opening 1a is also installed thereat.

Further, water tub cover 3 is provided with water tub cover opening (first opening) 3a at its position corresponding to housing opening 1a. Likewise, rotary drum 5 is provided with rotary drum opening (second opening) 5a at a position corresponding to housing opening 1a and water tub cover opening 3a. Thus, loading/unloading of laundry into/from rotary drum 5 is carried out through housing opening 1a, water tub cover opening 3a and rotary drum opening 5a.

Rotary drum 5 includes front portion 5b provided with

rotary drum opening 5a; body portion 5c forming the cylindrical wall; and bottom portion 5d forming the bottom. Further, a number of agitation blades 5e are disposed on an inner peripheral surface of rotary drum body portion 5c.

5 Rotary drum 5 is rotated by driving motor 7 installed at an external side of bottom portion 2c, and its rotational speed and direction are variable.

Water supply pipe 9 and water drain pipe 10 are connected to water tub 6. If water supply valve 11 (see Fig. 2) installed in housing 1 is opened, fresh tap water is supplied to water tub 6 via detergent dispenser 9a and water supply pipe 9. On the other hand, if water drain valve 13 installed on water drain pipe 10 is opened, soiled wash water is drained from water tub 6.

15 Moreover, the drum type washing machine has water level detector 14 (see Fig. 2) for detecting a water level in water tub 6 and control unit 15 (see Fig. 2) for controlling a series of operations of the washing machine from wash cycle to water-extraction cycle.

20 Referring to Fig. 2, there is provided a block diagram illustrating a configuration of control unit 15. Control unit 15 includes controller 16, setting unit 17, storage unit 18, power switching unit 19, and so forth. Depending on an input signal, e.g., an operation course, controller 16
25 with a microcomputer outputs a control signal to power switching unit 19 by using a control program stored in

storage unit 18.

Power switching unit 19 includes switching devices such as an SCR (Silicon Controlled Rectifier) and controls operations of driving motor 7, water supply valve 11, water drain valve 13 and so forth based on the control signal from controller 16.

Fig. 3 sets forth a perspective view of water tub main body 2 in accordance with the first preferred embodiment of the present invention. Water tub main body 2 has a closed bottom, and, specifically, it has opening 2a, body portion 2b and bottom portion 2c, water tub main body 2 being of a cylindrical shape.

Formed on the inner surface of bottom portion 2c adjacent to the boundary between bottom portion 2c and body portion 2b is bottom groove portion 2d of water tub main body 2, bottom groove portion 2d being formed to have a substantially concave shape, wherein bottom groove portion 2d is provided in an arc shape approximately concentric with body portion 2b. Also, bottom groove portion cover 23 of water tub main body 2 shaped to conform to bottom groove portion 2d is fixed to bottom groove portion 2d by fastening thereto screws 25 on the periphery of bottom groove portion cover 23 via second packing member 24, which is disposed on the periphery of bottom groove portion cover 23. Bottom groove portion 2d and bottom groove portion cover 23 jointly form first water circulation passage 22.

Water inlet port 20 provided at one end of first water circulation passage 22 is communicated with guide recess 21 whose bottom surface is smoothly curved from the bottom surface of bottom groove portion 2d to the inner surface of bottom portion 2c. Also, second water circulation passage 26 of a pipe shape extended from opening 2a to bottom portion 2c of water tub main body 2 is formed on the outer surface of body portion 2b as one body therewith. One end of second water circulation passage 26 at the side of bottom portion 2c is communicated with the other end of first water circulation passage 22.

Referring to Fig. 4, there is illustrated a perspective view of water tub cover 3 in accordance with the first preferred embodiment of the present invention.

Water tub cover 3 has front portion 3b provided with opening 3a; body portion 3c; and rear opening 3d, water tub cover 3 being of a substantially cylindrical shape.

Also, third water circulation passage 27 extended from rear opening 3d to front portion 3b is formed on an outer surface of body portion 3c at a position corresponding to second water circulation passage 26 as one body with body portion 3c .

Front groove portion 3e of water tub cover 3 is formed on an inner surface of front portion 3b in a substantially Y shape such that it forks into two branches as it approaches from the outer periphery of front portion 3b toward opening

3a. Front groove portion cover 29 shaped to conform to front groove portion 3e is fixed to front groove portion 3e by fastening screws 31 on the periphery of front groove portion cover 29 via third packing member 30, which is
5 provided on the periphery of front groove portion cover 29. Front groove portion 3e and front groove portion cover 29 jointly form fourth water circulation passage 28 of a substantially Y shape.

One end of a lower end portion of Y-shaped fourth
10 water circulation passage 28 is communicated with an end portion of third water circulation passage 27 at the side of front portion 3b. Further, front groove portion cover 29 has circulation nozzles 34 for discharging wash water, wherein circulation nozzles 34 are respectively installed in
15 the vicinity of leading ends of two branch portions of front groove portion cover 29.

With this configuration, circulation nozzles 34 as shown in Fig. 4 are disposed on an inner surface of front portion 3b, wherein the inner surface is located close to the
20 edge of opening 3a, while facing rotary drum opening 5a.

Further, when water tub 6, which is formed by assembling water tub main body 2 and water tub cover 3, is installed in housing 1, circulation nozzles 34 are configured to be located at a lower portion of water tub
25 cover front portion 3b and configured to be positioned lower than water inlet port 20.

Moreover, when water tub main body 2 and water tub cover 3 are connected and fixed to each other, second water circulation passage 26 and third water circulation passage 27 are also connected and fixed to each other via first
5 packing member 4 by the same method as employed to connect water tub main body 2 and water tub cover 3.

Figs. 5A to 5C illustrate a front view, a plan view and a sectional side elevation view of each circulation nozzle 34 in accordance with the first preferred embodiment
10 of the present invention, respectively. Each circulation nozzle 34 has substantially cylindrical nozzle 34a whose one end is connected to fourth water circulation passage 28 and the other end thereof is projected toward the inside of rotary drum 5; and substantially disk-shaped control plate
15 33 whose lower portion is formed as one body with the projected lower end portion of nozzle 34a and upper portion is sloped to be distanced apart from nozzle 34a as it reaches the inside of rotary drum 5, wherein the height of the upper end of control plate 33 is approximately identical
20 to that of the upper end of nozzle 34a. By configuring the upper portion of control plate 33 to be distanced away from nozzle 34a, one or more water discharge openings 32 are provided between control plate 33 and nozzle 34a. Also, by adjusting the slope of control plate 33, the angle for
25 discharging wash water, which reaches circulation nozzles 34 via first to fourth water circulation passage, can be

controlled.

Fig. 6 is an exterior plan view of bottom portion 5d of rotary drum 5 in accordance with the first preferred embodiment of the present invention. Fig. 7 sets forth a longitudinal cross sectional view of rotary drum 5.

By providing flange 5f, which projects outward, on the periphery of rotary drum bottom portion 5d, rotary drum bottom portion 5d becomes to be of a substantially concave shape. Flange 5f of rotary drum bottom portion 5d is connected to the rear end portion of rotary drum body portion 5c by caulking, welding or the like. Flange 5f may be installed along the entire circumference of rotary drum bottom portion 5d. Further, three flanges 5f may be installed at a same interval at locations corresponding to extended installation parts 35a of drum fixing member 35 to be connected thereto.

Inside the flange 5f installed on an outer surface of rotary drum bottom portion 5d, drum fixing member 35 made of aluminum die-cast is provided to have three extended installation parts 35a that are configured radially. Also, rib attachment members 37, each having a substantially arc shape conforming to the circumference of rotary drum bottom portion 5d, are installed between three extended installation parts 35a.

A central portion of drum fixing member 35 is connected to shaft 7a of motor 7 such that the rotary power

of motor 7 is transferred to rotary drum 5.

By installing outer wall 40 and inner wall 41, both of which are protruded in a rear direction, at the peripheral portion of each rib attachment member 37, rib attachment member 37 becomes to be of a substantially convex shape. Further, a plurality of ribs 38 for connecting outer wall 40 to inner wall 41 are disposed in rib attachment member 37 in a radial direction with respect to the center of rotary drum 5. Here, the height of each rib 38 is set to be substantially identical to those of outer wall 40 and inner wall 41. Also, respectively disposed at both end portions of each rib attachment member 37 are extended installation ribs 38a for attaching rib attachment members 37 to extended installation parts 35a of drum fixing member 35.

Here, it will be described how to assemble rotary drum 5, drum fixing member 35 and rib attachment members 37.

First, drum fixing member 35 is placed on a table such that its surface faces motor 7 downward. Then, three rib attachment members 37 are set up such that extended installation ribs 38a are to be located to correspond to predetermined positions of their corresponding extended installation parts 35a, with their surfaces on which ribs 38 are installed facing downward. Then, rib attachment members 37 are fixed in extended installation parts 35a by fastening screws 39a. Thereafter, rotary drum 5 is set up on drum fixing member 35 in a preset circumferential direction with

its bottom portion 5d facing downward, and is fixed to drum fixing member 35 with flange 5f interposed therebetween by fastening screws 39b into screw holes (not shown) provided at extended installation parts 35a.

5 Below, an operation of the drum type washing machine having the above-described configuration will be explained.

When laundry is loaded into rotary drum 5 and an operation start instruction is inputted, controller 16 reads a control program from storage unit 18 and starts a control
10 operation in accordance with a control sequence as follows.

First, controller 16 rotates rotary drum 5 to detect an amount of laundry by means of laundry amount detector 12. Laundry amount detector 12 detects a laundry amount based on a load variation imposed on driving motor 7, wherein the
15 load variation varies depending on the laundry amount. The laundry amount thus detected is inputted to controller 16 and is stored in storage unit 18.

Subsequently, controller 16 operates water supply valve 11, so that fresh tap water is supplied to water tub 6.
20 At this time, the water level in water tub 6 is detected by water level detector 14. When the water level reaches up to a predetermined value determined based on the laundry amount, water level detector 14 sends a signal to controller 16 to stop the operation of water supply valve 11. Since water
25 tub 6 and rotary drum 5 are declined toward the rear side of housing 1, supplied wash water is collected downward near

the boundary between the inner surfaces of body portion 2b and bottom portion 2c of water tub main body 2.

Then, a wash cycle is started. If rotary drum 5 is rotated by driving motor 7, the wash water is drawn up in direction A shown in Fig. 3 by the rotation of ribs 38 of rib attachment members 37 installed on rotary drum 5. When rotary drum 5 is rotated at a speed equal to or higher than a predetermined rotational speed, i.e., a rotational speed that generates a centrifugal force strong enough to make the laundry cling to the inner surface of rotary drum 5 against the gravity pulling down the laundry (e.g., 80 rpm), wash water is collected near the boundary between body portion 2b and bottom portion 2c of water tub main body 2 and starts to be rotated by a centrifugal force.

Here, due to the presence of outer wall 40 on rib attachment members 37, the wash water lifted up by ribs 38, which is apt to be sent toward body portion 2b by the centrifugal force, is made to flow along outer wall 40 toward bottom portion 2c in which water inlet port 2c is provided, as illustrated by an arrow B in Fig. 7.

When the wash water comes out to bottom portion 2c, it is made to rotate near the boundary between body portion 2b and bottom portion 2c of water tub main body 2. Here, since guide recess 21 is provided in bottom portion 2c, the wash water is directed toward guide recess 21 by gravity and the force allowing the wash water to be flown out of rib

attachment members 37, and is introduced into first water circulation passage 22 via water inlet port 20.

The wash water introduced into first water circulation passage 22 flows through second water circulation passage 26,
5 third water circulation passage 27 and fourth water circulation passage 28 and finally reaches circulation nozzles 34. Here, since first water circulation passage 22 is of an arc shape, the wash water can flow smoothly without being interrupted.

10 Upon reaching circulation nozzles 34, the wash water is discharged from water discharge openings 32 at a preset angle and with a preset width, which are controlled by control plate 33. The wash water thus discharged is sprayed toward the laundry which is being rotated in rotary drum 5.

15 The wash water sprayed toward the laundry permeates into the laundry, and then is flown out of rotary drum 5 through drum perforations 5g, which are provided in the peripheral surface of rotary drum 5, by the centrifugal force to be re-circulated into water tub 6.

20 Through the mechanism as described above, the laundry can be sufficiently soaked in the wash water at an earlier stage.

Here, since guide recess 21 and water inlet port 20 are provided at an upper part of bottom portion 2c and at
25 downstream of the flow path of the wash water being rotated, gravity and the force by which the wash water is flown from

water inlet port 20 are combined to be applied to the wash water within first water circulation passage 22. As a result, the flow of the wash water can be made stronger and the amount of the wash water sprayed from water discharge openings 32 can also be increased, which makes it possible to spray the wash water over the laundry more extensively.

Furthermore, by providing water inlet port 20 and guide recess 21 at downstream of the flow path of the wash water, first water circulation passage 22 can be made shorter than the case of providing them at upstream of the flow path of the wash water. Therefore, costs can be reduced, and the resistance against the flow of the wash water in first water circulation passage 22 can also be reduced. Moreover, since it is possible to use the rotary force of rotary drum 5 for a longer time, the force by which the wash water is directed into water inlet port 20 can be further increased.

Moreover, since water discharge openings 32 are located lower than water inlet port 20, the water pressure of water discharge openings 32 can be increased due to the difference in the heights of water discharge openings 32 and water inlet port 20, i.e., due to potential head. As a consequence, the force of the wash water being discharged can be increased, and the amount of water circulation can be increased as well. Also, due to the increased force of the wash water being discharged, it is possible to spray the

wash water into rotary drum 5 more extensively.

Thereafter, rotary drum 5 is stopped temporarily, and then it is rotated again at a rotational speed that makes the laundry lifted up by agitation blades 5e and dropped by gravity pulling down the laundry, provided on the inner cylindrical surface of rotary drum 5, in the drum 5's rotational direction to be dropped upon reaching a maximum height that depends on the rotational speed, during which the laundry is subjected to pounding motions. Here, by recirculating the wash water collected in water tub 6 into rotary drum 5, the laundry undergoes the pounding motions while it is sufficiently soaked by the wash water. Therefore, detergency can be improved in comparison with the case where the laundry is not fully soaked, and, also, soils can be removed from the laundry effectively. Further, washing time can be shortened while obtaining same cleaning effect.

In addition, in accordance with the first preferred embodiment of the present invention, though water inlet port 20 is located at the upper part of bottom portion 2c and, also, at downstream of the flow path of the wash water being rotated, as illustrated in Fig. 3, the location of providing water inlet port 20 is not limited thereto as long as the configuration allows the wash water, which is being rotated in water tub 6 by the rotation of rotary drum 5, to be guided to water discharge openings 32 and discharged out of

water discharge openings 32.

(Second preferred embodiment)

Referring to Fig. 8, there is provided a perspective
5 view of water tub main body 42 in accordance with a second
preferred embodiment of the present invention. Parts
identical to those described in the first preferred
embodiment will be assigned same reference numerals, and
description thereof will be omitted.

10 As shown in Fig. 8, body groove portion 42e of water
tub main body 42, body groove portion 42e being of a
substantially concave shape, is formed on the inner surface
of body portion 42b of water tub main body 42 near the
boundary between bottom portion 42c and body portion 42b of
15 water tub main body 42, wherein body groove portion 42e is
of an arc shape substantially concentric with body portion
42b. Further, body groove portion cover 43 of water tub
main body 42 shaped to conform to body groove portion 42e is
fixed to body groove portion 42e by screws 45 via fourth
20 packing member 44 provided on the periphery of body groove
portion cover 43. Body groove portion 42e and body groove
portion cover 43 jointly form first water circulation
passage 46. Water inlet port 47 and guide recess 48 serving
as one end of first circulation passage 46 are also formed
25 at body portion 42b. Other configurations are identical to
those described in the first preferred embodiment. Further,

second water circulation passage 49 also has the same configuration as in the first preferred embodiment, and one end of second water circulation passage 49 at the side of bottom portion 42c is communicated with the other end of first water circulation passage 46.

Fig. 9 is a longitudinal cross sectional view of rotary drum 5 in accordance with the second preferred embodiment of the present invention. Flanges 5f are formed only at extended installation parts 35a of drum fixing member 35, and each of rib attachment members 51 has only inner wall 52 without an outer wall.

By providing rib attachment member 51 with inner wall 52 protruded in a rear direction, rib attachment member 51 is formed to have a substantially L shape. Further, a plurality of ribs 53 connected to inner wall 52 are disposed in rib attachment member 51 in a radial direction with respect to the center of rotary drum 5, wherein the height of each rib 53 is identical to that of inner wall 52.

An operation of the drum type washing machine having the above-described configuration will now be described.

During a wash cycle, wash water drawn up by ribs 53 is made to flow along body portion 42b toward the peripheral side of rotary drum 5 by a centrifugal force, as shown by an arrow C in Fig. 9. Then, once the wash water is discharged toward body portion 42b, the wash water is made to rotate near the boundary between body portion 42b and bottom

portion 42c of water tub main body 42. Here, since guide recess 48 is provided at body portion 42b, the wash water is guided by guide recess 48 to flow into first water circulation passage 46 through water inlet port 47.

5 Moreover, though water inlet port 47 is provided near the boundary between body portion 42b and bottom portion 42c in the second preferred embodiment, the location of water inlet port 47 is not limited thereto as long as the configuration allows the wash water, which is being rotated
10 in water tub 50 by the rotation of rotary drum 5, to be guided to water discharge openings 32 and discharged out of water discharge openings 32.

 For example, as for a drum type washing machine with rotary drum 5 whose rotational axis is horizontally oriented,
15 the wash water rotates substantially uniformly along the inner surface of body portion 42b. Therefore, water inlet port 47 need not be installed adjacent to the boundary between body portion 42b and bottom portion 42c; and it may be installed away therefrom. Even in that case, the same
20 effect as that of the second embodiment can be obtained.

(Third preferred embodiment)

 Referring to Fig. 10, there is provided an exterior bottom view of rotary drum bottom portion 5d in accordance
25 with a third preferred embodiment of the present invention.

 As shown in Fig. 10, ribs 55 are installed in each rib

attachment member 54 such that they are slanted at predetermined angles in the flow direction of the wash water being rotated in water tub 6 as they approach the outer periphery of rib attachment member 54. Here, the height of each rib 55 is set to be substantially identical to those of outer wall 40 and inner wall 41. Parts identical to those described in the first preferred embodiment will be assigned same reference numerals, and description thereof will be omitted.

Below, an operation of the drum type washing machine having the above-described configuration will be explained.

During a wash cycle, rotary drum 5 is rotated at a predetermined rotational speed (for example, 80 rpm) in a direction indicated by an arrow D in Fig. 10. As in the first preferred embodiment, the wash water is drawn up by ribs 55 of rib attachment members 54 and is circulated into first water circulation passage 22, second water circulation passage 26, third water circulation passage 27 and fourth water circulation passage 28 through water inlet port 20 to be finally discharged into rotary drum 5 through circulation nozzles 34, while soaking the laundry. Thus, the laundry can be subjected to the following pounding motions while it is sufficiently soaked by the wash water.

Upon the completion of the wash cycle, water drain valve 13 is opened, so that soiled wash water is drained. When the draining of the wash water is finished, water-

extraction cycle is performed by spinning rotary drum 5 at a high rotational speed of about 900 rpm by means of driving motor 7. During the water-extraction cycle, if ribs 38 are radially disposed as in the first preferred embodiment, the wash water is pushed in the rotational direction of rotary drum 5 by a rotary force thereof and, at the same time, it is also pushed in a peripheral direction thereof by a centrifugal force. If the wash water is pushed in the peripheral direction of rotary drum 5, the space between water tub 6 and rotary drum 5 may be filled with the wash water more readily, which in turn makes it easier for the wash water to be drawn up by the rotation of rotary drum 5. As a result, the wash water would be rotated repeatedly without entering a water drain outlet (not shown), which is provided in a bottom portion of water tub 6 and connected to water drain valve 13. Accordingly, the draining of the wash water through water drain valve 13 would be difficult. Instead, the wash water would be directed into water inlet port 20 to be re-circulated into rotary drum 5.

In accordance with the third preferred embodiment of the present invention, the wash water is allowed to flow in the rotational direction up to the outer peripheral end portions of ribs 55 by the centrifugal force and then drop therefrom. At this time, since ribs 55 are slanted in the rotational direction, the wash water is pressed toward the rotational direction (indicated by the arrow D) when it

falls from the outer peripheral end portions of ribs 55. Therefore, in comparison with the case of providing the ribs in a radial manner, a stronger force is applied to the wash water in the rotational direction, resulting in an increase
5 of the amount of water circulation.

Through this mechanism, the force by which the wash water is directed into water inlet port 20 is strengthened and, at the same time, the flow rate of the wash water introduced into water inlet port 20 is increased. As a
10 consequence, the force by which the wash water is discharged through circulation nozzles 34 is also increased, resulting in the increase of the amount of water circulation. Ultimately, it is possible to spray the wash water over the laundry more extensively.

15 Meanwhile, in the water-extraction cycle in accordance with the third preferred embodiment of the present invention, though the wash water tends to flow in the peripheral direction of rotary drum 5 by the centrifugal force, its flow direction is changed as it collides with ribs 55 of
20 each rib attachment member 54 slantingly disposed in the rotational direction (indicated by the arrow D), so that the wash water is pressurized in the rotational direction. Accordingly, with this configuration of ribs 55, the amount of the wash water flowing outward can be reduced in
25 comparison with the case of providing ribs in the radial pattern. Therefore, it becomes difficult for the wash water

to be filled in the space between water tub main body 2 and rotary drum 5, and thus the rotary force of the wash water, which is generated by the rotation of rotary drum 5, is weakened as well. As a result, the wash water can be drained through a water drain outlet (not shown) easily.

(Fourth preferred embodiment)

Fig. 11 is an exterior bottom view of rotary drum bottom portion 5d in accordance with a fourth preferred embodiment of the present invention.

As shown in Fig. 11, ribs 57 of each rib attachment member 56 are smoothly curved in a direction opposite to the flow direction of the wash water being rotated in water tub 6, wherein the height of each rib 55 is set to be substantially identical to those of outer wall 40 and inner wall 41. Parts identical to those described in the first preferred embodiment will be assigned same reference numerals, and description thereof will be omitted.

Below, an operation of the drum type washing machine having the above-described configuration will be explained.

During a wash cycle, rotary drum 5 is rotated at a predetermined rotational speed (for example, 80 rpm) in a direction indicated by an arrow E in Fig. 11. At this time, the wash water being drawn up by ribs 57 of each rib attachment members 56 is given a rotary force and a centrifugal force applied thereto.

In accordance with the fourth preferred embodiment of the present invention, since ribs 57 of each rib attachment member 56 are smoothly curved such that it is convex in the direction opposite to the flow direction (indicated by the arrow E in Fig. 11) of the wash water being rotated in water tub 6, the wash water is allowed to flow in the rotational direction up to the outer peripheral end portions of ribs 57 by the centrifugal force and then drop therefrom. At this time, since tangential lines at the vicinity of the outer peripheries of ribs 55 are slanted in the rotational direction, the wash water is pressed toward the rotational direction (indicated by the arrow E) when it falls from the outer peripheral end portions of ribs 57. Therefore, in comparison with the case of providing the ribs in a radial manner, a stronger force is applied to the wash water in the rotational direction, resulting in an increase of the amount of water circulation.

Through this mechanism, the force by which the wash water is directed into water inlet port 20 is strengthened and, at the same time, the flow rate of the wash water introduced into water inlet port 20 is increased as well. As a consequence, the force by which the wash water is discharged through circulation nozzles 34 is also increased, resulting in the increase of the amount of water circulation. Ultimately, it is possible to spray the wash water over the laundry more extensively.

Meanwhile, in the water-extraction cycle in accordance with the fourth preferred embodiment of the present invention, though the wash water in water tub 6 tends to flow in the peripheral direction of rotary drum 5 by the centrifugal force, its flow direction is changed as it collides with ribs 57, so that the wash water is pressurized in the rotational direction (indicated by the arrow E). Accordingly, with this configuration of ribs 57, the amount of wash water flowing in the peripheral direction of rotary drum 5 can be reduced in comparison with the case of providing ribs in the radial pattern. Therefore, it becomes difficult for the wash water to be filled in the space between water tub main body 2 and rotary drum 5, and thus the rotary force of the wash water, which is generated by the rotation of rotary drum 5, is weakened as well. As a result, the wash water can be drained through a water drain outlet (not shown) easily.

(Fifth preferred embodiment)

Fig. 12 sets forth an exterior bottom view of rotary drum bottom portion 5d in accordance with a fifth preferred embodiment of the present invention.

Referring to Fig. 12, as in the third preferred embodiment, ribs 59 of each rib attachment member 58 are installed such that they are slanted at predetermined angles in the flow direction of the wash water being rotated in

water tub 6 as they approach to the outer periphery of rib attachment member 58. Here, the height of each rib 59 is set to be substantially identical to those of outer wall 40 and inner wall 41. Also, as in the fourth preferred embodiment of the present invention, ribs 59 are smoothly curved in a direction opposite to the flow direction of the wash water being rotated in water tub 6. Parts identical to those described in the first preferred embodiment will be assigned same reference numerals, and description thereof will be omitted.

Below, an operation of the drum type washing machine having the above-described configuration will be described.

During a wash cycle, rotary drum 5 is rotated at a predetermined rotational speed (for example, 80 rpm) in a direction indicated by an arrow F in Fig. 12. At this time, wash water drawn up by ribs 59 of rib attachment members 58 is given a rotary force and a centrifugal force applied thereto.

In accordance with the fifth preferred embodiment of the present invention, since ribs 59 of each rib attachment member 58 are smoothly curved such that it is convex in the direction opposite to the flow direction (indicated by the arrow F in Fig. 12) of the wash water being rotated in water tub 6, the wash water is allowed to flow in the rotational direction up to the outer peripheral end portions of ribs 59 by the centrifugal force and then drop therefrom. At this

time, since tangential lines at the vicinity of the outer peripheries of ribs 59 are slanted in the rotational direction, the wash water is pressurized toward the rotational direction (indicated by the arrow E) when it falls from the outer peripheral end portions of ribs 59. Therefore, in comparison with the case of providing the ribs in a radial manner, a stronger force is applied to the wash water in the rotational direction, resulting in an increase of the amount of water circulation.

Through this mechanism, the force by which the wash water is directed into water inlet port 20 is strengthened and, at the same time, the flow rate of the wash water introduced into water inlet port 20 is increased as well. As a consequence, the force by which the wash water is discharged through circulation nozzles 34 is also increased, resulting in the increase of the amount of water circulation. Ultimately, it is possible to spray the wash water over the laundry more extensively.

Meanwhile, in the water-extraction cycle in accordance with the fifth preferred embodiment of the present invention, though the wash water in water tub 6 tends to flow in the peripheral direction of rotary drum 5 by the centrifugal force, its flow direction is changed as it collides with ribs 59, so that the wash water is pressurized in the rotational direction (indicated by the arrow F). Accordingly, with this configuration of ribs 59, the amount

of wash water flowing in the peripheral direction of rotary drum 5 can be reduced in comparison with the case of providing ribs in the radial pattern. Therefore, it becomes difficult for the wash water to be filled in the space
5 between water tub main body 2 and rotary drum 5, and thus the rotary force of the wash water, which is generated by the rotation of rotary drum 5, is weakened as well. As a result, the wash water can be drained through a water drain outlet (not shown) easily.

10 Furthermore, in accordance with the first to the fifth preferred embodiments of the present invention, though first water circulation passage 22 is formed of: substantially concave bottom groove portion 2d provided on the inner surface of bottom portion 2c and bottom groove portion cover
15 23; and first water circulation passage 46 is formed of: substantially concave body groove portion 42e provided on the inner surface of body portion 42b and body groove portion cover 43, first water circulation passage 22 or 46 can be formed as a separate component from water tub main
20 body 2. In such a case, one end of first water circulation passage 22 or 46 formed of the separate component may be communicated with water inlet port 20 provided at bottom portion 2c or body portion 42b, while the other end thereof is communicated with second water circulation passage 26 or
25 49.

Moreover, though bottom portion 2c of water tub main

body 2, bottom portion 42c of water tub main body 42, bottom groove portion cover 23, body groove portion cover 43, water tub cover 3 and front groove portion cover 29 are fixed by using screws in the first to the fifth preferred embodiment, they can be fixed by another method, e.g., welding as long as they can be connected hermetically.

Also, though two circulation nozzles 34 are provided in the first to the fifth preferred embodiment, the number of circulation nozzles can be changed: it can be one or plural. Further, their installation locations can also be modified as long as the configuration allows wash water to be re-circulated into rotary drum 5.

The drum type washing machine in accordance with the present invention can improve detergency, remove soils from laundry and reduce manufacturing cost by re-circulating the wash water in a water tub into a rotary drum without using a circulation pump.

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 scope of the invention as defined in the following claims.

What is claimed is:

1. A drum type washing machine comprising:

a housing;

5 a cylindrical water tub, having a cylindrical body and a bottom, provided with a first opening through which a loading/unloading of laundry is performed, the water tub being accommodated in the housing; and

10 a cylindrical rotary drum, provided with a second opening corresponding to the first opening, having a bottom and a substantially horizontal or slanted rotational axis, the rotary drum being rotatably accommodated in the water tub,

wherein the water tub includes:

15 a water inlet port through which wash water being rotated in the water tub by a rotation of the rotary drum is supplied;

20 a water circulation passage, the water inlet port being communicated with one of two ends of the water circulation passage; and

25 one or more water discharge openings for discharging the wash water into the rotary drum therethrough, the water discharge openings being communicated with the other end of the water circulation passage.

2. The washing machine of claim 1, wherein the rotary drum is installed in the water tub such that its rotational axis is declined toward a rear side of the housing, and the water inlet port is provided near a boundary between inner
5 surfaces of the bottom and the body of the water tub.

3. The washing machine of claim 1 or 2, wherein each of the water discharge openings is provided inside the water tub near a peripheral edge of the first opening to thereby
10 allow the wash water to be discharged into the rotary drum through the second opening.

4. The washing machine of any one of claims 1 to 3, wherein the water inlet port is located higher than the
15 water discharge openings.

5. The washing machine of any one of claims 1 to 4, wherein the water inlet port is provided inside the water tub at an upper half portion of the bottom of the water tub and at downstream of a flow path of the wash water being
20 rotated in the water tub, and each of the discharge openings is disposed inside the water tub near a lower half portion of a periphery of the first opening.

25 6. The washing machine of any one of claims 1 to 4, wherein a plurality of ribs is installed at an outer side of

the bottom of the rotary drum such that they protrude toward the bottom of the water tub.

7. The washing machine of claim 5, wherein a plurality of
5 ribs is installed at an outer side of the bottom of the rotary drum such that they protrude toward the bottom of the water tub.

8. The washing machine of claim 6 or 7, wherein the ribs
10 are installed at the vicinity of a peripheral portion of the bottom of the rotary drum substantially in a radial pattern while being connected to substantially arc-shaped rib attachment members, and the water inlet port is provided inside the water tub at the bottom of the water tub near the
15 boundary between the bottom and the body of the water tub.

9. The washing machine of claim 6, wherein the ribs are installed at the vicinity of the peripheral portion of the bottom of the rotary drum substantially in a radial pattern
20 while being connected to substantially arc-shaped rib attachment members, and the water inlet port is provided inside the water tub at the body of the water tub near the boundary between the bottom and the body of the water tub.

25 10. The washing machine of claim 8 or 9, wherein the plurality of ribs are slanted at target angles in a flow

direction of the wash water being rotated in the water tub as they approach the peripheral portion of the rotary drum.

11. The washing machine of claim 8 or 9, wherein the
5 plurality of ribs are curved such that they are convex in a direction opposite to the flow direction of the wash water being circulated in the water tub.