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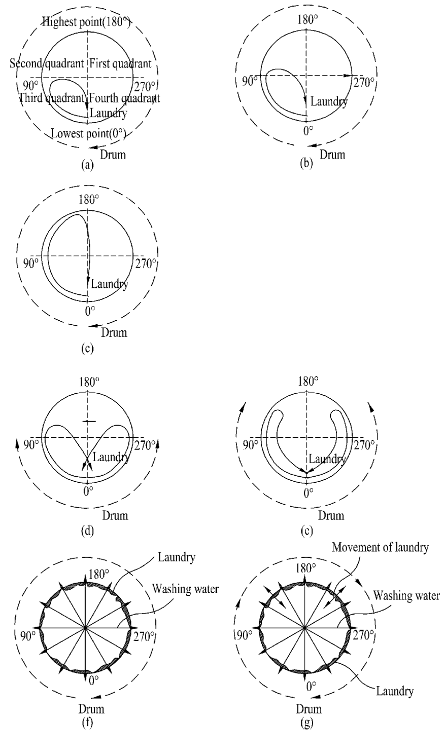
(54) CONTROLLING METHOD OF WASHING MACHINE

(57) The present invention relates to a method for controlling a washing machine which is provided with a drum motion for rotating a drum having laundry introduced thereto in a preset direction by using a motor. The method includes the steps of an observing motion performed before the drum motion is preformed, and an acceleration motion performed in succession to the observing motion.

[Fig.2]



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Description

[TECHNICAL FIELD]

[0001] The present invention relates to a method for controlling a washing machine having a drum for holding laundry and a motor for rotating the drum.

[BACKGROUND ART]

[0002] In general, the washing machine is a domestic appliance for removing dirt from laundry by actions of water and detergent.

[0003] There are agitator type, pulsator type, and drum type washing machines.

[0004] The agitator type washing machine has a washing pole upright at a center of a washing tub to be rotate in left/right directions for washing, the pulsator type washing machine has a disc like pulsator on a bottom of the washing tub to be rotated in left/right directions for washing by using friction between a water flow and laundry, and the drum type washing machine has a drum to be rotated for washing, with water, detergent and laundry placed in the drum.

[0005] The drum type washing machine is provided with a tub mounted in a cabinet which forms an exterior of the washing machine for holding washing water, a drum in the tub for holding the laundry, and a motor and a shaft on a rear of the tub for rotating the drum.

[0006] The drum type washing machine removes dirt from the laundry by friction between the washing water in the tub and the laundry in the drum, and a chemical reaction of the detergent in the washing water. Therefore, in the drum type washing machine, a rotation direction and speed of the drum has a close relation with a washing performance of the washing machine not inferior to the chemical reaction of the detergent.

[0007] In the meantime, a related art drum type washing machine performs a drum motion in which the drum is rotated in a preset direction in washing, wherein the related art drum type washing machine has a problem of a current peak in that intensity of a current to the motor increases sharply at an initial stage of the drum motion.

[DISCLOSURE OF INVENTION]

[TECHNICAL PROBLEM]

[0008] To solve the problems, an object of the present invention is to provide a method for controlling a washing machine which can prevent a current peak from taking place, in which intensity of a current to the motor increases sharply at the time a drum having laundry introduced thereto is rotated.

[TECHNICAL SOLUTION]

[0009] To achieve these objects and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, a method for controlling a washing machine which is provided with a drum motion for rotating a drum having laundry introduced thereto in a preset direction by using a motor, includes the steps of an observing motion in which the drum in a stationary state is rotated up to a preset observing reference angle in a direction opposite to a direction set in the drum motion before the drum motion is preformed, and an acceleration motion in which the drum is rotated up to a preset acceleration reference angle in a direction the same with the direction set in the drum motion in succession to the observing motion.

[0010] In this case, the observing reference angle is 15 - 45 degrees in a rotation direction of the observing motion with reference to a lowest point of the drum.

[0011] And, the step of observing motion includes the step of measuring a maximum intensity of a current supplied to the motor during the motor rotates the drum from the stationary state up to the observing reference angle.

[0012] And, the step of acceleration motion includes the step of supplying a current with intensity the same with the maximum intensity of the current measured in the observing motion to the motor for rotating the drum.

[0013] In the meantime, the method further includes a step of an inertia motion in which the supply of the current is cut off so that the drum rotates by inertia if the drum rotates to the observing reference angle.

[0014] In this case, the step of inertia motion is performed until the drum stops after the current supply to the motor is cut off.

[0015] And, the acceleration reference angle is the same with a rotation angle formed by the lowest point of the drum and an end point of the inertia motion in a rotation direction of the acceleration motion with reference to the lowest point of the drum.

[0016] In the meantime, the method further includes a step of shifting motion for shifting an intensity of the current being supplied to the motor after finish of the acceleration motion.

[0017] In this case, the step of shifting motion includes the step of shifting the intensity of the current being supplied to the motor from the intensity of the current being supplied in the acceleration motion to the intensity of the current for sustaining a rotation speed set in the drum motion.

[0018] And, the drum motion is performed in succession to the shifting motion, and the drum motion is a reversing-phase braking after rotating the drum to a preset motion angle at a speed at which the laundry does not move away from an inside circumferential surface of the drum.

[0019] In this case, the motion angle is 180 degrees in a rotation direction of the drum.

[0020] And, the motion angle is an angle between 90 - 180 degrees in a rotation direction of the drum.

[0021] And, the drum motion is performed in succession to the shifting motion, and the drum motion is a rheostatic braking after rotating the drum up to the preset motion angle.

[ADVANTAGEOUS EFFECTS]

[0022] The present invention has following advantageous effect.

[0023] A current peak can be prevented, in which a current being supplied to the motor increases sharply at the time the drum having laundry introduced thereto is rotated.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0024] The accompanying drawings, which are included to provide further understanding of the disclosure and are incorporated in and constitute a part of this application, illustrate embodiments of the disclosure and together with the description serve to explain the principle of the disclosure.

[0025] In the drawings:

FIG. 1 illustrates an exploded perspective view of a washing machine.

FIGS. 2A - 2G illustrate schematic views of drum motions, respectively.

FIGS. 3A - 3D illustrate schematic views of detail of a step motion.

FIGS. 4A - 4F illustrate schematic views of detail of a scrub motion.

FIGS. 5A - 5E illustrate conceptual views of a precedence motion performed before a drum motion for preventing a current peak from taking place.

FIGS. 6A and 6B illustrate graphs showing trends of a performing current of an observing motion and a sustaining current of a drum motion versus a laundry amount, respectively.

FIGS. 7A and 7B illustrate graphs for comparing a drum motion without a precedence motion and a drum motion with a precedence motion.

FIG. 8 illustrates a flow chart showing the steps of a method for controlling a washing machine in accordance with a preferred embodiment of the present invention.

[BEST MODE]

[0026] Reference will now be made in detail to the specific embodiments of the present invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

[0027] As far as there is no particular definition, all terms in the specification is the same with a general meaning of the term understood by persons skilled in this field of art, and, if the term used in the specification conflicts with the general meaning of the term, the meaning of the term used in the specification prevails.

[0028] In the meantime, a configuration or a control method of a device described hereinafter is provided only for describing embodiments of the present invention, but not for limiting scope of patent rights of the present invention.

[0029] FIG. 1 illustrates an exploded perspective view of a washing machine.

[0030] Referring to FIG. 1, the washing machine includes a cabinet 110 which forms an exterior of the washing machine, a tub 120 in the cabinet supported by the cabinet, a drum 130 rotatably mounted in the tub for introduction of laundry thereto, a motor 140 for rotating the drum by applying a torque to the drum, and a control panel 115 for enabling the user to select and put into operation of a washing course.

[0031] The cabinet 110 has a body 111, a cover 112 coupled to a front of the body, and a top plate 116 coupled to a top side of the body. The cover 112 may include an opening 114 for in/out of laundry, and a door 113 for selective opening/closing of the opening.

[0032] The drum 130 forms a space therein for washing the laundry introduced thereto. The drum 130 rotates as power of the motor 140 is provided thereto. Since the drum 130 has a plurality of pass through holes 131, the washing water in the tub 120 can flow into the drum 130 through the pass through holes 131, and the washing water in the drum can flow into the tub through the pass through holes 131. Therefore, if the drum rotates, the laundry in the drum has dirt removed therefrom in a process the laundry makes friction with the washing water in the tub.

[0033] The control panel 115 enables the user, not only to input information on washing, but also to notice information on washing. That is, the control panel 115 is provided for user interface.

[0034] Therefore, the control panel 115 includes an operation unit 117 and 118 for user's control order input, and a display unit 119 for displaying control information of the control order. The control panel 115 may include a control unit for controlling operation of the washing machine including operation of the motor according to the control order.

[0035] According to a method for controlling a washing machine of the present invention, the drum can be controlled to have various modes of driving motion. That is, the method for controlling a washing machine of the present invention may include, not only a tumbling motion and a spinning motion, but also drum motions different from above motions. The tumbling motion is a driving motion of the drum in which laundry is lifted and dropped in washing or rinsing of the laundry, and the spinning motion is a drum motion in which the laundry is kept rotating in a state the laundry is stuck to an inside of the drum in spinning.

[0036] The 'drum motion' is a rotation pattern of the drum in which rotation direction and speed of the drum are controlled to set movement of the laundry in the drum.

Therefore, if the washing machine has various drum motions, enabling to move the laundry in the drum in a variety of way during washing, an effect of washability improvement can be provided.

[0037] Various drum motions applicable to the embodiments of the present invention will be described in detail.

[0038] FIGS. 2A - 2G illustrate schematic views showing various drum motions, respectively.

[0039] As described before, the drum motion is a drum driving method for setting movement of laundry in the drum with a combination of the rotation direction and speed of the drum. The drum motion is produced by controlling the motor, and the movement of the laundry in the drum is determined by the drum motion.

[0040] Since the laundry is lifted and dropped by the lifts 135 on the inside circumferential surface of the drum at the time the drum rotates, if the rotation direction and speed of the drum are controlled, physical forces to be applied to the laundry can be varied. According to this, a friction force (friction between the laundries, friction between laundry and wash water) or an extent of pounding (shock power) the laundry for washing can be varied, and an extent of disentangling, dispersion or turning upside down of the laundry in the drum can be varied.

[0041] Accordingly, since the washing machine provided with the various drum motions can vary the drum motion according to kinds of the laundry, an extent of contamination of the laundry, respective courses, and detailed steps of the respective courses, the washing machine can maximize washability and can solve problems, such as delay of a washing time period and so on, taking place in a case the washing is made with a consistent drum motion.

[0042] In the meantime, in order to produce the various drum motions, it is preferable that the motor 140 is a direct drive motor. That is, a configuration of the motor is preferable in which a stator of the motor is fixedly secured to a rear of the tub 120, and a rotor of the motor is connected to the drum such that the motor rotates the drum 130, directly. This is because the direct drive motor facilitates to control the rotation direction and torque of the motor promptly. Therefore, the drum motion can be controlled without a time lag or a backlash.

[0043] However, if the washing machine is one that produces only a drum motion (for an example, the tumbling motion or the spinning motion) which does not matter the time lag or the back lash, the washing machine may have a configuration in which a torque from the motor is transmitted to the drum through a pulley and a belt. However, a power transmission structure in which the torque is transmitted from the motor to the drum through the pulley and the belt is liable to cause the time lag or the backlash, if the washing machine is one that is provided with a drum motion which requires an prompt action of the drum, a power transmission structure is preferable, in which rotation force is transmitted to the drum through a direct drive motor.

[0044] FIG. 2A illustrates a schematic view of a rolling motion. The rolling motion is a drum motion in which the motor 140 rotates the drum 130 in one direction and makes the laundry on the inside circumferential surface of the drum to drop from a position below about 90 degrees (a motion angle of below about 90 degrees) in the rotation direction of the drum to a direction of a lowest point of the drum.

[0045] That is, if the motor 140 rotates the drum at about 40RPM, the laundry at the lowest point of the drum 130 rises to a height in the rotation direction of the drum 130 and drops to the lowest point of the drum from a position below about 90degrees from the lowest point of the drum in the rotation direction as if the laundry rolls. It appears that the laundry keeps rolling at a third quadrant of the drum when the drum rotates in a clockwise direction.

[0046] The laundry is washed by friction with the washing water, friction between the laundry, and friction with the inside circumferential surface of the drum caused by the rolling motion. The motion causes an adequate turning upside down of the laundry enabling to provide an effect of softly rubbing the laundry.

[0047] Therefore, the RPM of the drum is determined such that the rolling motion generates the friction force and the centrifugal force which is weaker than gravity 1G.

[0048] However, it is preferable that the RPM (Revolution Per Minute) of the drum is determined in relation to a radius of the drum. That is, since the greater the RPM of the drum, the stronger the centrifugal force on the laundry in the drum, and a difference between the centrifugal force and the gravity makes movement of the laundry different. Moreover, taking the rotation force of the drum and the friction between the drum and the laundry into account, the RPM of the drum may also be determined.

[0049] FIG. 2B illustrates a schematic view of the tumbling motion.

[0050] The tumbling motion is a drum motion in which the motor 140 rotates the drum 130 in one direction and makes the laundry on the inside circumferential surface of the drum to drop from a position of about 90 - 110 degrees in the rotation direction of the drum to a direction of the lowest point. The tumbling motion is a drum motion generally used in washing and rinsing since the tumbling motion generates mechanical force (friction force between the laundries etc.) only when the drum is controlled to rotate in one direction at a proper RPM.

[0051] That is, the laundry introduced to the drum 130 is positioned at the lowest point of the drum 130 before the motor 140 is driven. When the motor 140 provides a torque to the drum 130, the drum 130 rotates, making the lifts 135 on the inside circumferential surface of the drum to lift the laundry from the lowest point of the drum to a height of the drum. If the motor 140 rotates the drum 130 at about 46RPM, the laundry drops from a position of about 90 - 110 degrees (a motion angle is about 90 - 110 degrees in the rotation direction of the drum) in the rotation direction to a direction of the lowest point of the drum.

[0052] In the tumbling motion, the RPM of the drum is set such that the tumbling motion generates centrifugal force stronger than the centrifugal force of the rolling motion, but weaker than the gravity.

[0053] The tumbling motion appears such that the laundry moves from the lowest point of the drum to a portion between a third quadrant and a second quadrant, moves away from the inside circumferential surface of the drum, and drops to the direction of the lowest point.

[0054] Accordingly, since the tumbling motion enables to wash the laundry by friction of the laundry with the washing water and an impact caused by dropping of the laundry, the tumbling motion can perform washing and rinsing with mechanical force stronger than the mechanical force of the rolling motion. And, since the tumbling motion is a dropping motion in which the laundry moves away from the inside of the drum in a certain extent, the tumbling motion has an effect of disentangling and separating (dispersing) the laundry.

[0055] FIG. 2C illustrates a schematic view of a step motion. The step motion is a drum motion in which the motor 140 rotates the drum 130 in one direction and makes the laundry on the inside circumferential surface of the drum to drop from a highest point (about 180 degree position) in the rotation direction of the drum to the direction of the lowest point.

[0056] If the motor 140 rotates the drum 130 over about 60RPM, the laundry can rotate without dropping down owing to the centrifugal force. The step motion is a motion in which an impulse to the laundry is maximized by rotating the drum at a speed at which the laundry does not drop from the inside circumferential surface of the drum owing to the centrifugal force, and suddenly braking the rotation of the drum.

[0057] In the step motion, the motor 140 is controlled to rotate the drum 130 at a speed (over about 60RPM) at which the laundry does not drop owing to the centrifugal force, and to supply a reverse torque to the drum 130 when the laundry is positioned in the vicinity of the highest point of the drum (A point where a rotation direction is 180 degree, and a motion angle is 180 degrees in the rotation direction of the drum).

[0058] Therefore, since the laundry rises in the rotation direction of the drum from the lowest point of the drum 130, and drops from the highest point of the drum 130 to the direction of the lowest point of the drum at the moment the drum stops by the reverse torque of the motor 140, the step motion is a motion for washing the laundry by using an impact generated when the laundry in the drum drops at a greatest head. The mechanical force generated by the step motion is stronger than the rolling motion or the tumbling motion.

[0059] The step motion appears that, when the drum rotates in a clockwise direction, the laundry moves to the highest point of the drum from the lowest point of the drum via the third quadrant and the second quadrant, and suddenly drops to the lowest point of the drum. Since the step motion has a greatest dropping distance in the drum compared to other motions, the step motion can provide an impulse to the laundry more effectively, if an amount of the laundry is small.

[0060] In the meantime, it is preferable that the motor 140 can make a reversing-phase braking (or plugging braking) for braking of the drum. The reversing-phase braking is a motor braking method in which the motor is rotated in a direction opposite to a present rotation direction of the motor for braking the motor. In order to generate the rotation force in a direction opposite to the rotation direction of the motor, a phase of the current being supplied to the motor may be inverted. The reversing-phase braking makes the sudden braking available. Therefore, the reversing-phase braking is the most appropriate braking method for the step motion that gives a strong impact to the laundry.

[0061] Then, the motor 140 applies a torque to the drum 130 again to make the laundry at the lowest point of the drum to rise to the highest point. That is, after applying a torque to make the drum 130 to rotate in the clockwise direction, a torque is applied to the drum to rotate in an anti-clockwise direction momentarily to stop the drum suddenly, and then, a torque is applied to the drum to rotate in the clockwise direction again, thereby producing the step motion.

[0062] At the end, the step motion is a drum motion in which washing of the laundry is made by friction between the washing water and the laundry in rotation of the drum, and by the impulse of dropping of the laundry when the laundry is positioned at the highest point of the drum.

[0063] FIG. 2D illustrates a schematic view of a swing motion. The swing motion is a drum motion in which the motor 140 rotates the drum 130 bidirectionally, and makes the laundry to drop in the vicinity of about 90 degree (A motion angle of about 90 degrees in the rotation direction of the drum) in the rotation direction of the drum.

[0064] That is, if the motor 140 rotates the drum 130 in the anti-clockwise direction at about 40RPM, the laundry at the lowest point of the drum rises to the direction of the anti-clockwise direction. In this instance, the motor stops the rotation of the drum before the laundry reaches to a 90 degree point, such that the laundry drops to the direction of the lowest point of the drum from in the vicinity of 90 degrees in the anti-clockwise direction.

[0065] Then, the motor 140 rotates the drum 130 in a clockwise direction at about 40RPM, making the laundry dropping thus to rise to a height in the rotation direction of the drum. In the meantime, the motor 140 stops rotation of the drum before the laundry reaches to a 90 degree position of the drum in the clockwise direction, such that the laundry drops to the direction of the lowest point of the drum from in the vicinity of 90 degrees of the drum in the clockwise direction.

[0066] That is, the swing motion is a motion in which one direction rotation and stop of the drum and the other direction rotation and stop of the drum are repeated, to appear such the laundry repeats a motion in which the laundry rises from the third quadrant to a portion of the second quadrant of the drum and drops therefrom softly, and then, the laundry rises from the fourth quadrant to a portion of the first quadrant of the drum and drops therefrom softly.

[0067] In this instance, rheostatic braking is used for braking the motor 140 for minimizing a load on, and mechanical wear of, the motor 140, and controlling an impact being applied to the laundry.

[0068] The rheostatic braking is a braking method which uses a generator like action of the motor owing to rotation inertia thereof when a current to the motor is turned off. If the current to the motor is turned off, since a direction of the current to the coil of the motor becomes opposite to a direction of the current before the power is turned off, force acts in a direction which interferes the rotation of the motor, to brake the motor. Different from the reversing-phase braking, the rheostatic braking does not make sudden braking of the motor, but makes a smooth change of the rotation direction of the drum.

[0069] Accordingly, the swing motion appears that the laundry makes a motion which looks like a laid down character 8 over the third quadrant and the fourth quadrant of the drum.

[0070] FIG. 2E illustrates a schematic view of a scrub motion. The scrub motion is a drum motion in which the motor 140 rotates the drum 130 bidirectionally, and makes the laundry to drop from beyond about 90 degrees in the rotation direction of the drum (The laundry drops from a position of a motion angle greater than 90 degrees in the rotation direction of the drum).

[0071] That is, if the motor 140 rotates the drum 130 in the anti-clockwise direction over about 60RPM, the laundry rises from the lowest point of the drum 130 to a height in the anti-clockwise direction. In this instance, the motor provides a reverse torque to the drum after the laundry passes about a 90 degree position in the anti-clockwise direction of the drum, to stop rotation of the drum momentarily. Then, the laundry is separated or dropped from the inside circumferential surface of the drum, suddenly.

[0072] Then, the motor 140 rotates the drum at about 60RPM in the clockwise direction so as to raise the laundry to a height in the clockwise direction and to scrub the laundry by the inside circumference of the drum. When the laundry passes the 90 degree point of the drum in the clockwise direction, the motor 140 provides a reverse torque to the drum 130 to stop the drum momentarily. After that, the motor rotates the drum in the anti-clockwise direction again. Accordingly, the laundry separated from the inside circumferential surface of the drum will be dropped from the inside circumference of the drum, and in the middle of the dropping the laundry will be scrubbed with the inside circumference of the drum.

[0073] The scrub motion washes the laundry by making the laundry to drop suddenly from the height. In the meantime, it is preferable that the motor 140 is braked by the reversing-phase braking.

[0074] The scrub motion enables to have a powerful rubbing effect of washing as the laundry does not move away from the inside circumferential surface of the drum substantially owing to the sudden change of the rotation direction. The scrub motion is a repetitive motion in which the laundry moves to a portion of the second quadrant via the third quadrant, drops therefrom suddenly, moves to a portion of the first quadrant via the fourth quadrant, and drops therefrom suddenly. Therefore, the scrub motion appears that the laundry moves up/down along the inside circumference of the drum, repeatedly.

[0075] FIG. 2F illustrates a schematic view of a filtration motion. The filtration motion is a drum motion in which the motor 140 rotates the drum 130 such that the laundry does not drop from the inside circumferential surface of the drum, while the washing water is sprayed to an inside of the drum.

[0076] That is, in the filtration motion, the washing water is sprayed to the inside of the drum while the laundry is spread, come into close contact with the inside circumferential surface of the drum and rotated, such that the washing water escapes from the tub 120 through the laundry and the pass through holes 131 by centrifugal force. Therefore, since the filtration motion makes the washing water to penetrate the laundry while enlarging a surface area of the laundry, an effect can be obtained, in which the washing water is supplied to the laundry, uniformly.

[0077] In the filtration motion, the washing water can be sprayed by circulating the washing water from the tub with by using a circulating water flow passage (not shown) and a pump.

[0078] FIG. 2G illustrates a schematic view of a squeeze motion. The squeeze motion is a drum motion in which the motor 140 repeats operations of rotating the drum 130 such that the laundry does not drop from inside circumferential surface of the drum, and reducing the rotation speed such that the laundry moves away from the inside circumferential surface of the drum, while the washing water is sprayed into the drum.

[0079] That is, the squeeze motion is different from the filtration motion in that, while, in the filtration motion, the laundry is rotated at a speed at which the laundry does not move away from the inside circumferential surface of the drum, in the squeeze motion, the rotation speed of the drum varies for making the laundry to repeat sticking to, and moving away from, the inside circumferential surface of the drum.

[0080] Though a process for supplying the washing water to the drum 130 during the filtration motion and the squeeze motion is not shown in FIG. 1, the process can be implemented by using the circulating water flow passage and the pump. The pump connected to a bottom surface of the tub 120 pressurize the washing water, and the circulating water flow passage may be provided to have one side connected to the pump and the other side enabled to spray the washing water to the drum from an upper side of the drum.

[0081] However, since the circulating water flow passage and the pump are provided for spraying the washing water from the tub, the spray of the washing water does not exclude a case in which the washing water is sprayed to the drum through a spray water supply flow passage connected to the water supply source outside of the cabinet.

[0082] That is, if the spray water supply flow passage has one side connected to the water supply source and the other side connected to the tub and is provided with a nozzle for spraying the washing water to the drum, the washing water can be sprayed in the filtration motion or the squeezed motion.

[0083] FIGS. 3A - 3D illustrate schematic views showing detail of the step motion. Since the drum rotates in one direction when the motor 140 applies a torque to the drum 130 in the one direction, the laundry rises in close contact with the inside circumferential surface of the drum. In this instance, it is preferable that the drum rotates over about 60RPM such that the laundry rises in close contact with the inside circumferential surface of the drum. In this instance, the rotation speed of the drum is determined in relation to an inside radius of the drum, at a speed at which the centrifugal force becomes stronger than the gravity.

[0084] In order to stop rotation of the drum momentarily just before the laundry reaches to the highest point of the drum passing through the 90degree point in the rotation direction of the drum 130, the motor 140 is subjected to a reversing-phase braking. Since a time point at which the motor 140 is subjected to a reversing-phase braking is closely related to a position of the laundry in the drum 130, it is preferable that a device for determining or predicting the position of the laundry, for an example, a sensing device having a hall effect sensor, provided to the motor for determining a rotation angle of the rotor.

[0085] By means of the hall effect sensor, the control unit can determine, not only the rotation angle of the rotor, but also a rotation direction of the rotor, and detailed description of which will be omitted since things related thereto are well known to persons skilled in this field of art.

[0086] The control unit can determine the rotation angle of the drum by means of the sensing device and can control the motor 140 to be subjected to the reversing-phase braking before the drum reaches to 180 degrees. As described before, the reversing-phase braking means application of a reverse phased current for the drum to rotate in an opposite direction. For an example, the reversing-phase braking means application of a current to the motor for the motor to rotate in the anti-clockwise direction suddenly after a current is applied to the motor to rotate in the clockwise direction.

[0087] Therefore, the drum rotating in the clockwise direction stops momentarily at an angle of 180 degrees substantially, dropping the laundry from the highest point of the inside of the drum to the direction of the lowest point of the inside of the drum. Then, the current is kept applied for the drum to keep rotating in the clockwise direction.

[0088] Though FIG. 3 illustrates a case the drum is rotated in the clockwise direction, it does not matter even if the step motion is performed during the drum is rotated in the anti-clockwise direction. However, it is preferable that, since the step motion causes a heavy load on the motor 140, it is preferable that the step motion is put into practice with a reduced net acting ratio thereof.

[0089] The net acting ratio is a ratio of a motor driving time period to a sum of the driving time period and a stationary time period. If the net acting ratio is unity, it implies that the motor is driven without pause. It is preferable that the step motion has about a net acting ratio of 70% taking the load on the motor into account, for an example, by driving the motor for 10 seconds and pause the motor for 4 seconds.

[0090] FIGS. 4A - 4F illustrate schematic views showing detail of the scrub motion. If the motor 140 applies a torque to the drum 130, the laundry in the drum rotates in the clockwise direction. It is preferable that the motor 140 is controlled to rotate the drum 130 over about 60RPM to rotate the laundry in close contact with the inside circumferential surface of the drum. Then, since the motor 140 is subjected to the reversing-phase braking when the laundry passes the 90 degree point of the drum in the rotation direction of the drum, the laundry drops to the direction of the lowest point of the drum, along the inside circumferential surface of the drum.

[0091] If the laundry drops to the lowest point of the drum, the motor 140 provides a torque which rotates the drum in the anti-clockwise direction. Therefore, the laundry dropped thus rotates in close contact with the inside circumferential surface of the drum in the anti-clockwise direction, and, since the motor is subjected to the reversing-phase braking when the laundry is positioned between the 90 degree point of the drum in the anti-clockwise direction and the highest point of the drum, the laundry in close contact with the inside circumferential surface of the drum drops to the lowest point of the drum, along the inside circumferential surface of the drum.

[0092] However, alternatively, the motor provides a torque which rotates the drum in the anti-clockwise direction immediately after the reverse-phase braking. Namely, the motor may be subjected to the reverse-phase braking when the laundry positioned between the 90 degree point of the drum in the clockwise direction and the highest point of the drum, and the motor provides a torque which rotates the drum in the anti-clockwise direction immediately after the reverse-phase braking. Therefore, the laundry separated from the inside circumferential surface of the drum drops to the direction of the lowest point of the drum along the inside circumferential surface of the drum. In the middle of the dropping, the laundry can be rubbed by the circumferential surface of the drum.

[0093] Alike the step motion, since the scrub motion also imposes a heavy load on the motor 140, it is preferable that the scrub motion is practiced with a reduced net acting ratio, for an example, after practicing the scrub motion for 10 seconds, the motor is paused for 4 seconds to operate the motor at a 70% net acting ratio.

[0094] In the meantime, the method for controlling a washing machine in accordance with a preferred embodiment of the present invention may include a precedence motion (another name, starting motion) in which the drum is rotated in a rotation direction the same with the rotation direction set in the drum motion after the drum is rotated at a predetermined angle in a rotation direction opposite to the rotation direction set in the drum motion before the drum is rotated in the set direction (the clockwise direction or the anti-clockwise direction) in respective drum motions.

[0095] In putting the drum motion into action, if the drum is rotated at a set speed (a set rpm) directly in the direction set in the drum motion, the current peak can occur, in which intensity of the current being supplied to the motor rises, sharply.

[0096] Since the laundry introduced to the drum is stationary before starting the drum motion, and a load on the motor is the greatest between the lowest point of the drum and the 90 degree point of the drum in the rotation direction when the drum is rotated, it is required to supply a high intensity of current to the motor at an initial stage of putting the drum motion into action. Particularly, if the amount of laundry is large, requiring higher intensity of the current to be supplied to the motor, a possibility that the current peak takes place is high, in which the intensity of the current to be supplied to the motor becomes high, abnormally.

[0097] Since the current peak taken place at the initial drum motion is liable to cause a problem in safety of the washing machine, the present invention suggest performing the precedence motion before putting the drum motion into action for easy implementation of the drum motion.

[0098] The precedence motion includes an observing motion in which the drum is rotated in a direction opposite to a rotation direction set in the drum motion up to a preset observing reference angle, and an acceleration motion in which the drum is rotated up to a preset acceleration reference angle in a direction the same with the rotation direction set in the drum motion.

[0099] That is, since the drum is rotated in the direction the same with the rotation direction set in the drum motion after drum is rotated in a direction opposite to a rotation direction set in the drum motion up to the preset angle, the precedence motion enables, not only to utilize potential energy of the laundry obtained during the observing motion is performed in the acceleration motion, but also prevent the current peak from taking place, which is liable to take place at the initial stage of the drum motion as the drum enters into the drum motion after passing through the acceleration motion.

[0100] In the meantime, since maximum intensity of the current supplied to the motor for rotating the drum to the observing reference angle is measured in the observing motion, and, in the acceleration motion, the drum is rotated by supplying the maximum intensity of current measured thus at the observing motion to the motor, the current supplied to the motor in the acceleration motion varies with the laundry amount. Eventually, the method for controlling a washing machine of the present invention can prevent the current peak from taking place regardless of the laundry amount (will be described in detail, later).

[0101] FIGS. 5A - 5E illustrate conceptual views of a precedence motion performed before a drum motion for preventing a current peak from taking place, and FIG. 8 illustrates a flow chart showing the steps of a method for controlling a washing machine in accordance with a preferred embodiment of the present invention.

[0102] The precedence motion will be described at first in view of the drum motion and the precedence motion will be described in view of the control method.

[0103] Basically, the precedence motion provided to the control method of the present invention includes the observing motion and the acceleration motion, and the precedence motion can further includes an inertia motion performed after finish of the observing motion, and a shifting motion performed after the acceleration motion is finished.

[0104] FIG. 5A illustrates a schematic view of a state in which the drum is stationary before the drum motion starts, and FIG. 5B illustrates a schematic view of the observing motion in which the drum is rotated up to the observing reference angle S in a case the drum motion is set in the clockwise direction.

[0105] If the rotation direction set in the drum motion is in the clockwise direction, the drum is rotated in the anti-clockwise direction in the observing motion, and if the rotation direction set in the drum motion is in the anti-clockwise direction, the drum is rotated in the clockwise direction in the observing motion. For convenience's sake, description will proceed with reference to a case in which the rotation direction set in the drum motion is the clockwise direction.

[0106] In the observing motion, the drum rotates by the preset reference angle S (the observing reference angle) in the anti-clockwise direction. The observing reference angle S can be selected from a significant section of 15 - 45 degrees at which the laundry amount can be effectively sensed through a current (an observing motion performing current) supplied to the motor for performing the observing motion, and FIG. 3B illustrates a case when an angle of 22.5 degrees is set.

[0107] For the drum to rotate up to the observing reference angle S, the control unit (not shown) of the washing machine is required to supply a current to the motor, wherein an intensity of the current supplied to the motor in a case the laundry amount is great is different from the intensity of the current supplied to the motor in a case the laundry amount is small.

[0108] Referring to FIGS. 6A and 6B, the greater the laundry amount, the higher the intensity of the current (the observing motion performing current) to be supplied in the observing motion, and the intensity of the current to be supplied to the motor for performing the drum motion (a drum motion sustaining current) is the highest in a case an amount of the laundry equal to an half of a washing capacity is introduced to the drum (an half loaded state). The intensity of the current is the highest in the half loaded state, because movement of the laundry in the drum is the greatest in a case the laundry amount is equal to the half of the washing capacity. Since the movement of the laundry in the drum taking place during the drum motion acts as a load on the motor, in order to rotate the drum in the set rotation speed, it is required to supply more current to the motor.

[0109] In the meantime, if an amount of laundry exceeding the half loaded state is introduced to the drum, reducing a space for the laundry to move in the drum, a load caused by the movement of the laundry is small. Therefore, even if a current smaller than the drum motion sustaining current required in the half loaded state is supplied to the motor, the drum can be rotated at a rotation speed set in the drum motion.

[0110] Moreover, in a case the laundry amount is less than the half loaded state, the load caused by the movement of the laundry in the drum is not great enough to increase the drum motion sustaining current since the laundry amount is comparatively small even if the movement of the laundry is violent.

[0111] In the meantime, a maximum value of the observing motion performing current supplied to the motor during performance of the observing motion is stored to storage means, such as a memory, by the control unit, for the control unit to supply a current the same with the maximum value of the observing motion performing current to the motor in the acceleration motion to be described later in detail in description of the acceleration motion.

[0112] Upon finishing the observing motion, the inertia motion is performed. The inertia motion is a motion in which, if the drum rotates to the observing reference angle, the current to the motor is cut off for the drum to perform rotation until rotation of the drum stops.

[0113] The inertia motion is provided for acceleration of the drum by utilizing potential energy of the laundry obtainable in the inertia motion for the acceleration motion performed, subsequently.

[0114] Since the drum is rotated by a torque provided thereto from the motor, even if the observing motion is finished, the drum and the laundry can rotate a certain angle by the inertia. Therefore, if the inertia motion is provided after finish of the observing motion, the potential energy of the laundry can be made greater by using the inertia of the laundry and the drum obtained in the observing motion. A position "A" of the laundry disclosed in FIG. 5C is a point at which the potential energy of the laundry will be the maximum as a result of the observing motion. Therefore, since the acceleration motion (FIG. 5D) to be performed after the inertia motion will rotate the drum in a direction the same with a rotation direction set in the drum motion by utilizing the potential energy the laundry has, an intensity of the current to be supplied to the motor in a section (between the lowest point 0 and B point in FIG. 5D) which is vulnerable to the current peak can be minimized.

[0115] In the meantime, a maximum point A of the potential energy of the laundry obtainable from the observing motion can be determined by using the sensing device, such as the hall sensor (hall effect sensor), provided to the motor.

[0116] Since supply of the current to the motor is cut off starting from a point S the observing motion is finished, the drum and the laundry will rotate a certain angle in the anti-clockwise direction by the inertia of the observing motion. However, if the drum and the laundry reach to a point A at which the potential energy of the laundry is a maximum, the drum will stop and change the rotation direction to the clockwise direction. Therefore, if the hall sensor is provided to sense a stop or a change of rotational direction, the control unit can perceive whether the laundry reaches to a point A at which the potential energy is the maximum or not such that the control unit performs the acceleration motion shown in FIG. 5D when the laundry reaches to the A point.

[0117] In the acceleration motion, the maximum intensity of the observing motion performing current (or an amplified value the maximum intensity of the observing motion performing current by a predetermined ratio) is supplied to the motor to rotate the drum up to a preset acceleration reference angle "B" in a direction the same with a rotation direction set in the drum motion.

[0118] It is preferable that the acceleration reference angle is set as an angle which enables to utilize the potential energy obtainable from the observing motion and the inertia motion to the maximum, and FIG. 5D illustrates an example of the acceleration reference angle set as two times of an angle a, the lowest point 0 of the drum and the potential energy maximum point A of the laundry form.

[0119] That is, an angle the lowest point 0 of the drum to the potential energy maximum point A of the laundry form by the inertia motion and an angle the lowest point 0 of the drum and a position B of the drum at which the acceleration motion finishes form are the same. This is for utilizing the potential energy secured by the observing motion and preventing the current peak (See FIG. 7A) from taking place, in which a current value being supplied to the motor increases sharply in a section (0-B section) at which the load on the motor becomes maximum.

[0120] As described before briefly, the current supplied to the motor in the acceleration motion has intensity the same with the maximum intensity of the observing motion performing current supplied to the motor in the observing motion.

[0121] Though the intensity of the current to be supplied to the motor varies with the rotation speed set in the drum motion, the intensity of the current to be supplied to the motor at an initial stage of the drum motion at which the drum starts to rotate from a stationary state is highly dependent on the laundry amount.

[0122] In the meantime, since the maximum intensity of the observing motion performing current is a maximum intensity of the current to be supplied to the motor for rotating the drum to the observing reference angle from a stationary state of the drum, the maximum intensity of the observing motion performing current enables to predict an initial intensity of current required for rotating the drum in a rotation direction set in the drum motion from a stationary state of the drum having the same laundry introduced thereto. Therefore, if a current the same with the maximum intensity of the observing motion performing current is supplied to the motor in the acceleration motion, a risk of causing the current peak (See FIG. 7A) can be minimized, in which an intensity of the current to be supplied to the motor increases sharply in a section (0-B section) at which the load on the motor becomes a maximum in the related art. Moreover, since the acceleration motion rotates the drum by using the potential energy obtainable from the inertia motion, enabling to reduce the load on the motor in the load maximum section (0-B section), the acceleration motion can reduce the risk of causing the current peak, further (See FIG. 7B).

[0123] Upon finishing the acceleration motion, the control method of the present invention starts the shifting motion disclosed in FIG. 5E. The shifting motion is a motion in which the intensity of the current is shifted from the intensity of the current (The maximum intensity of the observing motion performing current) supplied to the motor in the acceleration motion to the intensity of current for sustaining the rotation speed (rpm) set in the drum motion.

[0124] A starting time point of the shifting motion can be determined by monitoring a rotation angle of the drum by means of the sensing device, such as the hall sensor, and respective drum motions are performed starting from the time when the intensity of the current to be supplied to the motor is shifted by the shifting motion.

[0125] The precedence motion of the present invention will be discussed in view of control steps with reference to FIG. 8.

[0126] In the method for controlling a washing machine of the present invention, upon application of a drum motion performing signal (S10), after a precedence motion S20 including an observing motion S21, an acceleration motion S25, and a shifting motion S27 are performed, a drum motion S30 is performed.

[0127] In the observing motion S21, a current is supplied to a motor for rotating a drum in a first direction (An opposite direction of a rotation direction set in the drum motion) (S211).

[0128] After supplying a current to the motor, reach of the drum to an observing reference angle S (See FIG. 5) is determined with a sensing device like a hall sensor (S212), and, if the drum fails to reach to the observing reference angle, though the current is supplied such that the motor keeps rotation in the first direction, if it is determined that the drum reaches to the observing reference angle, the supply of current to the motor is cut off (S213).

[0129] In the meantime, in the observing motion, at the same time with cutting off of the current supply to the motor (s213), the maximum intensity of the observing motion performing current (Or an amplified intensity of the maximum intensity of the observing motion performing current or an average of the maximum intensity of the observing motion performing current) supplied for rotating the drum up to the observing reference angle is measured and stored (S214).

[0130] Then, an inertia motion is performed in which the drum and the laundry rotate by the inertia obtained from the observing motion, and, in the control method of the present invention, whether the laundry reaches to the maximum point A (See FIG. 5) by the potential energy of the inertia from the observing motion or not is sensed (S23) in the middle of performance of the inertia motion.

[0131] If the laundry reaches to the maximum point A, the control method of the present invention performs an acceleration motion S25.

[0132] In the acceleration motion S25, a current is supplied to the motor for rotating the drum in a second direction (A direction the same with the rotation direction set in the drum motion) opposite to the rotation direction of the drum at the time of the observing motion (S251), at an intensity of the current the same with the maximum intensity of the observing motion performing current.

[0133] Then, in the acceleration motion S25, whether the drum reaches to an acceleration reference angle B or not is determined (S252), and, if it is determined that the drum reaches to the acceleration reference angle, the control method of the present invention starts a shifting motion S27.

[0134] In the shifting motion, a current supplied to the motor is shifted from the maximum intensity of the observing motion performing current supplied to the motor in the acceleration motion S25 to a current required for sustaining a rotation speed (rpm) set in the drum motion, and, thereafter, the drum rotates at a speed set in the drum motion.

[0135] However, the shifting motion can be omitted depending on a laundry amount introduced to the drum. That is, depending on the laundry amount introduced to the drum, if the intensity of the current to be supplied to the motor for rotating the drum at a rotation speed set in the drum motion is the same with the intensity of the current to be supplied to the motor in the acceleration motion, the shifting motion will not be required.

[0136] In the foregoing description, even though a case is described in which the precedence motions of the present invention are performed as precedence motions of the 7 drum motions disclosed in FIG. 2, since this is an exemplary description, and the effects of the precedence motions of the present invention can be produced even if the precedence motions of the present invention are preceded when it is intended to rotate the drum in motions other than the drum motions disclosed in FIG. 2, it is not necessary to limit objects and effects of the present invention to the precedence motions that precede the drum motions disclosed in FIG. 2.

[0137] It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

Claims

1. A method for controlling a washing machine which is provided with a drum motion for rotating a drum having laundry introduced thereto in a preset direction by using a motor, comprising the steps of:

an observing motion in which the drum in a stationary state is rotated up to a preset observing reference angle in a direction opposite to a direction set in the drum motion before the drum motion is preformed; and
an acceleration motion in which the drum is rotated up to a preset acceleration reference angle in a direction the same with the direction set in the drum motion in succession to the observing motion.

2. The method as claimed in claim 1, wherein the observing reference angle is 15 - 45 degrees in a rotation direction of the observing motion with reference to a lowest point of the drum.

3. The method as claimed in claim 1, wherein the step of observing motion includes the step of measuring a maximum intensity of a current supplied to the motor during the motor rotates the drum from the stationary state up to the observing reference angle.

4. The method as claimed in claim 3, wherein the step of acceleration motion includes the step of supplying a current with intensity the same with the maximum intensity of the current measured in the observing motion to the motor for rotating the drum.

5. The method as claimed in claim 4, further comprising a step of an inertia motion in which the supply of the current is cut off so that the drum rotates by inertia when the drum rotates to the observing reference angle.

6. The method as claimed in claim 5, wherein the step of inertia motion is performed until the drum stops after the current supplied to the motor is cut off.

7. The method as claimed in claim 6, wherein the acceleration reference angle is the same with a rotation angle formed between the lowest point of the drum and an end point of the inertia motion.

8. The method as claimed in claim 5, further comprising a step of shifting motion for shifting an intensity of the current being supplied to the motor after finish of the acceleration motion.

9. The method as claimed in claim 8, wherein the step of shifting motion includes the step of shifting the intensity of the current being supplied to the motor from the intensity of the current being supplied in the acceleration motion to the intensity of the current for sustaining a rotation speed set in the drum motion.

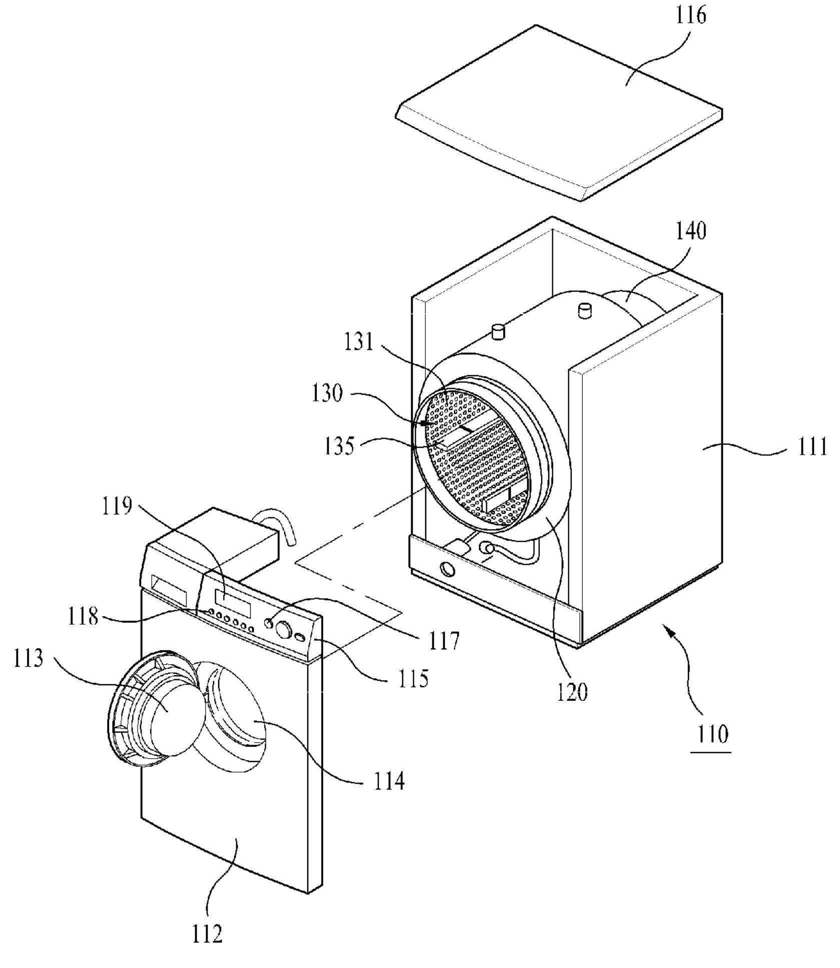
10. The method as claimed in claim 8, wherein the drum motion is performed in succession to the shifting motion, and the drum motion is a reversing-phase braking after rotating the drum to a preset motion angle at a speed at which the laundry does not move away from an inside circumferential surface of the drum.

11. The method as claimed in claim 10, wherein the motion angle is 180 degrees in a rotation direction of the drum.

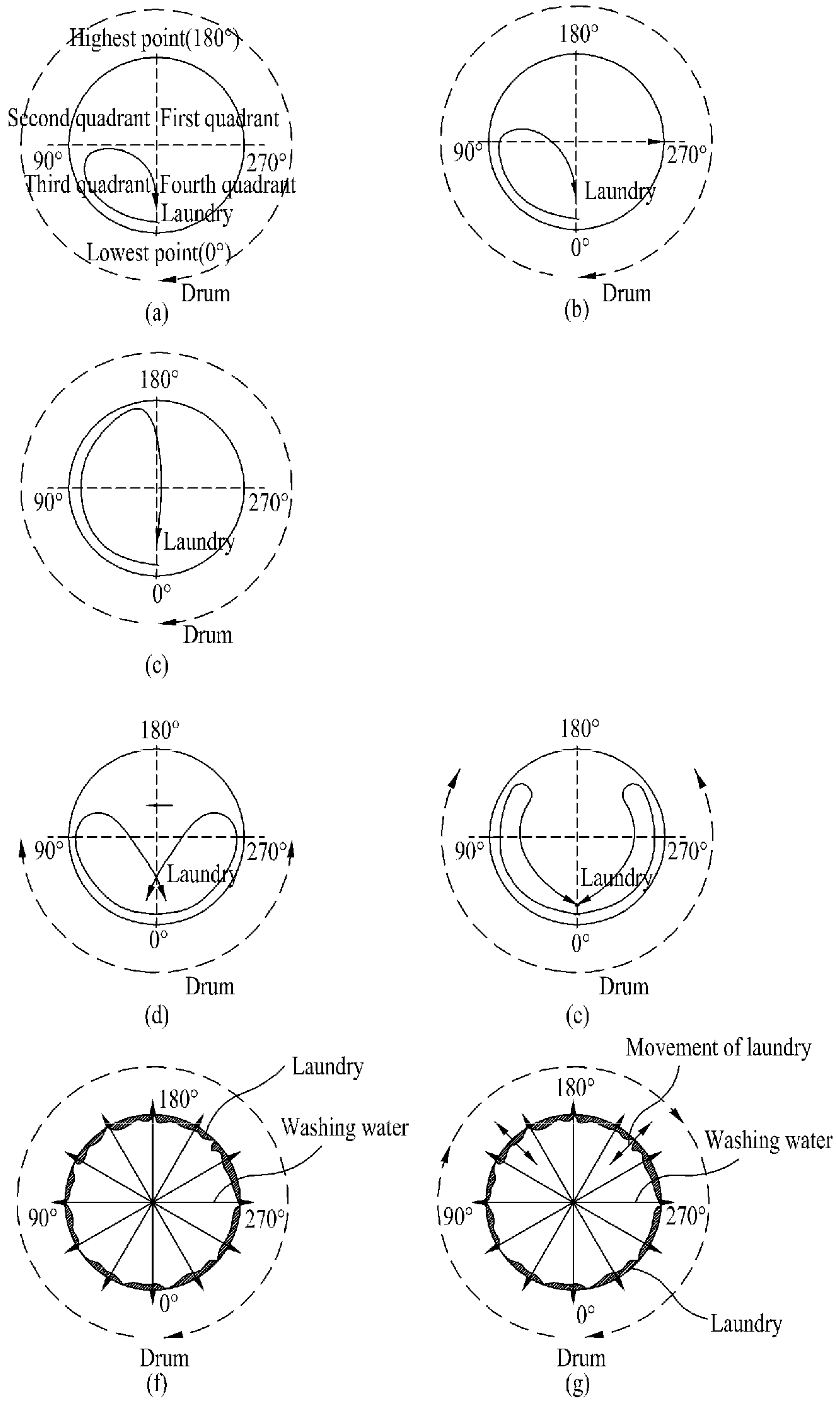
12. The method as claimed in claim 10, wherein the motion angle is an angle between 90 ~ 180 degrees in a rotation direction of the drum.

13. The method as claimed in claim 8, wherein the drum motion is performed in succession to the shifting motion, and the drum motion is a rheostatic braking after rotating the drum up to the preset motion angle.

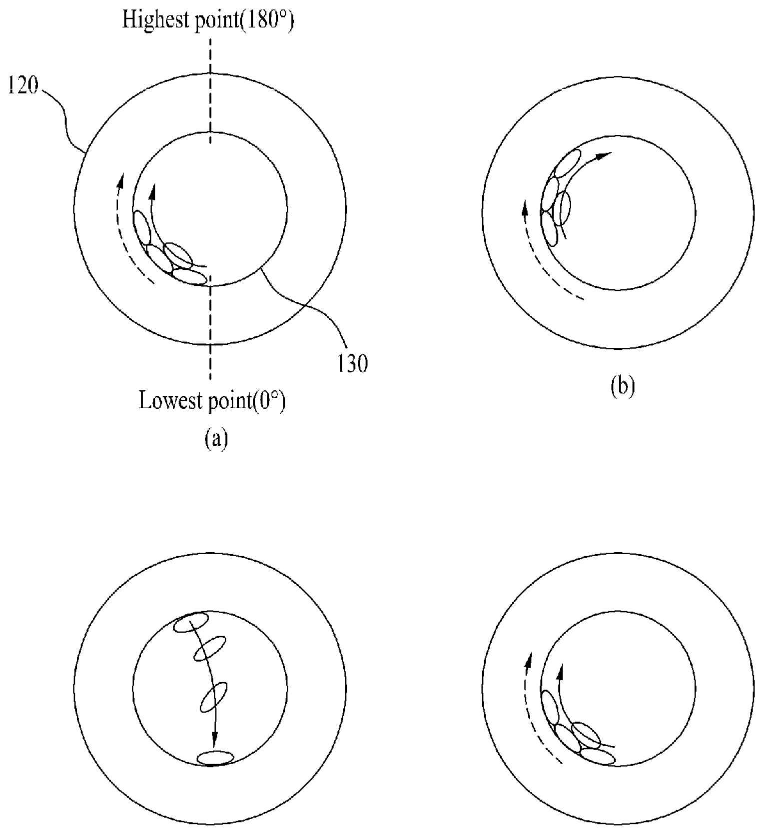
[Fig.1]



[Fig.2]

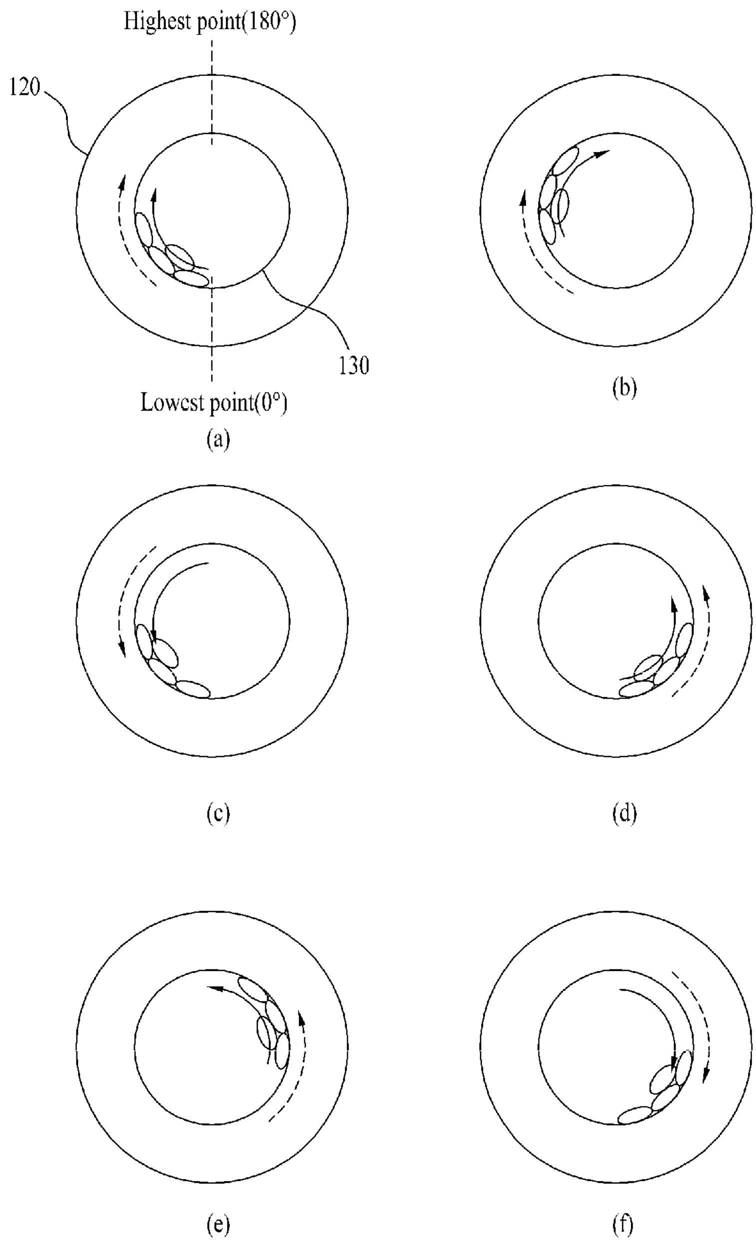

Highest point(180°)
Second quadrant
First quadrant
90°
270°
Third quadrant
Fourth quadrant
Laundry
Lowest point(0°)
Drum
(a)
180°
90°
270°
Laundry
0°
Drum
(b)
180°
90°
270°
Laundry
0°
Drum
(c)
180°
90°
270°
Laundry
0°
Drum
(d)
180°
90°
270°
Laundry
0°
Drum
(c)
Laundry
180°
Washing water
90°
270°
0°
Drum
(f)
Movement of laundry
180°
Washing water
90°
270°
0°
Laundry
Drum
(g)

[Fig.3]

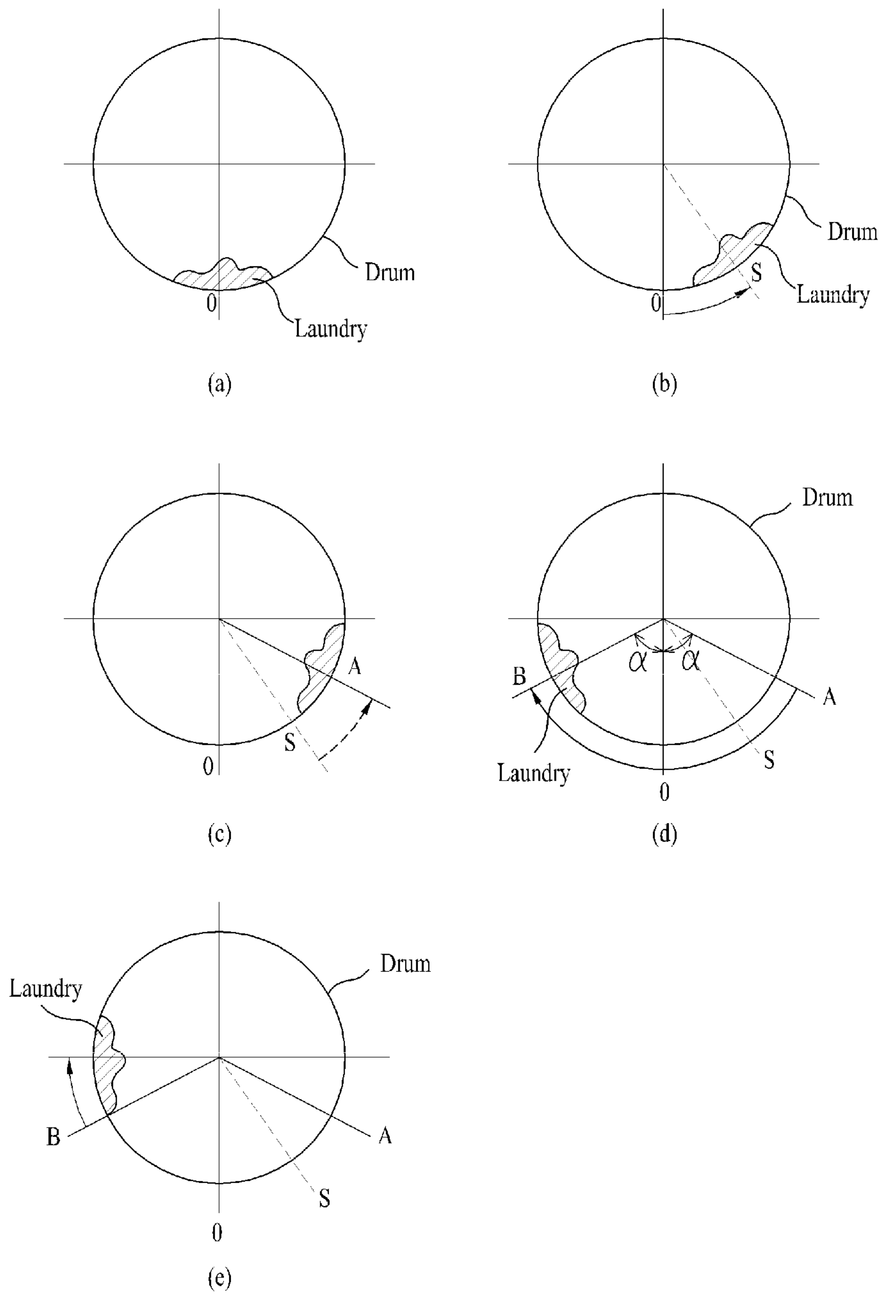


(c) (d)

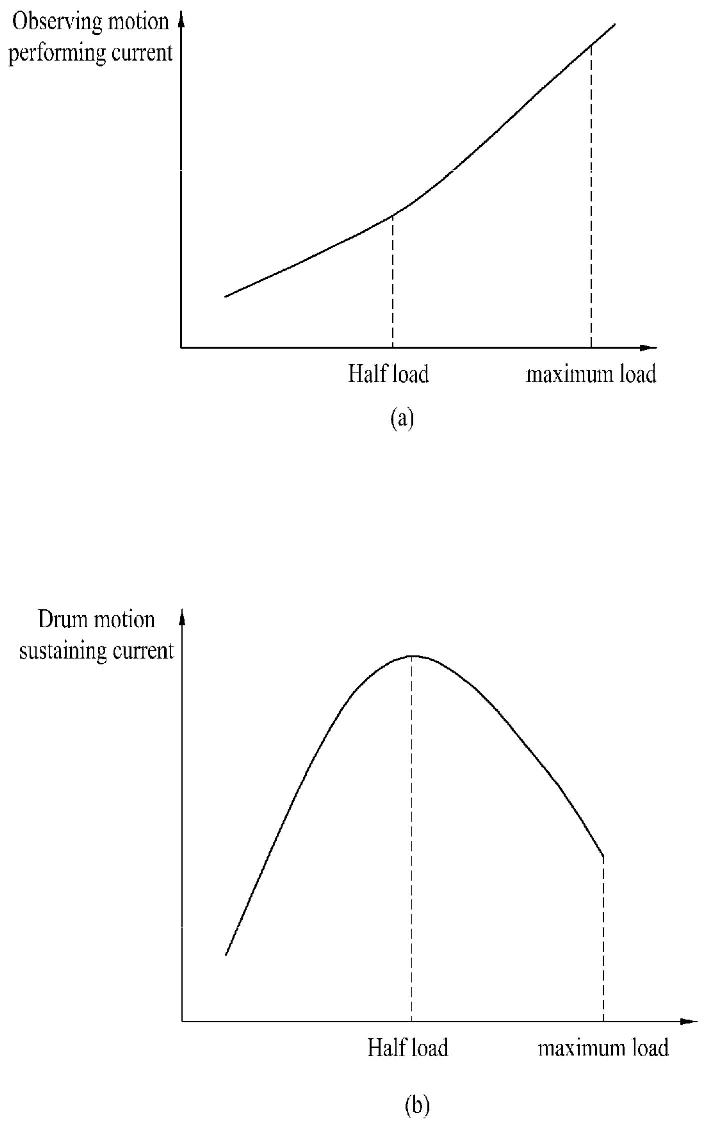
[Fig.4]



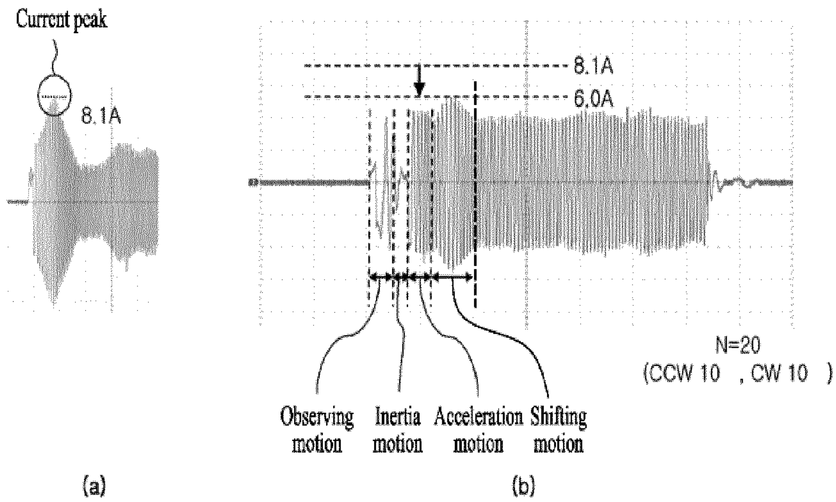
[Fig.5]


Drum
Laundry
0
(a)
Drum
Laundry
S
0
(b)
A
S
0
(c)
Drum
α
α
B
A
Laundry
S
0
(d)
Laundry
Drum
B
A
S
0
(e)

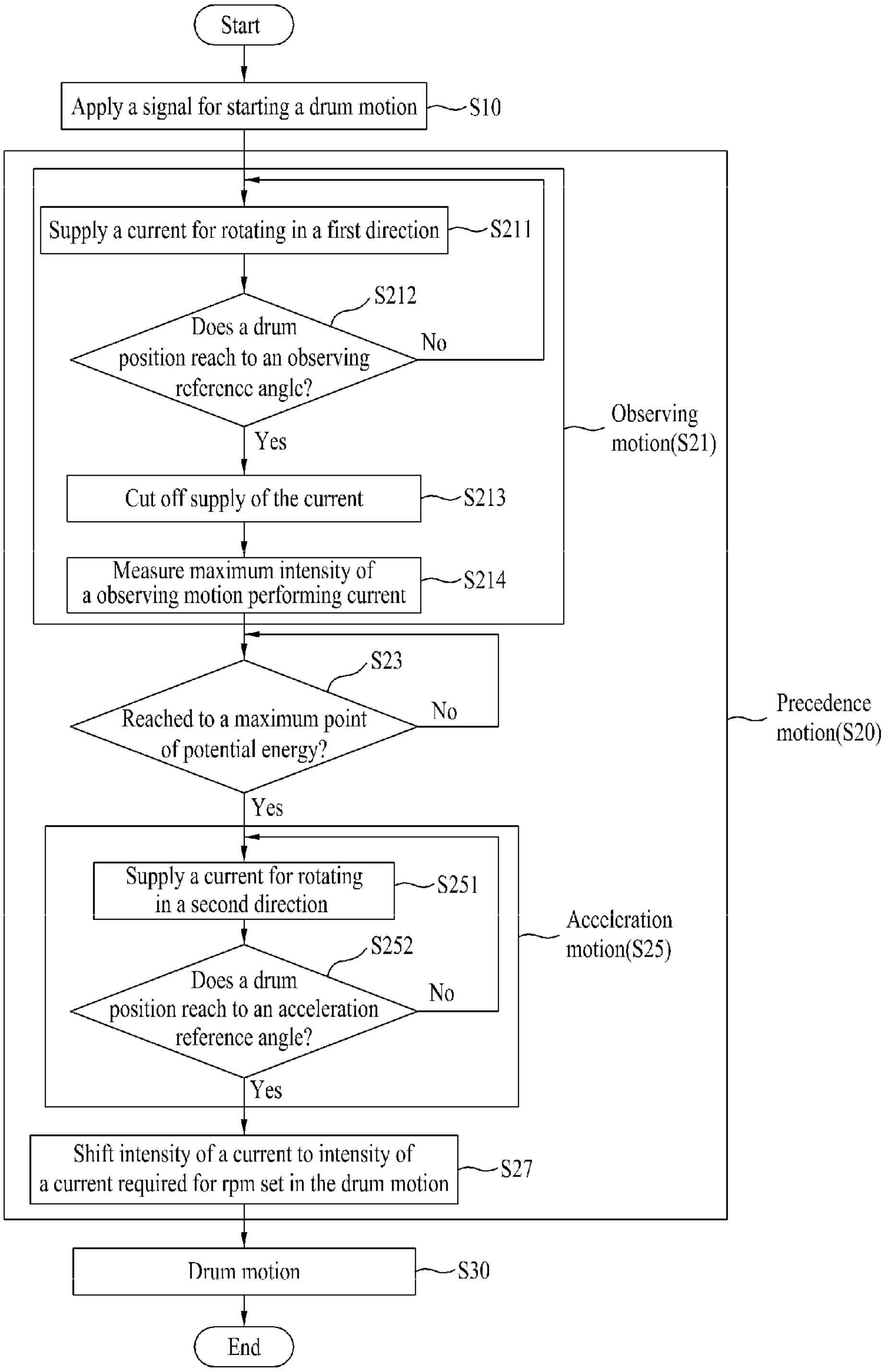
[Fig.6]


Observing motion performing current
Half load
maximum load
(a)
Drum motion sustaining current
Half load
maximum load
(b)

[Fig.7]


Current peak
8.1A
8.1A
6.0A
N=20
(CCW 10 , CW 10)
Observing motion
Inertia motion
Acceleration motion
Shifting motion
(a)
(b)

[Fig.8]


Start
Apply a signal for starting a drum motion
S10
Supply a current for rotating in a first direction
S211
S212
Does a drum position reach to an observing reference angle?
No
Yes
Cut off supply of the current
S213
Measure maximum intensity of a observing motion performing current
S214
Observing motion(S21)
S23
Reached to a maximum point of potential energy?
No
Yes
Precedence motion(S20)
Supply a current for rotating in a second direction
S251
S252
Does a drum position reach to an acceleration reference angle?
No
Yes
Acceleration motion(S25)
Shift intensity of a current to intensity of a current required for rpm set in the drum motion
S27
Drum motion
S30
End