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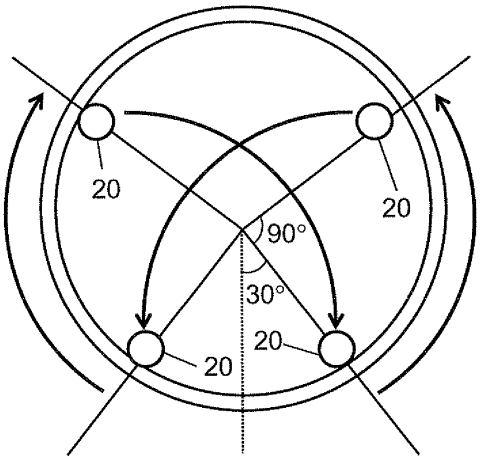
(54) DRUM TYPE WASHING MACHINE

(57) The rotary drum formed in a cylindrical shape having a bottom is installed in the washing tub so that the direction of rotation shaft is set to be horizontal or inclined downward from the horizontal direction from the opened front side to the back side at the bottom. The controller drives the motor rapidly to pivot the rotary drum quickly at a change rate so that the laundry sticks to the inner circumference of the rotary drum by centrifugal force, and the laundry is lifted from the lowest position of the rotary drum, at the position of 0 degree, to the position of less than 180 degrees by surpassing the position of 90 degrees. The motor rotation is braked suddenly at a change rate so that the laundry is peeled off from the inner circumference of the rotary drum, and is dropped to the side opposite the lifting side in the rotary drum. The controller executes this series of operation in a normal and reverse pivot drive mode by repeating normal and reverse rotation alternately.

FIG. 4G



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Description

TECHNICAL FIELD

[0001] The present invention relates to a drum type washing machine for washing laundries in a rotary drum by driving the rotary drum installed in a washing tub so that the direction of rotation shaft is set to be horizontal or inclined downward from the horizontal direction.

BACKGROUND ART

[0002] FIG. 7 is a sectional view showing the structure of a conventional drum type washing machine. The washing machine has casing 31, washing tub 32, rotary drum 34, motor 35, and door 36. Washing tub 32 is supported in casing 31 by suspension structure. Rotary drum 34 provided with a multiplicity of holes 33 is installed in washing tub 32. Motor 35 drives rotary drum 34. Door 36 is provided at the front side of casing 31. A user opens door 36, and can put in or take out laundries in rotary drum 34 through the front opening of washing tub 32 and the front opening of rotary drum 34.

[0003] In an ordinary washing mode, the user opens door 36, and puts the laundries and a detergent into rotary drum 34, and starts operation. Then, water feeder 37 supplies water into washing tub 32. As the water is supplied, a specified amount of water is supplied also into rotary drum 34 through holes 33. Motor 35 drives rotary drum 34 at a specified rotating speed, and the laundries contained in rotary drum 34 is hooked by agitating protrusion 38 provided in the inner circumference of rotary drum 34, and is lifted in the rotating direction. Then the laundries fall from a proper height. Thus the laundries are washed by such beating action. After the washing step, the stained washing water is discharged from drain unit 41, and water feeder 37 newly supplies water to begin a rinsing step. After the rinsing step, rotary drum 34 rotates at high speed, and a dewatering step begins. These steps are executed automatically according to a specified control procedure.

[0004] Rotary drum 34 is installed so that rotation shaft 34A is set to be horizontal or inclined downward from the horizontal direction from the opening side to the bottom side. When washing laundries by rotary drum 34 thus installed, the user can easily put into or take out the laundries. However, when rotary drum 34 is installed in such direction, the beating action of lifting and dropping the laundries is weak. In particular, in rotary drum 34 having an inclined rotation shaft, the laundries tend to be collected at a lower position even in the direction of rotation shaft, and the washing effect is particularly weak.

[0005] To solve this problem, Patent document 1 discloses the following technology. That is, the laundries lifted by rotation of rotary drum 34 fall from a height position where the own weight is larger, and this behavior is supposed to be first predetermined rotating speed, and rotary drum 34 is driven at this speed for a first predetermined time. Then, the rotation of rotary drum 34 is stopped for a specified time, and the positions of the laundries tending to be collected at a lower position are exchanged.

[0006] FIG. 8A, FIG. 8B show the behavior of laundries 61 in rotary drum 34 in the washing machine disclosed in Patent document 1. FIG. 8A shows a twisted state of laundries 61 in sticking state after dewatering, and FIG. 8B shows an entangled state of laundries 61 in sticking state after dewatering. In the washing machine disclosed in Patent document 1, by alternating such rotation in normal and reverse directions, the twisted state and the entangled state of laundries 61 can be suppressed to a certain extent. As a result, laundries 61 can be taken out easily in some degree.

[0007] When the diameter of rotary drum 34 is 500±50 mm, supposing the first predetermined rotating speed to be 30±5 rpm, the beating action by dropping is increased. This speed is higher than the ordinary speed when rotary drum 34 is installed in horizontal position. The first predetermined time is shown as 13 seconds or 4 minutes, for example, and the rotation is continuous in relation to the rotating speed.

[0008] In the technology of Patent document 1, the rotating speed of rotary drum 34 is higher than that of horizontal installation. In this method, however, only the lifted laundry 61 is dropped by gravity from a height position where the own weight is larger than the centrifugal force by rotary drum 34. That is, depending on the type of laundry 61, the lifting position may be insufficient, and the beating action may be insufficient.

[0009] Besides, since normal continuous rotation and reverse continuous rotation are executed alternately, laundries 61 are twisted and entangled during continuous rotation. Even if a pause period is provided between normal continuous rotation and reverse continuous rotation during continuous rotation, the entangled state as shown in FIG. 8B may be eliminated, but the twisted state may not be suppressed sufficiently. In addition, laundries 61 stick to the inner circumference of rotary drum 34 after washing. When taking out, laundries 61 must be peeled off from other direction, and it is not easy. Yet, since laundries 61 are creased, it also takes time and labor for straightening after washing.

Patent document 1: Japanese Patent Unexamined Publication No. 2005-124764

DISCLOSURE OF THE INVENTION

[0010] The present invention provides a drum type washing machine extremely suppressing the occurrence of entangling and twisting, enhanced in the function of mechanical force, and suppressing the occurrence of creasing. The drum type washing machine of the present invention includes a washing tub, a rotary drum, a motor, and a controller. The rotary drum for containing the laundry in the inside is formed in a cylindrical shape having a bottom. It is installed in the washing tub so that the

direction of rotation shaft is set to be horizontal or inclined downward from the horizontal direction from the opened front side to the back side at the bottom. The motor drives the rotary drum. The controller controls at least the motor, and executes at least the washing step and rinsing step. Further, the controller drives the motor rapidly, and thereby rotates the rotary drum in a quick pivot, and by the centrifugal force of the quick pivot of the rotary drum, laundries are stuck to the inner circumference of the rotary drum, and the laundries are lifted from the lowest position of the rotary drum, at the position of 0 degree, to the position of less than 180 degrees by surpassing the position of 90 degrees. The controller also brakes the rotation of the motor suddenly, and the laundries are peeled off from the inner circumference of the rotary drum, and are dropped to the opposite side of the laundry-lifting side of the rotary drum. The controller executes the series of operation by repeating normal and reverse rotation alternately, which is called a normal and reverse pivot drive mode, at least in part of at least one of washing step and rinsing step.

[0011] By executing this normal and reverse pivot drive mode, the laundries are lifted from the lowest position of the rotary drum to the position of less than 180 degrees by surpassing the position of 90 degrees at maximum by the quick pivot of the rotary drum. A braked state is established by quick braking at the final stage of lifting of the laundries. From this braked state, the laundries are peeled off from the inner circumference of the rotary drum by their inertia and own weight, and are dropped securely to the opposite side of the lifting side of the lower range of the rotary drum. By quick pivot drive of alternate normal and reverse rotation, the lifting position and dropping position of the laundries can be alternately exchanged right and left every time in quick pivot drive, and the sleaving action is enhance while preventing entangling of the laundries. The cleaning performance can be further enhanced because the number of times of mechanical force applied to the laundries can be increased.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

FIG. 1 is a sectional view showing a configuration of a drum type washing machine according to an exemplary embodiment of the present invention.

FIG. 2 is a backside view showing the inside of the drum type washing machine shown in FIG. 1.

FIG. 3 is a sectional view showing nearly half of mounting portion of a motor in the drum type washing machine shown in FIG. 1.

FIG. 4A is a schematic view showing positions of laundries in a rotary drum in a stopped state of the drum type washing machine shown in FIG. 1.

FIG. 4B is a schematic view showing a starting state of rotation of the rotary drum from the state shown in FIG. 4A.

FIG. 4C is a schematic view showing a decelerated state of rotation of the rotary drum from the state shown in FIG. 4B.

FIG. 4D is a schematic view showing an accelerated state in reverse direction of rotation of the rotary drum from the state shown in FIG. 4C.

FIG. 4E is a schematic view showing a decelerated state of rotation of the rotary drum from the state shown in FIG. 4D.

FIG. 4F is a schematic view showing an accelerated state in normal direction of rotation of the rotary drum from the state shown in FIG. 4E.

FIG. 4G is a schematic view showing a right and left exchange behavior of lifting position and dropping position of a laundry in a normal and reverse pivot drive mode shown in FIG. 4C to FIG. 4F.

FIG. 5 is a rotation characteristic diagram about sticking and peeling of a laundry to and from the inner circumference of the rotary drum for realizing the normal and reverse pivot drive mode ideally in the drum type washing machine in FIG. 1.

FIG. 6A is a schematic view showing a state example of laundries after dewatering step in the normal and reverse pivot drive mode in the drum type washing machine in FIG. 1.

FIG. 6B is a schematic view showing other state example of laundries after dewatering step in the normal and reverse pivot drive mode in the drum type washing machine in FIG. 1.

FIG. 7 is a sectional view of essential parts of a conventional drum type washing machine.

FIG. 8A is a schematic view showing a state example of laundries after dewatering step in the conventional drum type washing machine.

FIG. 8B is a schematic view showing other state example of laundries after dewatering step in the conventional drum type washing machine.

REFERENCE MARKS IN THE DRAWINGS

[0013]

1	Casing
2	Washing tub
3	Hole
4	Rotary drum
4a	Rotation shaft
5	Motor
5A	Stator
51	Inner rotor
52	Outer rotor
6	Door
7	Water feeder
8	Agitating protrusion
9	Controller
11	Drain unit
12	Blower
13	Ventilating flue

14 Operation unit
15 Filter
16 Dehumidifier
17 Heater
18 Compressor
19 Air conditioner
20 Laundry

DETAILED DESCRIPTION OF THE INVENTION

[0014] Exemplary embodiments of the present invention are described specifically below while referring to the accompanying drawings. The following explanation relates to specific examples of the present invention, and is not intended to limit the scope of the present invention.

[0015] FIG. 1 is a sectional view showing a configuration of drum type washing machine in an exemplary embodiment of the present invention. FIG. 2 is a backside view showing the inside of the drum type washing machine shown in FIG. 1. FIG. 3 is a sectional view showing nearly half of a mounting portion of a motor in the drum type washing machine shown in FIG. 1.

[0016] This washing machine includes casing 1, washing tub 2, rotary drum 4, motor 5, and door 6. Washing tub 2 is supported in casing 1 by suspension structure. Rotary drum 4 of cylindrical shape with a bottom and provided with a multiplicity of holes 3 is installed in washing tub 2. Motor 5 drives rotary drum 4. Door 6 is provided at the front side of casing 1. A user opens door 6, and can put laundries into rotary drum 4 and take them out through the front opening of washing tub 2 and the front opening of rotary drum 4.

[0017] The user sets a mode from operation unit 14. According to this setting, controller 9 executes various modes. Controller 9 includes a microcomputer which stores control programs.

[0018] In an ordinary washing mode, the user opens door 6, and puts the laundry and a detergent into rotary drum 4, and starts operation. As a result, controller 9 operates water feeder 7 to supply water into washing tub 2. As the water is supplied, a specified amount of water is supplied also into rotary drum 4 through holes 3.

[0019] Then, controller 9 drives rotary drum 4 at specified rotating speed by means of motor 5. The laundries contained rotary drum 4 are hooked by agitating protrusion 8 provided in the inner circumference of rotary drum 4, and are lifted in the rotating direction. Then the laundries fall from a proper height. Thus the laundries are washed by such beating action. After the washing step, controller 9 discharges the stained washing water from drain unit 11, newly supplies water from water feeder 7, and executes a rinsing step. After the rinsing step, controller 9 rotates rotary drum 4 at a high speed, and executes a dewatering step. Controller 9 executes these steps automatically according to a specified control procedure. In this manner, controller 9 controls at least motor 5, and executes at least the washing step and the rinsing step.

[0020] Controller 9 also sucks air in washing tub 2 and rotary drum 4 by means of blower 12. Dehumidifier 16 dehumidifies the sucked air. Heater 17 heats the dehumidified air. Ventilating flue 13 connects blower 12 and washing tub 2, as well as heater 17 and washing tub 2. By the drying section thus formed, controller 9 blows dry and hot air into washing tub 2 and rotary drum 4. In the drum type washing machine also called drum type washing and drying machine, the drying step is also executed after the dewatering step.

[0021] Water feeder 7 supplies water properly as indicated by solid line arrow by opening and closing a solenoid valve not shown. By making use of the supply water, a detergent in a detergent container not shown is properly put into washing tub 2. Drain unit 11 discharges water properly as indicated by dashed-dotted line arrow as required, at the end of washing step and at the end of rinsing step, by opening and closing a solenoid valve not shown.

[0022] Blower 12 circulates air in washing tub 2 and rotary drum 4, as indicated by broken line arrow in FIG. 1 and FIG. 2, in ventilating flue 13 composing the drying section. Ventilating flue 13 is provided with filter 15 for capturing and removing lint and other dust in the air introduced from washing tub 2 and rotary drum 4. Therefore, dehumidifier 16 dehumidifies the introduced air after filtering. Blower 12 is disposed at the downstream side of heater 17 so as to be free from effects of humidity.

[0023] In FIG. 1 and FIG. 2, dehumidifier 16 and heater 17 are respectively composed of an evaporator and a condenser for exchanging heat with the circulating air. In the evaporator and the condenser, a refrigerant is circulated by compressor 18. That is, these elements are combined to compose air conditioner 19. Dehumidifier 16 and heater 17 are not particularly specified by such configuration, and may be built in other structure.

[0024] Rotary drum 4 is disposed so that the direction of rotation shaft 4A is set to be horizontal or inclined downward from the horizontal direction, from the opening side to the bottom side. In the example in FIG. 1, motor 5 on washing tub 2 is directly coupled to rotation shaft 4A of rotary drum 4, which is inclined and installed together with washing tub 2 so that the direction of rotation shaft 4A is set to be at an angle $\theta = 20 \pm 10$ degrees from the horizontal direction.

[0025] When washing laundries by rotary drum 4 thus installed, the opening is positioned obliquely upward even if rotary drum 4 is installed at the same height as when rotation shaft 4A is installed in the horizontal direction. Accordingly, the user can put the laundries in or take them out easily without changing the body direction. In particular, since the inclination angle θ is 20 ± 10 degrees, the laundries can be handled most easily and equally by a child, an adult, or a person sitting in a wheelchair.

[0026] In addition, since the water supplied into rotary drum 4 is collected at the back side, deep water is collected even if the amount of water is small. However, when rotary drum 4 is installed in such direction, the beating action of lifting and dropping the laundries is weak.

In particular, in an inclined rotary drum 4, the laundry tends to be gathered at low position even in the direction of the rotation shaft, and the washing effect is very poor.

[0027] To solve such problems, in the present embodiment, a pivot drive mode is set in controller 9 for driving and controlling rotary drum 4 by motor 5. Herein, "pivot" means a rotary motion smaller than one revolution. In the "pivot drive mode", from the position of 90 degrees to a position of less than 180 degrees, supposing the lower end of perpendicular direction to be the position of 0 degree, rotary drum 4 pivots at high speed, and is braked suddenly. That is, controller 9 drives motor 5 quickly and pivots rotary drum 4 quickly at such a change rate as to stick the laundries to the inner circumference of rotary drum 4 by a centrifugal force. From the position of 0 degree at the lowest position of rotary drum 4, to a position of less than 180 degrees surpassing the position of 90 degrees, the laundries are lifted. Successively, controller 9 quickly brakes the rotation of motor 5 at such a change rate as to peel off the laundries from the inner circumference of rotary drum 4, and drops the laundries to the opposite side of the lifted side.

[0028] FIG. 4A to FIG. 4F are schematic diagrams showing the position of laundry 20 in rotary drum 4 in the pivot drive motor of the drum type washing machine shown in FIG. 1. In this mode, laundry 20 is mostly lifted up over 90 degrees to less than 180 degrees. In a final stage of lifting of laundry 20, rotary drum 4 is quickly braked. When rotary drum 4 is braked in such a manner, laundry 20 is peeled off from the inner circumference of rotary drum 4 by the inertia acting on laundry 20 and its own weight, and dropped securely by the own weight. As a result, the sleaving effect is enhanced while suppressing twisting or entangling of laundries 20. Since the mechanical force is securely applied to laundry 20, the washing performance is enhanced. It is further preferable to operate in a normal and reverse pivot drive mode in which quick normal pivot in normal direction and quick reverse pivot in reverse direction of pivot drive mode are alternately repeated. By such normal and reverse alternate quick pivot drive, the lifting position and the dropping position of laundry 20 are alternately exchanged right and left every time in pivot drive. Further, the sleaving effect is enhanced while preventing entangling of laundries 20, and the mechanical force is applied to laundry 20 more times. As a result, the washing performance is further enhanced.

[0029] The motion of laundry 20 in pivot drive mode and normal and reverse pivot drive mode is explained by referring to FIG. 4A to FIG. 4F. FIG. 4A to FIG. 4F are schematic diagrams for explaining the motion of laundry 20, and are not intended to limit the scope of the present invention.

[0030] First, as shown in FIG. 4A, while the drum type washing machine is stopped, laundry 20 in rotary drum 4 is at the lower side, that is, near the position of 0 degree. When rotary drum 4 pivots at high speed (quick normal pivot drive) beyond the position of 90 degrees to a position of less than 180 degrees, laundry 20 is lifted beyond the position of 90 degrees to a position of less than 180 degrees, that is, from the broken line position to the solid line position as shown in FIG. 4B. As shown in FIG.4C, when rotary drum 4 is braked at a final stage of lifting of laundry 20, laundry 20 is securely peeled off from the inner circumference of rotary drum 4 by its inertia and own weight. As a result, laundry 20 is dropped to the opposite side of lifting side of rotary drum 4 by drawing a parabolic curve as indicated by arrow from the broken line position to the solid line position by the own weight.

[0031] After such braking, rotary drum 4 is driven to pivot at high speed in the reverse direction to a position of less than 180 degrees by surpassing the position of 90 degrees (quick reverse pivot drive). As a result, as shown in FIG. 4D, laundry 20 is lifted from the broken line position to the solid line position in reverse direction by surpassing the position of 90 degrees to a position of less than 180 degrees. Then, as shown in FIG. 4E, when rotary drum 4 is braked at a final stage of lifting of laundry 20, laundry 20 is securely peeled off from the inner circumference of rotary drum 4 by its inertia and own weight. As a result, laundry 20 is dropped to the opposite side of lifting side of rotary drum 4 by drawing another parabolic curve as indicated by arrow from the broken line position to the solid line position by the own weight. Then, as shown in FIG. 4F, rotary drum 4 is quickly driven in normal pivot, and the operation as explained in FIG. 4C to FIG. 4E is repeated.

[0032] By thus normal and reverse alternate quick pivot drive, the lifting position and the dropping position of laundry 20 are alternately exchanged right and left every time as shown in FIG. 4G in pivot drive. Hence, the sleaving effect of laundries 20 is enhanced, and the mechanical force is applied to laundry 20.

[0033] Thus, controller 9 controls pivot motion of rotary drum 4, and lifts laundry 20 to the upper part of right and left side of rotary drum 4 alternately in normal and reverse direction. At a final point or near the end of lifting of laundry 20, laundry 20 is peeled off by force by its inertia and own weight in slowdown or braked state, and dropped to right and left opposite sides by the own weight. By repeating the normal and reverse pivot motions, the lifting position and the dropping position of laundry 20 are alternately exchanged right and left in every pivot motion. As a result, the sleaving action on laundries 20 is enhanced, and entangling and twisting, and sticking to the inner circumference of rotary drum 4 can be prevented. Hence, laundry 20 can be taken out easily, and creasing of laundry 20 is prevented remarkably. In addition, a mechanical force is applied to laundry 20, the number of times of dropping of laundry 20 with beating action can be increased significantly, and the washing effect and functions at each step of the washing machine can be realized.

[0034] From the lowest position (position of 0 degree) to a position near 90 degrees of rotary drum 4, rotary drum 4 is driven to pivot by quick acceleration so that

laundry 20 may stick to the inner circumference of rotary drum 4. When laundry 20 is lifted from the lowest position of rotary drum 4, laundry 20 cannot follow up the rotation of rotary drum 4, and is like to fall by own weight near a position of 90 degrees. Controller 9 controls driving motor 5 by such quick acceleration and laundry 20 is caused to stick to the inner circumference of rotary drum 4. Accordingly, laundry 20 is lifted without slip to a position surpassing 90 degrees, and is securely lifted to a specified position along with enough inertia suited to the rotating speed of rotary drum 4. At the changing point to braked state, controller 9 peels off laundry 20 by the inertia and own weight of laundry 20, and drops to the opposite side of lifting side by the own weight of laundry 20. By such drive mode, controller 9 securely exchanges the lifting position and dropping position of laundry 20 between right and left.

[0035] When exchanging the pivot directions of rotary drum 4 in normal and reverse directions, an abrupt braking action is inserted from a position over 90 degrees to a position of less than 180 degrees in pivot motion of rotary drum 4. As a result, even in the quick acceleration condition for causing sticking of laundry 20, laundry 20 is securely peeled off by inertia of quick deceleration and own weight at a final stage of pivot of laundry 20, and is stopped to the opposite side of the lifting side. Thus, loss of mechanical force applied to laundry 20 is suppressed. Therefore, the effects of each step of washing machine are obtained in a shorter time, while twisting and entangling can be prevented, and creasing is suppressed.

[0036] Observing such operation from the viewpoint of behavior of laundry 20, in the pivot drive mode of the present embodiment, controller 9 sticks laundry 20 to the inner circumference of rotary drum 4 and lifts upward by the centrifugal force according to the quick pivot of rotary drum 4. Then, laundry 20 thus lifted is peeled off from the inner circumference of rotary drum 4 by its inertia according to quick braking of rotary drum 4, and is dropped by the own weight. The normal and reverse pivot drive mode of the present embodiment is understood as a mode in which the normal pivot drive mode and the reverse pivot drive mode are alternately repeated.

[0037] In a more preferable normal and reverse pivot drive mode, controller 9 sticks laundry 20 to the inner circumference of rotary drum 4 and lifts to the upper range of rotary drum 4 by the centrifugal force according to the quick pivot of rotary drum 4. Then, laundry 20 is peeled off from the inner circumference of rotary drum 4 by its inertia according to the quick braking of rotary drum 4, and is dropped to the opposite side of the lifting side in the lower range of rotary drum 4 by inertia and own weight. Such driving control is alternately repeated in normal and reverse direction.

[0038] In these cases, normal pivot and reverse pivot of rotary drum 4 are repeated preferably within positions of less than 180 degrees, more preferably over the position of 90 degrees by the same reasons as mentioned above.

[0039] Herein, by rotary drum 4 of 500±50 mm in diameter, the gravity of laundry 20 is divided into a central direction and a tangential direction of rotary drum 4, and the drum rotating speed balanced between the force in the central direction and the centrifugal force is calculated in formula (1).

$$mr\omega^2 = mg\cos\theta \quad \ldots (1)$$

where "m" is mass of laundry, "r" is radius of rotation, "ω" is angular velocity, "g" is gravitational acceleration, "θ" is angle of rotating direction supposing the vertical direction to be 0 degree.

[0040] Results of calculation are shown in FIG. 5. In FIG. 5, the X-axis denotes drum rotating angle position, which shows the angular position from the lowest position of rotary drum 4 where the reference point of rotary drum 4 is located, supposing the lowest point to be the reference point when rotary drum 4 is stopped. The square plots show the drum rotating speed necessary for balancing of the force in the central direction and the centrifugal force at each angular position where the reference point of rotary drum 4 is located. The broken line and solid line arrows indicate the rotating speed of rotary drum 4 at each angular position.

[0041] From point 21 showing the stopped moment, rotary drum 4 pivots quickly as indicated by the broken line, and reaches a rotating speed of about 45 rpm at point 22. At point 22, since the solid line arrow exceeds the plot, laundry 20 securely sticks to rotary drum 4. Thus, when the rotating angle position of reference point of rotary drum 4 is at the position of 90 degrees, laundry 20 securely sticks to rotary drum 4. Accordingly, laundry 20 is lifted by surpassing the position of 90 degrees. As mentioned above, lifting of laundry 20 by sticking is at a position of less than 180 degrees by surpassing the position of 90 degrees of rotary dram 4, but in this example, the position is near 120 degrees as indicated by point 26.

[0042] Near the position of 120 degrees, the solid line arrow intersects with the plots, and the solid line arrow is lower than the plots. In this condition, laundry 20 no longer sticks to rotary drum 4, but is peeled off. Hence, at point 26 near the position of 120 degrees, controller 9 applies braking to rotary drum 20 to stop near the position of 140 degrees as indicated by point 23. By this braking, laundry 20 is peeled off from the inner circumference of rotary drum 4 by the rotational inertia acting on laundry 20 and its own weight. Thus, by the maximum rotating speed of 45 rpm and a slight deceleration state, it is understood that laundry 20 is peeled off from rotary drum 4.

[0043] From such calculation and experience, the maximum rotating speed of pivot in normal and reverse pivot drive mode is preferred to be 40 rpm or more. Braking for peeling off laundry 20 is executed at maximum rotating speed, so that the effect by normal and reverse pivot drive mode can be obtained. Peeling of laundry 20

in normal and reverse pivot drive mode can be executed by braking in a range from position of 120 degrees to position of 140 degrees as shown in the example in Fig. 5. More specifically, when decelerated from pivot at maximum rotating speed 45 rpm, peeling force according to deceleration is applied to laundry 20 by rotational inertia and own weight of laundry 20 continuing to rotate at this rotating speed.

[0044] Further, as shown in FIG. 5, it is preferable that a first pivot motion from FIG. 4A to FIG. 4C is executed from the position of 0 degree to a position near 140 degrees. And it is preferable that the subsequent pivot motions repeating from FIG. 4C to FIG. 4F is executed from a position of about 140 degrees to a position of about 30 degrees. Hence, at first pivot motion, laundry 20 stopping still in a lower range of rotary drum 4 as shown in FIG. 4A is lifted to a position near 120 degrees, and is braked in a position from 120 degrees to 140 degrees. As a result, laundry 20 is dropped to the right or left opposite side of rotary drum 4, specifically nearly on the diameter or lower position of rotary drum 4. In the subsequent pivot motions, rotary drum 4 is driven in a range of 110 degrees from a position near 140 degrees to a position near 30 degrees. That is, laundries 20 are moved while shifted to either right or left side of rotary drum 4. More specifically, laundry 20 dropped by nearly 30 degrees from the lower end of rotary drum 4 is lifted to an upper position at the same side of rotary drum 4, specifically to a position of nearly 120 degrees, and is dropped to a position of nearly 30 degrees at the opposite right or left side of rotary drum 4. Such behavior is performed nearly symmetrically to right and left, and is achieved securely by achieving the maximum dropping distance equal to the diameter of rotary drum 4. Thus, the sleaving effect and the beating effect of laundries 20 are enhanced.

[0045] That is, it is preferable that controller 9 controls a first pivot motion of rotary drum 4 in normal and reverse pivot drive mode from the position of 0 degree to a position of over 120 degrees and less than 180 degrees. The subsequent pivot motions are preferred to be controlled from the end position of first pivot to a position inverted by 110 degrees from the end position of first pivot. According to the control, laundry 20 stopping still in a lower range of rotary drum 4 in first pivot can be lifted to an upper position of the first pivot side. Hence, laundry 20 can be dropped to right or left opposite side of rotary drum 4. In the subsequent pivot motions, laundry 20 shifted and dropped to right or left side of rotary drum 4 can be lifted to an upper position of same side of rotary drum 4, and can be dropped to opposite right or left side of rotary drum 4.

[0046] In order to move laundries 20 in good balance at right and left side in this manner, it is preferable to stop or invert for inverting the rotating direction of rotary drum 4 until laundry 20 sticking to the inner circumference of rotary drum 4 is dropped. As a result, the dropping position of laundry 20 is shifted from the lifting side of pivoting direction to right or left opposite side, and lifting by inverted pivot can be realized. Accordingly, the lifting position and dropping position of laundry 20 can be alternately exchanged right and left every time by pivot drive in a sufficiently balanced state. As a result, the sleaving action on laundries 20 is enhanced, and the mechanical force is more efficiently applied to laundry 20. Meanwhile, it is preferable that laundry 20 is peeled off instantly from the lifting position thereof. For this purpose, braking is indispensable, and such braking is realized by mechanical braking and electrical braking. There are various electrical braking, and the electrical braking is noted for its merit of maintenance-free operation without requiring complicated mechanism.

[0047] If the maximum rotating speed of pivot in normal and reverse pivot drive mode is less than 40 rpm, the rotational inertia acting on laundry 20 by braking of rotary drum 4 is too weak to peel off laundry 20 from the inner circumference of rotary drum 4. That is, when rotary drum 4 is rotated in reverse direction, laundry 20 remains stuck to the inner circumference of rotary drum 4, and rotates together with rotary drum 4. Hence washing by beating effect is not obtained.

[0048] If the rotating angle of rotary drum 4 in pivot in normal and reverse pivot drive mode is smaller than 60 degrees, laundry 20 cannot be lifted higher than the position of 90 degrees. If the rotating angle of rotary drum 4 is more than 150 degrees, laundry 20 surpasses the position of 180 degrees (highest position) when rotary drum 4 is rotated in reverse direction. Accordingly, laundry 20 is not alternately exchanged right and left as shown in FIG. 4G.

[0049] To realize such normal and reverse pivot drive mode of rotary drum 4, meanwhile, an extremely large driving load is applied to motor 5. Accordingly, the number of poles of motor 5 is required to be increased, and the size will increase. In the present embodiment, however, as shown in FIG. 1, FIG. 3, inner rotor 51 is disposed at the inner side and outer rotor 52 is disposed at outer side of stator 5A fixed to the outer side of the bottom of washing tub 2. Inner rotor 51 and outer rotor 52 are directly coupled to rotation shaft 4A. Thus, inner rotor 51 and outer rotor 52 mutually act on stator 5A from inner and outer circumferences. Hence, the driving power can be multiplied without increasing the size of motor 5, and motor 5 with a small size can easily execute normal and reverse pivot drive mode accompany by sudden inverting.

[0050] Thus, the normal and reverse pivot drive mode accompany by sudden inverting having right and left well-balanced rotation characteristic as shown in FIG. 5 can be executed perpetually. That is, in both normal pivot and reverse pivot of rotary drum 4, laundry 20 can be dropped nearly at the same position at nearly 30 degrees of the opposite side of the rotating direction. Further, by pivot from the dropping point to a position of same rotating angle of 60 degrees, laundry 20 reaches the sticking region, laundry 20 is then peeled off from rotary drum 4 by sudden braking at rotating angle of nearly 30 degrees.

During the braking motion, rotary drum 4 further pivots by 20 degrees. The required time from peeling position at point 24 till peeling position at point 26 is about 0.8 second, and the required time from dropping position at point 25 till dropping position at point 23 is about 0.8 second, so that the both are equal.

[0051] In a general washing machine, at the washing step and the rising step, a continuous rotation drive mode, or a normal and reverse rotation drive mode is executed. In the normal and reverse rotation drive mode, laundry 20 lifted by rotation of rotary drum 4 is dropped from a height where the own weight exceeds, and at the rotating speed showing such behavior, continuous rotation of rotary drum 4 is alternately repeated in normal and reverse directions. It is preferable that part or whole of such continuous rotation drive mode, or part or whole of normal and reverse rotation drive mode is replaced by the normal and reverse pivot drive mode mentioned above. As a result, lifting and dropping behaviors of laundry 20 are alternately repeated in normal and reverse direction, and mechanical actions are applied to laundry 20, and the sleaving action and the beating action of laundry 20 can be enhanced.

[0052] As a result, the washing time can be shortened, and the twisting or entangling conventionally shown after dewatering step is remarkably decreased in laundry 20. The user can take out laundry 20 easily, and handling after washing is easy. The finished state is clean with little crease, and the straightening labor is saved.

[0053] When normal and reverse pivot drive mode is executed after the dewatering step, the beating action works as a straightening action, and little-creased and well-finished state is obtained. In addition, laundry 20 hardly sticks to the inner circumference of rotary drum 4 in dewatering process, and laundry 20 is soft and airy as shown in FIG. 6A, FIG. 6B. Accordingly, the user can easily take out laundry 20 from rotary drum 4. The subsequent process is easy and it does not take time and labor in straightening. When normal and reverse pivot drive mode is executed in drying step after dewatering, the straightening effect by beating action is further improved.

[0054] Although the driving load is high in normal and reverse pivot drive mode, the mechanical load is reduced by the portion of execution of normal and reverse continuous pivot drive mode instead of this mode. Therefore, at the washing step and the rinsing step in which the driving load is heavy due to water contained in laundry 20, the use of both modes is particularly effective. By both modes, two different behaviors are applied to laundry 20 in the process of washing and rinsing. More specifically, a firm hand-washing behavior is applied by normal and reverse pivot drive mode, and continuous and uniform washing behavior is applied to the laundries by normal and reverse continuous pivot drive mode.

[0055] It is not economical to increase the power of motor 5 excessively. Therefore, if motor 5 goes into the detuning limit thereof when driving motor 5 according to first motor drive instruction for driving rotary drum 4, it is preferable that controller 9 controls the rotation of motor 5 by second motor drive instruction. In the second motor drive instruction, the rotating speed is determined so as not to exceed the upper limit load of motor 5. By this control, if the driving load varies from time to time, the rotation characteristic of rotary drum 4 is guaranteed so as to apply behavior of lifting and peeling to laundry 20 according to the setting. At the same time, the upper limit of power increase is suppressed. For this purpose, the rotating speed of rotary drum 4 may be monitored, and controlled by feedback, for example.

[0056] Meanwhile, it is preferable to vary driving of rotary drum 4 depending on the lapse of time or weight of laundry 20. According to the change, rotary drum 4 is driven in a state optimum for laundry 20 depending on the change of washing condition along with progress of washing, or difference in driving load depending on the amount of laundry 20. The amount of laundry 20 may be measured by any known detecting method.

INDUSTRIAL APPLICABILITY

[0057] In the drum type washing machine of the present invention, the washing effect can be enhanced while suppressing twisting or entangling of the laundries by controlling the rotation of the rotary drum installed in horizontal direction or inclined state. Further, creasing of the laundry can be prevented.

Claims

1. A drum type washing machine comprising:

a washing tub,
a rotary drum for containing a laundry in an inside thereof, the rotary drum being formed in a cylindrical shape having a bottom, being installed in the washing tub so that the direction of a rotation shaft thereof is set to be horizontal or inclined downward from the horizontal direction from a opened front side to a back side at the bottom,
a motor configured to drive the rotary drum, and a controller configured to control at least the motor, and execute at least a washing step and a rinsing step,
wherein the controller controls a series of operation in a normal and reverse pivot drive mode as follows:
the motor is driven at a change rate so that the laundry is stuck to an inner circumference of the rotary drum by a centrifugal force, and the laundry is lifted from a lowest position of the rotary drum, at the position of 0 degree, to a position of less than 180 degrees by surpassing a position of 90 degrees, and the motor is braked at a

change rate so that the laundry is peeled off from the inner circumference of the rotary drum, and is dropped to a side opposite a lifting side in the rotary drum,
and the controller executes the normal and reverse pivot drive mode by repeating normal and reverse rotation alternately, at least in part of at least one of the washing step and the rinsing step.

2. The drum type washing machine according to claim 1, wherein the controller specifies a maximum rotating speed of the rotary drum at 40 rpm or higher in normal and reverse pivots in the normal and reverse pivot drive mode.

3. The drum type washing machine according to claim 1, wherein the controller drives the motor by a second motor drive instruction in which a rotation speed of the motor is an upper limit load of the motor or lower if a first motor drive instruction exceeds a detuning limit of the motor.

4. The drum type washing machine according to claim 1, wherein the controller stops the motor or inverts the motor for changing normal and reverse rotating directions of the rotary drum until the laundry sticking to the inner circumference of the rotary drum is dropped off.

5. The drum type washing machine according to claim 1, wherein the controller pivots the rotary drum via the motor in a first time from the position of 0 degree to a position of 120 degrees or more and less than 180 degrees in a first pivot of the normal and reverse pivot drive mode, and pivots the rotary drum from an end position of the first pivot to a position inverted by 120 degrees in subsequent pivot motions.

FIG. 1

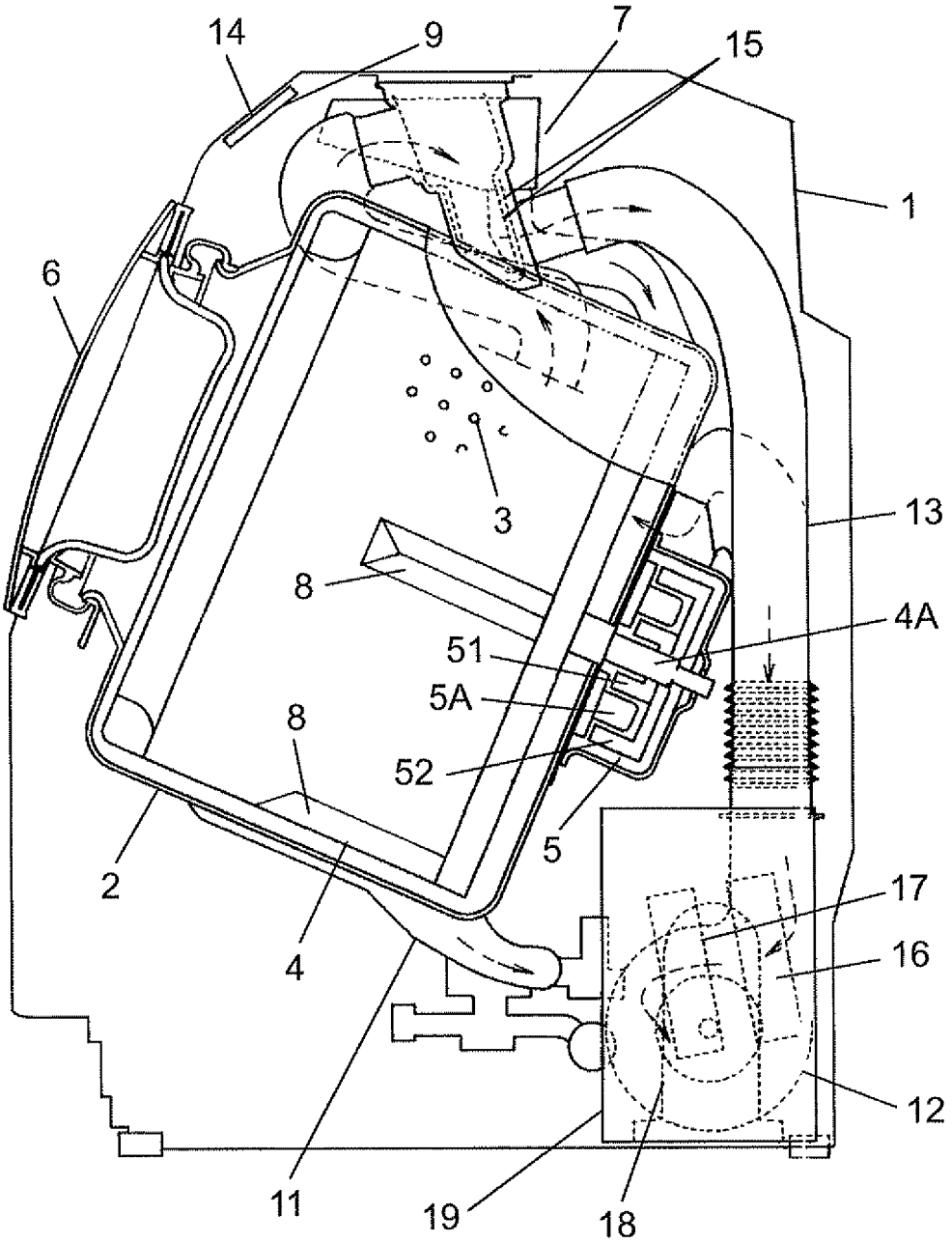


FIG. 2

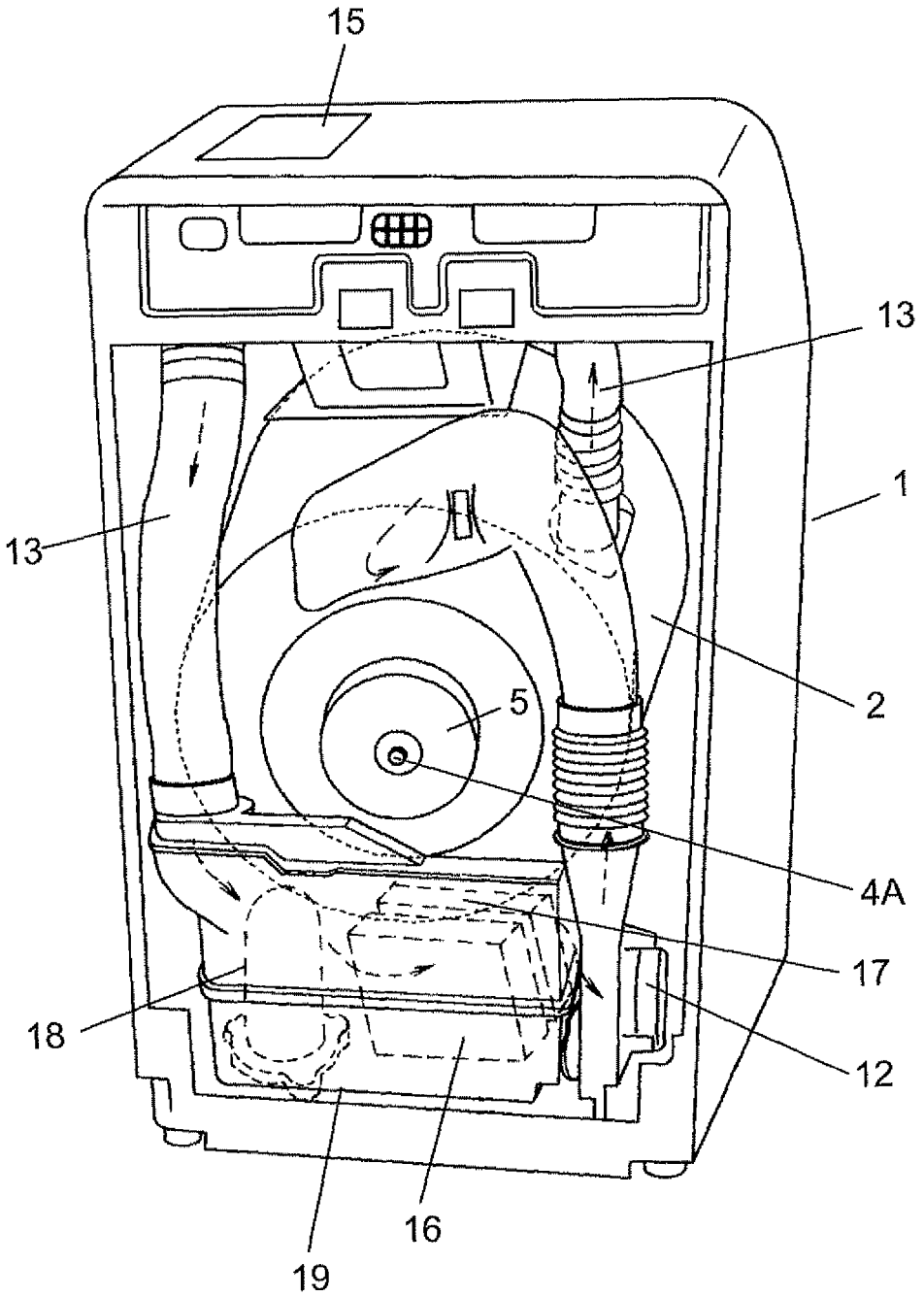


FIG. 3

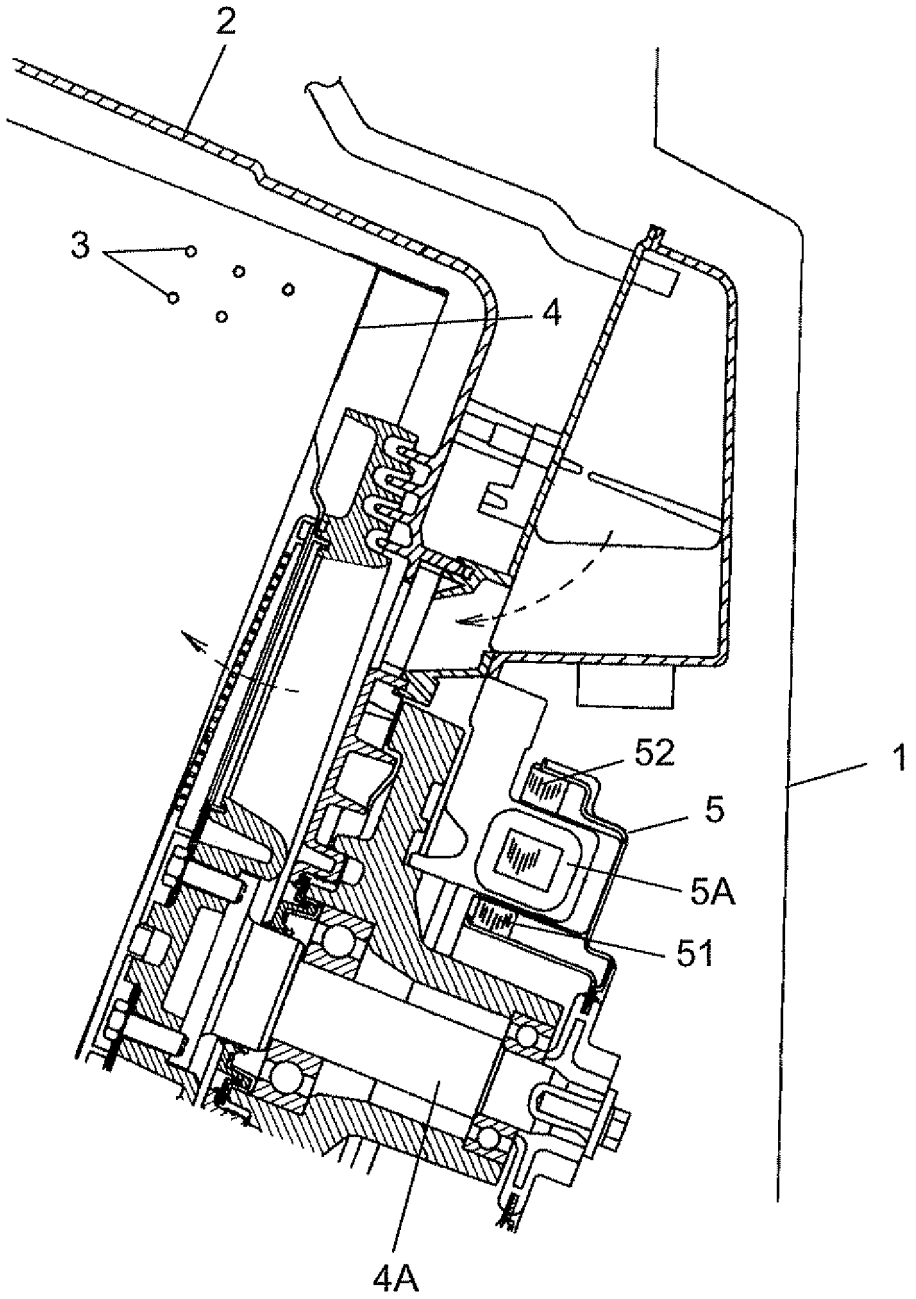


FIG. 4A

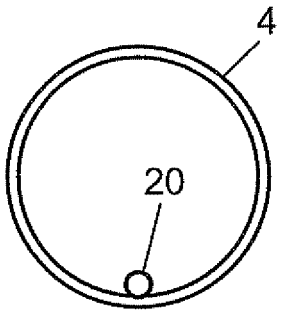


FIG. 4B

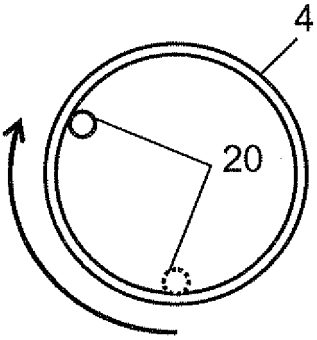


FIG. 4C

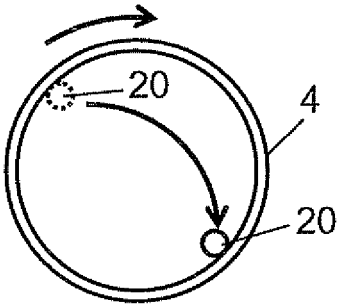


FIG. 4D

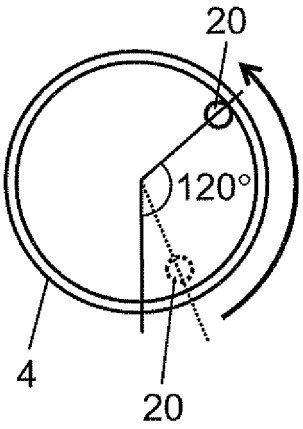


FIG. 4E

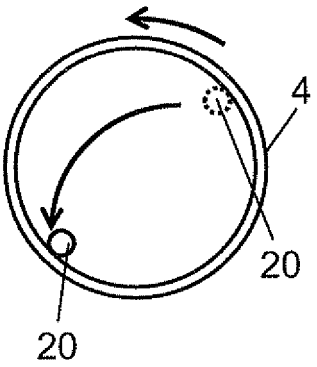


FIG. 4F

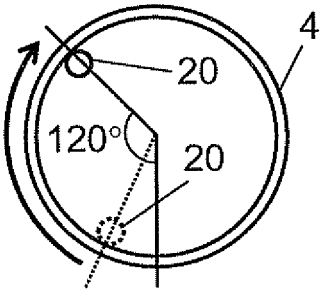


FIG. 4G

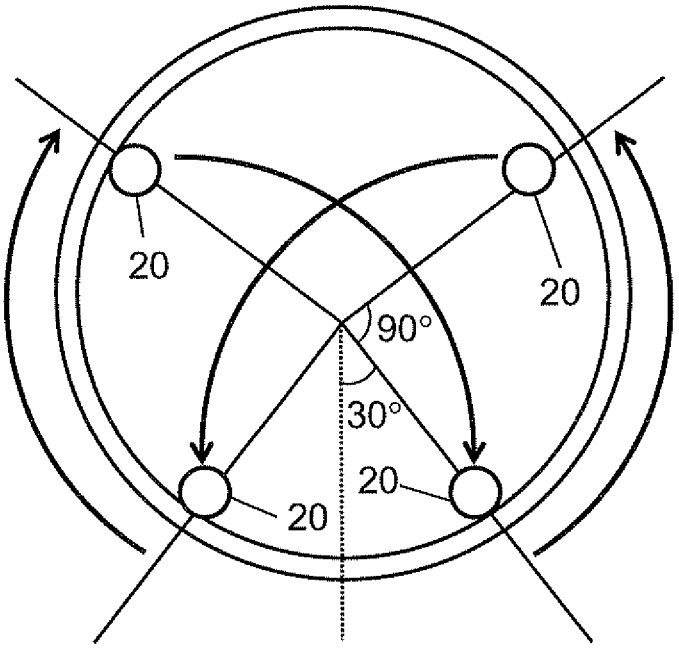


FIG. 5

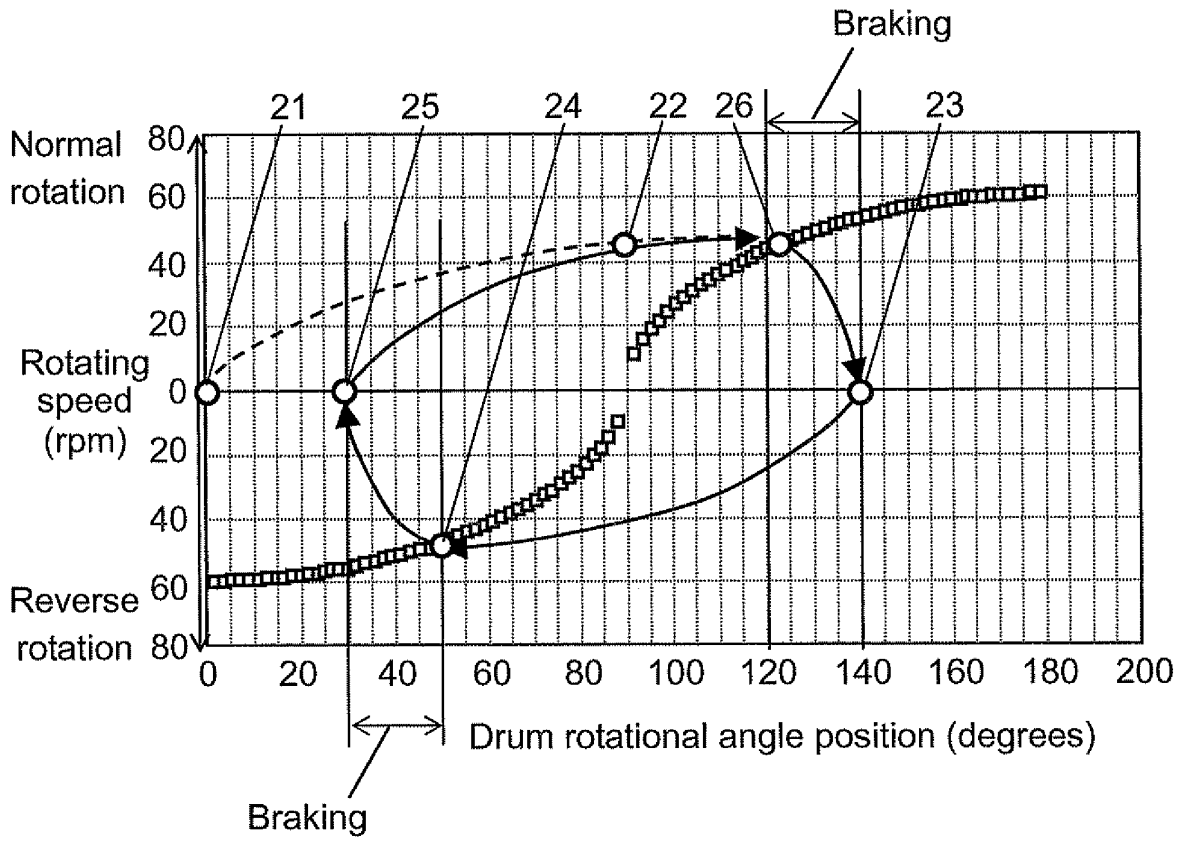

Braking
21
25
24
22
26
23
Normal rotation
80
60
40
20
Rotating speed (rpm)
0
20
40
60
Reverse rotation
80
0
20
40
60
80
100
120
140
160
180
200
Drum rotational angle position (degrees)
Braking

FIG. 6A

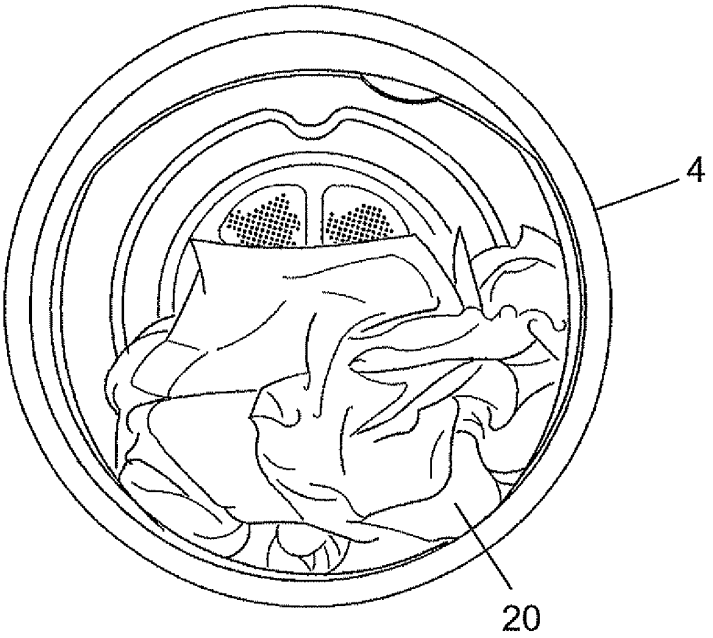


FIG. 6B

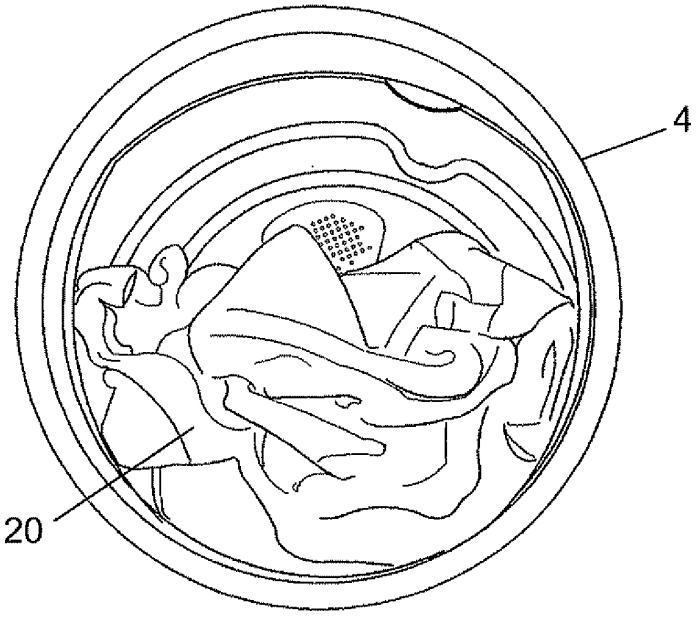


FIG. 7

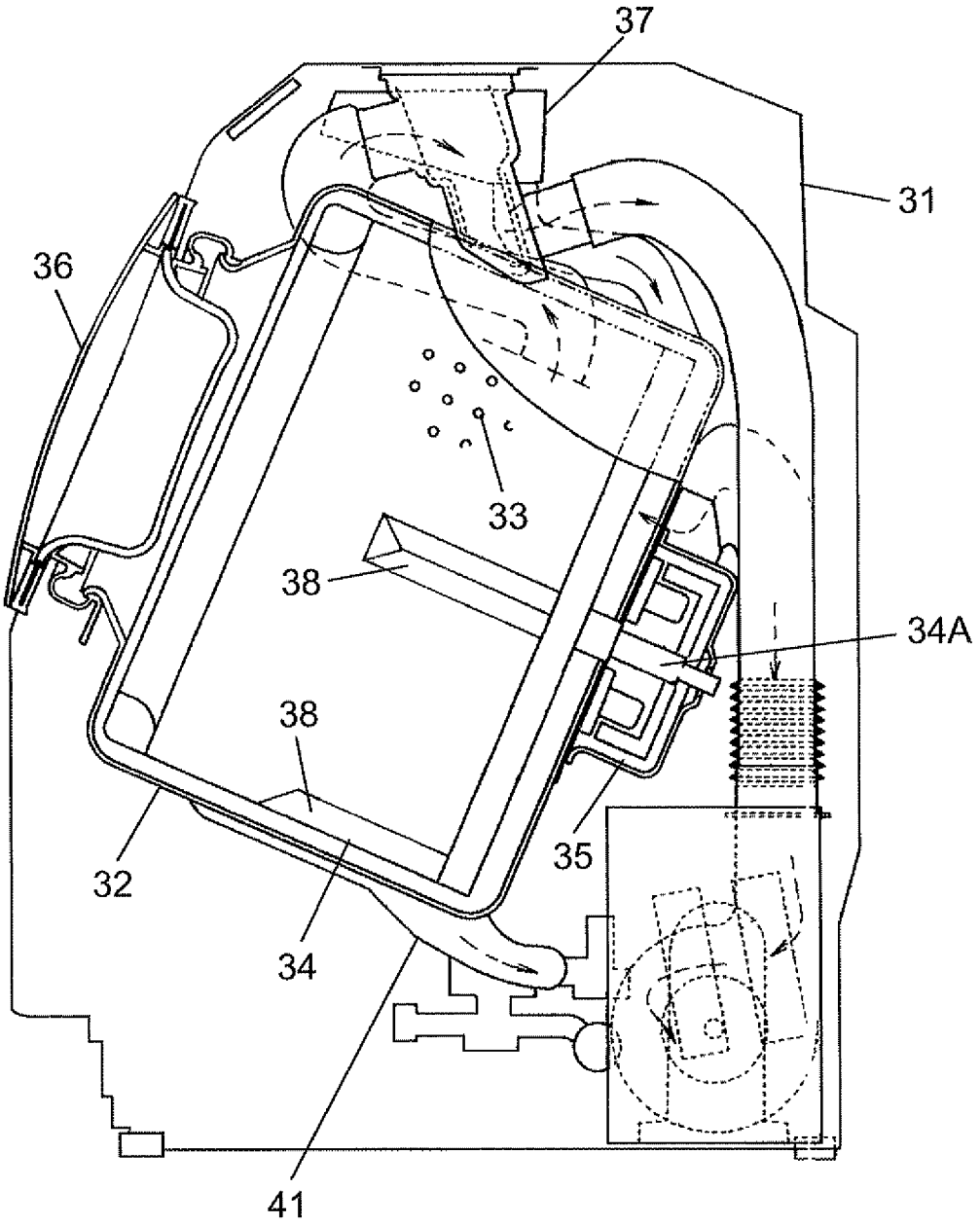


FIG. 8A

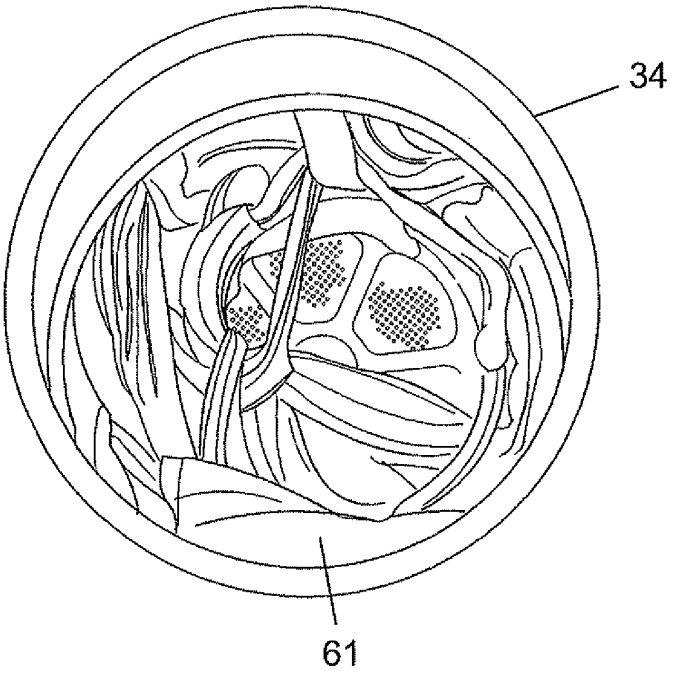
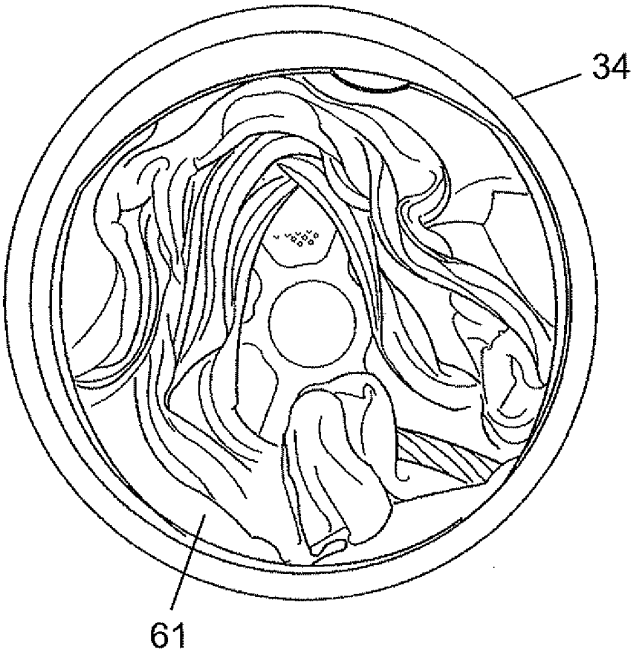


FIG. 8B



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/072889

A. CLASSIFICATION OF SUBJECT MATTER
D06F33/02(2006.01)i, *D06F37/04*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
D06F33/02, D06F37/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2007
Kokai Jitsuyo Shinan Koho	1971-2007	Toroku Jitsuyo Shinan Koho	1994-2007

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2005-124764 A (Matsushita Electric Industrial Co., Ltd.), 19 May, 2005 (19.05.05), Par. Nos. [0017] to [0043]; Figs. 1 to 7 & EP 1526209 A2 Par. Nos. [0018] to [0046]; Figs. 1 to 7	1-5
A	JP 54-58962 A (Tosen Machinery Corp.), 12 May, 1979 (12.05.79), Page 1, lower right column, line 16 to page 2, lower left column, line 5; Figs. 1 to 3 (Family: none)	1-5

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search 18 December, 2007 (18.12.07)	Date of mailing of the international search report 25 December, 2007 (25.12.07)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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Patent documents cited in the description

- JP 2005124764 B **[0009]**