

(19)



(11)

EP 2 470 708 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
09.08.2017 Bulletin 2017/32

(51) Int Cl.:
D06F 33/02 (2006.01) **D06F 39/04** (2006.01)
D06F 37/22 (2006.01) **D06F 37/24** (2006.01)
D06F 35/00 (2006.01)

(21) Application number: **10812331.6**

(86) International application number:
PCT/KR2010/005814

(22) Date of filing: **27.08.2010**

(87) International publication number:
WO 2011/025318 (03.03.2011 Gazette 2011/09)

(54) CONTROL METHOD OF LAUNDRY MACHINE

STEUERVERFAHREN FÜR EINE WASCHMASCHINE

PROCÉDÉ DE COMMANDE D'UN LAVE-LINGE

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR

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(30) Priority: **27.08.2009 KR 20090080123**
27.08.2009 KR 20090079912
27.08.2009 KR 20090079923

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(43) Date of publication of application:
04.07.2012 Bulletin 2012/27

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Description**Technical Field**

[0001] The present invention relates to a control method of a laundry machine.

Background Art

[0002] In general, a laundry machine may include washing, rinsing and spinning cycles. Here, the spinning cycle includes a rotating step of rotating a drum provided in such a laundry machine at the highest RPM. Because of the step, the spinning cycle would generate noise and vibration quite a lot, which is required to be solved in the art the present invention pertains to.

[0003] EP 1950336 A1 describes a control method of a washing machine, including detecting the number of rotations, determining whether the detected number of rotations has reached a predetermined number, which is a predetermined number of rotations lower than a number of excessive vibration rotations of the water tub, controlling the motor such that the number of rotations is maintained at the predetermined number of rotations for a predetermined first time, and increasing the number of rotations after the predetermined first time has elapsed, and braking the motor when the water tub is vibrated at more than a predetermined vibration level, and reincreasing the number of rotations after a predetermined second time has elapsed, thereby reducing the excessive vibration of the water tub.

[0004] EP 2000576 A2 describes a method of controlling a washing machine including increasing the speed of the rotation tub stepwise in a period in which an excessive vibration of the water tub occurs, and measuring a current of a motor to detect an amount of unbalance while the speed of the rotation tub is increased stepwise, and controlling the speed of the rotation tub based on the detected amount of unbalance.

Disclosure of Invention**Technical Problem**

[0005] Accordingly, the present invention is directed to a control method of a laundry machine.

[0006] An object of the present invention is to provide a control method of a laundry machine which can solve the above problem.

Solution to Problem

[0007] To solve the problems, an object of the present invention is to provide a control method of a laundry machine comprising a balancer, the control method comprising decreasing a speed of a drum in case vibration of the drum sensed in an accelerating step is a predetermined value or more and rotating a drum at a constant

speed for a predetermined time period to implement balancing.

[0008] The invention is indicated in the independent claim. Further embodiments are indicated in the dependent claims.

Advantageous Effects of Invention

[0009] The present invention has following advantageous effects.

[0010] According to the spinning cycle control method of the laundry machine described above, if the vibration of the drum is a predetermined value or more at the RPM higher than the transient region, the vibration of the drum may be reduced in the laundry machine having the vibration of the drum separated from that of the tub.

[0011] For example, the laundry machine may comprise a driving unit comprising a shaft connected to a drum, a bearing housing to rotatably support the shaft, and a motor to rotate the shaft, and a suspension assembly is connected to the driving unit.

[0012] For example, the laundry machine may comprise a rear gasket for sealing to prevent washing water from leaking from a space between a driving unit and a tub, and enabling the driving unit movable relative to the tub.

[0013] For example, a tub is supported rigidly more than a drum being supported by a suspension assembly.

Brief Description of Drawings

[0014] 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.

[0015] In the drawings:

FIG. 1 is an exploded perspective view illustrating a laundry machine according to the present invention to which a control method is applied;

FIG. 2 is a sectional view illustrating a connection state of FIG. 1;

FIG. 3 is a graph illustrating a spinning control method according to a first embodiment of the present invention;

FIG. 4 is a graph illustrating a spinning control method according to a second embodiment of the present invention;

FIG. 5 is a graph showing a relation of mass vs. a natural frequency. ;and

FIG. 6 is a graph illustrating vibration characteristics of the laundry machine of FIG. 2.

Best Mode for Carrying out the Invention

[0016] As follows, an exemplary embodiment of the

present invention will be described in reference to the accompanying drawings. First of all, a laundry machine a control method according to an embodiment of the present invention can be applied to will be described and the control method according to an embodiment of the present invention will be described after that.

[0017] According to a laundry machine according to an embodiment, the tub may be fixedly supported to the cabinet or it may be supplied to the cabinet by a flexible supporting structure such as a suspension unit which will be described later. Also, the supporting of the tub may be between the supporting of the suspension unit and the completely fixed supporting.

[0018] That is, the tub may be flexibly supported by the suspension unit which will be described later or it may be complete-fixedly supported to be movable more rigidly. Although not shown in the drawings, the cabinet may not be provided unlike embodiments which will be described later. For example, in case of a built-in type laundry machine, a predetermined space in which the built-in type laundry machine will be installed may be formed by a wall structure and the like, instead of the cabinet. In other words, the built-in type laundry machine may not include a cabinet configured to define an exterior appearance thereof independently.

[0019] In reference to FIGS. 1 and 2, a tub 12 provided in the laundry machine is fixedly supported to a cabinet. The tub 12 includes a tub front 100 configured to define a front part of the tub and a tub rear 120 configured to define a rear part of the tub. The tub front 100 and the tub rear 120 are assembled to each other by screws, to form a predetermined space big enough to accommodate the drum. The tub rear 120 has an opening formed in a rear portion thereof and an inner circumference of the rear portion composing the tub rear 120 is connected with an outer circumference of a rear gasket 250. The tub back 130 has a through-hole formed in a center thereof to pass a shaft to pass there through. The rear gasket 250 is made of a flexible material not to transmit the vibration of the tub back 130 to the tub rear 120.

[0020] The tub rear 120 has a rear surface 128 and the rear surface 128, the tub back 130 and the rear gasket 250 may define a rear wall of the tub. The rear gasket 250 is connectedly sealed with the tub back 130 and the tub rear 120, such that the wash water held in the tub may not leak. The tub back 130 is vibrated together with the drum during the rotation of the drum. At this time, the tub back 130 is distant from the tub rear 120 enough not to interfere with the tub rear. Since the rear gasket 250 is made of the flexible material, the tub back 130 is allowed to relative-move, without interference of the tub rear 120. The rear gasket 250 may include a corrugated portion 252 extendible to a predetermined length to allow the relative-motion of the tub back 130.

[0021] A foreign substance preventing member 200 configured to prevent foreign substances from drawn between the tub and the drum may be connected to a front portion of the tub front 100. The foreign substance pre-

venting member 200 is made of a flexible material and it is fixed to the tub front 100. Here, the foreign substance preventing member 200 may be made of the flexible material identical to the material composing the rear gasket 250. Hereinafter, the foreign substance preventing member 200 will be referenced to as 'front gasket'.

[0022] The drum 32 includes a drum front 300, a drum center and a drum back 340. Balancers 310 and 330 may be installed in front and rear parts of the drum, respectively. The drum back 340 is connected with a spider 350 and the spider 350 is connected with the shaft 351. The drum 32 is rotated in the tub 12 by a torque transmitted via the shaft 351.

[0023] The shaft 351 is directly connected with a motor 170, passing through the tub back 130. Specifically, a rotor 174 composing the motor 170 is directly connected with the shaft 351. a bearing housing 400 is secured to a rear portion of the tub back 130 and the bearing housing 400 rotatably supports the shaft, located between the motor 170 and the tub back 130.

[0024] A stator 172 composing the motor 170 is secured to the bearing housing 400 and the rotor 174 is located surrounding the stator 172. As mentioned above, the rotor 174 is directly connected with the shaft 351. Here, the motor 170 is an outer rotor type motor and it is directly connected with the shaft 351.

[0025] The bearing housing 400 is supported via a suspension unit with respect to a cabinet base 600. The suspension unit 180 includes three perpendicular supporters and two oblique supporters configured to support the bearing housing 400 obliquely with respect to a forward and rearward direction.

[0026] The suspension unit 180 may include a first cylinder spring 520, a second cylinder spring 510, a third cylinder spring 500, a first cylinder damper 540 and a second cylinder damper 530.

[0027] The first cylinder spring 520 is connected between a first suspension bracket 450 and the cabinet base 600. The second cylinder spring 510 is connected between a suspension bracket 440 and the cabinet base 600.

[0028] The third cylinder spring 500 is directly connected between the bearing housing 400 and the cabinet base 600.

[0029] The first cylinder damper 540 is inclinedly installed between the first suspension bracket 450 and a rear portion of the cabinet base. The second cylinder damper 530 is inclinedly installed between the second suspension bracket 440 and a rear portion of the cabinet base 600.

[0030] The cylinder springs 520, 510 and 500 of the suspension unit 180 may be elastically connected to the cabinet base 600 enough to allow a forward/rearward and rightward/ leftward movement of the drum, not connected to the cabinet base 600 fixedly. That is, they are elastically supported by the base 600 to allow the drum to be rotated to a predetermined angle in forward/rearward and rightward/leftward directions with respect to the

connected portion.

[0031] The perpendicular ones of the suspension unit may be configured to suspend the vibration of the drum elastically and the oblique ones may be configured to dampen the vibration. That is, in a vibration system including a spring and damping means, the perpendicular ones are employed as spring and the oblique ones are employed as damping means.

[0032] The tub front 100 and the tub rear 120 are fixedly secured to the cabinet 110 and the vibration of the drum 32 is suspendedly supported by the suspension unit 180. The supporting structure of the tub 12 and the drum 32 may be called 'separated' substantially, such that the tub 12 may not be vibrated even when the drum 32 is vibrated.

[0033] The bearing housing 400 and the suspension brackets may be connected with each other by first and second weights 431 and 430.

[0034] In case the drum 30 and 32 is rotated after the laundry 1 is loaded in the drum 30 and 32 of the laundry machine according to the above embodiments, quite severe noise and vibration may be generated according to the position of the laundry 1. For example, when the drum 30 and 32 is rotated in a state of the laundry not distributed in the drum 30 and 32 uniformly (hereinafter, 'unbalanced rotation'), much noise and vibration may be generated. Especially, if the drum 30 and 32 is rotated at a high speed to spin the laundry, the noise and vibration may be problematic.

[0035] Because of that, the laundry machine may include balancer 70, 310 and 330 to prevent the noise and vibration generated by the unbalanced rotation of the drum 30 and 32. The balancer 70, 310 and 330 may be provided in a front or rear portion, or in both of the portions of the drum 30 and 32.

[0036] The balancers are mounted to the drum 30 and 32 to reduce the unbalance. Because of that, the balancer may have a movable gravity center. For example, the balancer may include movable bodies having a predetermined weight located therein and a passage the movable bodies move along. If the balancers may be ball balancers, the balancer 70, 310 and 330 may include balls 72, 312 and 332 having a predetermined weight located therein and a passage the ball moves along.

[0037] More specifically, the balls are rotated by the friction generated during the rotation of the drum 30 and 32 and they are not kept unmovable in the drum when the drum is rotated. Because of that, the balls are rotated at a different speed from the rotation speed of the drum. Here, the laundry which generates the unbalance may be rotated at the almost same speed as the speed of the drum because of the friction generated by the close contact with an inner circumferential surface of the drum and the lifters provided in the inner circumferential surface. As a result, the rotation speed of the laundry is different from that of the balls. The rotation speed of the laundry is higher than that of the balls during an initial rotation stage in which the drum is rotated at a relatively low

speed, specifically, a rotation angle speed of the laundry is higher. In addition, a phase difference between the balls and the laundry, which is a phase difference with respect to a rotation center of the drum, may changes continuously.

[0038] Hence, when the rotation speed of the drum is getting higher, the balls may be in close contact with an outer circumferential surface of the passage by the centrifugal force. At the same time, the balls are aligned at a predetermined position having approximately 90° to 180° of the phase difference with respect to the laundry. If the rotation speed of the drum is a predetermined value or more, the centrifugal force is getting larger and the friction generated between the outer circumferential surface and the balls is a predetermined value or more and the balls may be rotated at the same speed as the drum. At this time, the balls are rotated at the same speed as the drum, with maintaining the position having the 90° to 180°, preferably, approximately 180° of the phase difference with respect to the laundry. In this specification of the present invention, the rotation of the balls at the predetermined positions as mentioned above may be expressed as 'unbalance corresponding position' or 'balancing'.

[0039] As a result, in case load is concentrated on a predetermined portion of the drum inside by the laundry, the balls located in the balancers 70, 310 and 330 may move to an unbalance corresponding position to reduce the unbalance.

[0040] Before describing a spinning control method according to an embodiment of the present invention, a characteristic of vibration generated in a laundry machine will be described as follows.

[0041] Fig. 6 is a graph showing a vibration of drum while the rotation speed of the drum increases.

[0042] First, vibration characteristics of the laundry machine according to the embodiment of the present invention will now be described with reference to FIG. 6.

[0043] As the rotation speed of the drum is increased, a region (hereinafter, referred to as "transient vibration region") where irregular transient vibration with high amplitude occurs is generated. The transient vibration region irregularly occurs with high amplitude before vibration is transitioned to a steady-state vibration region (hereinafter, referred to as "steady-state region"), and has vibration characteristics determined if a vibration system (laundry machine) is designed. Though the transient vibration region is different according to the type of the laundry machine, transient vibration occurs approximately in the range of 200rpm to 270rpm. It is regarded that transient vibration is caused by resonance. Accordingly, it is necessary to design the balancer by considering effective balancing at the transient vibration region.

[0044] In the mean time, as described above, in the laundry machine according to the embodiment of the present invention, the vibration source, i.e., the motor and the drum connected with the motor are connected with the tub 12 through the rear gasket 250. Accordingly,

vibration occurring in the drum is little forwarded to the tub, and the drum is supported by a damping means and the suspension unit 180 via a bearing housing 400. As a result, the tub 12 can directly be fixed to a cabinet 110 without any damping means.

[0045] As a result of studies of the inventor of the present invention, vibration characteristics not observed generally have been found in the laundry machine according to the present invention. According to the general laundry machine, vibration (displacement) becomes steady after passing through the transient vibration region. However, in the laundry machine according to the embodiment of the present invention a region (hereinafter, referred to as "irregular vibration") where vibration becomes steady after passing through the transient vibration region and again becomes great may be generated. For example, if the maximum drum displacement or more generated in an RPM band lower than the transient region or the maximum drum displacement or more of steady state step in a RPM band higher than the transient region is generated, it is determined that irregular vibration is generated. Alternatively, if an average drum displacement in the transient region, +20% to -20% of the average drum displacement in the transient region or 1/3 or more of the maximum drum displacement in the natural frequency of the transient region are generated, it may be determined that the irregular vibration is generated.

[0046] However, as a result of the studies, irregular vibration has occurred in a RPM band higher than the transient region, for example has occurred at a region (hereinafter, referred to as "irregular vibration region") in the range of 350 rpm to 1000rpm, approximately. Irregular vibration may be generated due to use of the balancer, the damping system, and the rear gasket. Accordingly, in this laundry machine, it is necessary to design the balancer by considering the irregular vibration region as well as the transient vibration region.

[0047] For example, the balancer is provide with a ball balancer, it is preferable that the structure of the balancer, i.e., the size of the ball, the number of balls, a shape of the race, viscosity of oil, and a filling level of oil are selected by considering the irregular vibration region as well as the transient vibration region. When considering the transient vibration region and/or the irregular vibration region, especially considering the irregular vibration region, the ball balancer has a greater diameter of 255.8mm and a smaller diameter of 249.2. A space of the race, in which the ball is contained, has a sectional area of 411.93mm². The number of balls is 14 at the front and the rear, respectively, and the ball has a size of 19.05mm. Silicon based oil such as Poly Dimethylsiloxane (PDMS) is used as the oil. Preferably, oil has viscosity of 300CS at a room temperature, and has a filling level of 350cc.

[0048] In addition to the structure of the balancer, in view of control, it is preferable that the irregular vibration region as well as the transient vibration region is considered. For example, to prevent the irregular vibration, if

the irregular vibration region is determined, the balancing may be implemented at least one time before, while and after the drum speed passes the irregular vibration region. Here, if the rotation speed of the drum is relatively high, the balancing of the balancer may not be implemented properly and the balancing may be implemented with decreasing the rotation speed of the drum. however, if the rotation speed of the drum is decreased to be lower than the transient region to implement the balancing, it has to pass the transient region again. In decreasing the rotation speed of the drum to implement the balancing, the decreased rotation speed may be higher than the transient region.

[0049] As follows, a control method of the laundry machine having the configuration described above will be described. The laundry machine includes the washing cycle, the rinsing cycle and the spinning cycle. According to the present invention, a spinning cycle control method will be described in reference to the accompanying drawings.

[0050] FIG. 3 is a graph illustrating changes of RPM of the drum according to the time passage. A horizontal axis of the graph shown in FIG. 3 is the time and a vertical axis is the rotation speed of the drum 32, that is, RPM changes.

[0051] In reference to FIG. 3, the spinning cycle control method according to the present invention includes a laundry distributing step (S100) and a spinning step (S200).

[0052] The laundry distributing step (S100) distributes the laundry loaded into the drum uniformly, with rotating the drum at a relatively low speed. The spinning step (S200) rotates the drum at a relatively high speed and it removes the moisture from the laundry. However, such the laundry distributing step and spinning step are named with respect to main functions thereof. The functions of the steps may not be limited to the names. For example, the laundry distributing step may remove the moisture of the laundry by using the rotation of the drum, as well as the laundry distributing.

[0053] The laundry distributing step (S100) composing the control method according to the present invention may include a wet laundry sensing step (S110), a laundry disentangling step (S130) and an unbalance sensing step (S150). The spinning step (S200) may include a transient region passing step (S210) and an accelerating step (S230). As follows, each one of the above steps will be described.

[0054] Once the rinsing cycle is completed, the laundry located in the drum 32 is wet by the moisture. A control part senses the amount of the laundry, that is, the amount of the wet laundry located in the drum 32, when the spinning cycle is put into operation (S110).

[0055] The reason why the amount of the wet laundry is that the amount of the dry laundry measured in an initial stage of the washing cycle is different from the amount of the wet laundry containing the moisture. The sensed amount of the wet laundry may be used as an element

configured to determine an allowable condition of the drum accelerating or to determine to re-implement the laundry distributing step after decreasing the speed of the drum 32 based on an unbalance condition in the transient region passing step (S210).

[0056] According to the control method of the present invention, the amount of the wet laundry located in the drum 32 is measured in case the drum is rotated at a decreased speed after rotated at a constant speed of approximately 100 to 110 RPM reached by the acceleration for a predetermined time period. If the rotation speed of the drum is decreased, rheostatic braking is used. Specifically, the amount of the wet laundry is measured by using the amount of acceleration period rotation in accelerating the motor 170 configured to rotate the drum 32, the amount of the acceleration period rotation in decreasing the speed of the motor 170, and an applied DC voltage.

[0057] After measuring the amount of the wet laundry, the control part may implement the laundry disentangling step (S130) configured to distribute the laundry inside the drum uniformly.

[0058] The laundry disentangling step distributes the laundry located in the drum 32 uniformly to prevent the laundry from concentrated on a specific region inside the drum, which might increase the unbalance. If the unbalance is increased, noise and vibration will be increased in case the RPM of the drum is heightened. The laundry disentangling step accelerates the drum in a predetermined single direction with a predetermined oblique and it is implemented until the RPM reaches a rotation speed of the unbalance sensing step which will be described later.

[0059] Hence, the control part senses the unbalance of the drum (S150).

[0060] If the laundry is concentrated on a specific region inside the drum 32, not distributed uniformly, the unbalance is increased and the noise and vibration will be generated when the RPM of the drum 32 is heightened. Because of that, the control part senses the unbalance of the drum and it determines whether the drum is accelerated.

[0061] The unbalance sensing uses difference of the accelerated speeds during the rotation of the drum 32. That is, there is difference of the accelerated speeds when the drum is rotated downward along the gravity and when it is rotated upward reversely according to the level of the generated unbalance. The control part measures the difference of the accelerated speeds by using a speed sensor, for example, a hall sensor provided in the motor 170 to sense the amount of the unbalance. In case the unbalance is sensed, the laundry located inside the drum keeps the close contact with the inner circumferential surface of the drum, without dropped from the inner circumferential surface, even during the rotation of the drum. The case having the drum rotated at approximately 100 to 110 RPM is corresponding to this case.

[0062] If the drum is accelerated at a high speed in

case the sensed unbalance amount of the drum having a predetermined amount of wet laundry is a reference unbalance value or more, the vibration and noise of the drum will increase remarkably and it is difficult to accelerate the speed of the drum. Because of that, the control part may store a reference unbalance value, which allows the acceleration of the speed according to the amount of the wet laundry as a table typed data. After that, the control part applies the sensed wet-laundry amount and the unbalance amount to the table and it determines whether the speed of the drum is accelerated. That is, in case the unbalance amount sensed according to the sensed wet-laundry amount is the reference unbalance value or more, it can be determined that the unbalance amount is too much to accelerate the drum speed and the above wet-laundry sensing, laundry disentangling and unbalance sensing steps are repeated.

[0063] As mentioned above, the repetition of the wet laundry sensing step, the laundry disentangling step and the unbalance sensing step may be continued until the sensed unbalance amount meets less than the reference unbalance value. However, if the laundry machine is in an abnormal state or the laundry is entangled severely inside the drum, the sensed unbalance amount cannot meet less than the reference unbalance value and the steps may be repeated. As a result, it is preferable that the control part controls the drum to stop the rotation and notifies the user that the spinning cycle is not completed normally, if the speed of the drum fails to be accelerated for a predetermined time period, for example, approximately more than 20 to 30 minutes after the spinning cycle starts.

[0064] In case the unbalance amount sensed according to the sensed wet laundry amount is less than the reference unbalance amount, the RPM accelerating condition is satisfied and the control part implements the transient region passing step (S210).

[0065] Here, the transient region is a predetermined RPM band including at least one resonance frequency which generates resonance according to the system of the laundry machine. When the system of the laundry machine is determined, the transient region is a unique vibration property generated according to the determined system. The transient region is variable according to the system of the laundry machine. For example, the transient region includes a scope of approximately 200 to 270 RPM in the laundry according to the first embodiment and a scope of approximately 200 to 350 RPM in the laundry machine according to the second embodiment.

[0066] FIG. 5 illustrates a graph showing a relation of mass vs. a natural frequency. It is assumed that, in vibration systems of two laundry machines, the two laundry machines have mass of m_0 and m_1 respectively and maximum holding laundry amounts are Δm , respectively. Then, the transition regions of the two laundry machines can be determined taking Δn_{f0} and Δn_{f1} into account, respectively. In this instance, amounts of water contained in the laundry will not be taken into account, for the time

being.

[0067] In the meantime, referring to FIG. 5, the laundry machine with smaller mass m_1 has a range of the transition region greater than the laundry machine with greater mass m_0 . That is, the range of the transition region having variation of the laundry amount taken into account becomes the greater as the mass of the vibration system becomes the smaller.

[0068] The ranges of the transition regions will be reviewed on the related art laundry machine and the laundry machine of the embodiment.

[0069] The related art laundry machine has a structure in which vibration is transmitted from the drum to the tub as it is, causing the tub to vibrate. Therefore, in taking the vibration of the related art laundry machine into account, the tub is indispensable. However, in general, the tub has, not only a weight of its own, but also substantial weights at a front, a rear or a circumferential surface thereof for balancing. Accordingly, the related art laundry machine has great mass of the vibration system.

[0070] Opposite to this, in the laundry machine of the embodiment, since the tub, not only has no weight, but also is separated from the drum in view of a supporting structure, the tub may not be put into account in consideration of the vibration of the drum. Therefore, the laundry machine of the embodiment may have relatively small mass of the vibration system.

[0071] Then, referring to FIG. 5, the related art laundry machine has mass m_0 and the laundry machine of the embodiment has mass m_1 , leading the laundry machine of the embodiment to have a greater transition region, at the end.

[0072] Moreover, if the amounts of water contained in the laundry are taken into account simply, Δm in FIG. 5 will become greater, making a range difference of the transition regions even greater. And, since, in the related art laundry machine, the water drops into the tub from the drum even if the water escapes from the laundry as the drum rotates, an amount of water mass reduction come from the spinning is small. Since the laundry machine of the embodiment has the tub and the drum separated from each other in view of vibration, the water escaped from the drum influences the vibration of the drum, instantly. That is, the influence of a mass change of the water in the laundry is greater in the laundry machine of the embodiment than the related art laundry machine.

[0073] Under above reason, though the related art laundry machine has the transition region of about 200 ~ 270rpm, A start RPM of the transient region of the laundry machine according to this embodiment may be similar to a start RPM of the transient region of the conventional laundry machine. An end RPM of the transient region of the laundry machine according to this embodiment may increase more than a RPM calculated by adding a value of approximately 30% of the start RPM to the start RPM. For example, the transient region finishes at an RPM calculated by adding a value of approximately 80% of

the start RPM to the start RPM. According to this embodiment, the transient region may include a RPM band of approximately 200 to 350 rpm.

[0074] In the meantime, by reducing intensity of the vibration of the drum, unbalance may be reduced. For this, even laundry spreading is performed for spreading the laundry in the drum as far as possible before the rotation speed of the drum enters into the transition region.

[0075] In a case, a balancer is used, a method may be put into account, in which the rotation speed of the drum passes through the transition region while movable bodies provided in the balancer are positioned on an opposite side of an unbalance of the laundry. In this instance, it is preferable that the movable bodies are positioned at exact opposite of the unbalance in middle of the transition region.

[0076] However, as described above, the transient region of the laundry machine according to this embodiment is relatively wide in comparison to that of the conventional laundry machine. Because of that, even if the laundry even-spreading step or ball balancing is implemented in a RPM band lower than the transient region, the laundry might be in disorder or balancing might be failed with the drum speed passing the transient region.

[0077] As a result, balancing may be implemented at least one time in the laundry machine according to this embodiment before and while the drum speed passing the transient region. Here, the balancing may be defined as rotation of the drum at a constant-speed for a predetermined time period. Such the balancing allows the movable body of the balancer to the opposite positions of the laundry, only to reduce the unbalance amount. By extension, the effect of the laundry even-spreading. Eventually, the balancing is implemented while the drum speed passing the transient region and the noise and vibration generated by the expansion of the transient region may be prevented.

[0078] Here, when the balancing is implemented before the drum speed passing the transient region, the balancing may be implemented in a different RPM band from the RPM of the conventional laundry machine. For example, if the transient region starts at 200 RPM, the balancing is implemented in the RPM band lower than approximately 150 RPM. Since the conventional laundry machine has a relatively less wide transient region, it is not so difficult for the drum speed to pass the transient region even with the balancing implemented at the RPM lower than approximately 150 RPM. However, the laundry machine according to this embodiment has the relatively wide expanded transient region as described above. if the balancing is implemented at the such the low RPM like in the conventional laundry machine, the positions of the movable bodies might be in disorder by the balancing implemented with the drum speed passing the transient region. Because of that, the laundry machine according to this embodiment may increase the balancing RPM in comparison to the conventional bal-

ancing RPM, when the balancing is implemented before the drum speed enters the transient region. That is, if the start RPM of the transient region is determined, the balancing is implemented in a RPM band higher than a RPM calculated by subtracting a value of approximately 25% of the start RPM from the start RPM. For example, the start RPM of the transient region is approximately 200 RPM, the balancing may be implemented in a RPM band higher than 150RPM lower than 200 RPM.

[0079] Moreover, the unbalance amount may be measured during the balancing. That is, the control method may further include a step to measure the unbalance amount during the balancing and to compare the measured unbalance amount with an allowable unbalance amount allowing the acceleration of the drum speed. If the measured unbalance amount is less than the allowable unbalance amount, the drum speed is accelerated after the balancing to be out of the transient region. In contrast, if the measured unbalance amount is the allowable unbalance amount or more, the laundry even-spreading step may be re-implemented. in this case, the allowable unbalance amount may be different from an allowable unbalance amount allowing the initial accelerating.

[0080] That is, in case the rotation speed of the drum 32 passes the transient region, the resonance is generated in the laundry machine and noise and vibration of the laundry machine are generated remarkably. The noise and vibration of the laundry machine will give an unpleasant feeling to the user and they will interfere with the acceleration of the drum speed. As a result, in case the rotation speed of the drum passes the transient region, an acceleration inclination may be adjusted appropriately in the transient region and to noise and vibration may be maintained as little as possible during the acceleration of the drum 32.

[0081] Specially, the control part controls the speed of the drum to pass the transient vibration region in the state of the balls located in the unbalance corresponding positions. If the sensed unbalance amount is less than the reference unbalance amount, the control part determines an acceleration point of the drum from the unbalance wave described above.

[0082] The centrifugal force is too small to implement the balancing at a rotation speed below the transient vibration region. Because of that, the control part identifies the positions of the balls, with rotating the drum at a constant speed, and it accelerates the drum at a predetermined acceleration point to pass the transient vibration region. While the speed passing the transient region, the control part controls the balls to be located in opposite positions of the unbalance. That is, even though not implementing the balancing, the speed of the drum is controlled to pass the transient region while the balls are located in the opposite position of the unbalance. For example, the speed is controlled to pass the transient region, with the angle between the laundry generating unbalance and the balls being maintained at 90° or more

and it is preferable that that angles is 180° at an intermediate RPM of the transient region.

[0083] As a result, when accelerating the drum, with controlling the balancer described above, the control part may store the acceleration point allowing the speed to pass the transient region while the balls are located in the unbalance corresponding positions, as table data like the table data including the wet laundry amount and the sensed unbalance amount. That is, although the balls are not located in the unbalance corresponding positions at the acceleration point, the balls are located in the unbalance corresponding positions during the passage of the transient region. Preferably, the phase difference between the balls and the laundry may be approximately 180° at the intermediate RPM of the transient region. Because of that, the control part applies the sensed amount of the wet laundry and the amount of the unbalance to the table mentioned above while implementing the spinning cycle substantially.

[0084] As the drum 32 is accelerated while the RPM passing the transient region or unexpected external shock is applied to the drum, the unbalance amount of the drum 32 may be larger. If the unbalance amount of the drum 32 is larger than a predetermined value, noise will be large remarkably and it is difficult to accelerate the drum continuously. Because of that, the control part senses the unbalance amount of the drum 32 continuously while the RPM passing the transient region.

[0085] In addition, the control part may control a vibration sensor provided in the drum of the laundry machine to sense the vibration of the drum, in the transient region. Especially, the tub provided in the laundry machine having the vibration of the drum separated from that of the drum may be fixedly mounted and only the drum may be vibrated. Because of that, it is required to sense the vibration of the drum to prevent the contact between the drum and the tub. If the vibration and/or the unbalance amount of the drum sensed in the transient region passing step is a predetermined value or more, the control part decreases the RPM of the drum 32 and it repeats the wet laundry sensing step, the laundry disentangling step and the unbalance sensing step which are described above.

[0086] After the transient region passing step, the control part implements the accelerating step (S230). Once passing the transient region, the RPM of the drum 32 is accelerated at a relatively high speed to remove water elements from the laundry. That is, the RPM of the drum 32 is increased to a predetermined value and the moisture of the laundry inside the drum 32 is removed, in the accelerating step (S230). However, the accelerating step increases the RPM of the drum 32 at the high speed and noise and vibration will be generated a lot in the laundry machine. Especially, the noise and vibration may be increasing in proportion to the unbalance amount of the drum 32.

[0087] In the meanwhile, the laundry machine having the spinning cycle control method applied thereto may

include the balancer 310 and 330 configured to prevent the noise and vibration generated by unbalance. The balls provided in the balancer 310 and 330 are configured to move to the unbalance corresponding positions to reduce the unbalance amount. Here, the balls of the balancer may moveable more smoothly in the constant RPM than the accelerated speed and in the relatively slow speed than in the high speed. Because of that, if the drum 32 is accelerated at the relatively high speed, the balls cannot move to the unbalance corresponding positions smoothly. The spinning cycle control method may include a step of moving the balls to move to the unbalance corresponding positions, passing the transient region, namely, a balancing step.

[0088] In this case, the RPM used to implement the balancing may be set to be higher than the transient region of the laundry machine. The balancing is more and more advantageous to implement, as the RPM of the drum 32 is getting lower. However, if the RPM is decreased below the transient region again to implement the balancing, the noise and vibration may be generated by resonance. As a result, the first balancing (S232) of the control method may be implemented at a second RPM (RPM 2), for example, 350 to 400 RPM.

[0089] After the first balancing step, the control part increases the RPM of the drum 32 to a target RPM, to remove the moisture from the laundry. Then, the control part controls the constant speed rotation of the drum to be embodied at the target RPM for a predetermined time period such that it may remove the moisture from the laundry smoothly.

[0090] In the first balancing step, the control part may sense the vibration of the drum. If the laundry machine includes a vibration sensor, the control part may directly sense the vibration by using the vibration sensor. Without the vibration sensor, the control part may directly sense the vibration of the drum by using the unbalance amount. If the sensed vibration of the drum is a predetermined value or more, the control part decreases the speed of the drum and it repeats the wet laundry sensing step, the laundry disentangling step and the unbalance sensing step which are described above.

[0091] In the meanwhile, the irregular vibration would be generated in the irregular vibration region according to the laundry machine as mentioned above. In case the irregular vibration is generated, a control method configured to reduce the irregular vibration will be described as follows.

[0092] Specifically, when the laundry machine includes the vibration sensor configured to sense vibration, the control part may directly sense the vibration of the drum by using the vibration sensor. That is, the control part receives a sensed vibration value from the vibration sensor and it compares the received vibration value with a preset reference vibration value. In case the sensed vibration value is the reference vibration value or more based on the result of the comparison, the control parts determines that the irregular vibration is generated. Pref-

erably, in case the vibration is continued at a predetermined interval for a predetermined time period or longer, the irregular vibration is determined to be generated.

[0093] If such the irregular vibration is generated, the control part implements a second balancing (S234), without increasing the RPM of the drum to the target RPM of the spinning cycle. Here, the RPM of the second balancing (S234) is a value higher than the transient region, approximately, 350 to 400 RPM, and the drum may be constant-speed-rotated at that RPM approximately for 60 seconds.

[0094] The second balancing step (S234) enables the balls of the balancer to move to the unbalance corresponding positions smoothly. Because of that, when the drum is re-accelerated, the vibration of the drum may be reduced as much as possible.

[0095] After the second balancing step, the control part re-accelerates the drum and controls the vibration sensor to sense the vibration of the drum simultaneously. In case the sensed vibration value of the drum is less than the predetermined value, the control part accelerates the drum up to the target RPM of the spinning cycle to remove the moisture from the laundry. In case the sensed vibration value of the drum is the predetermined value or more, the control part re-implements the second balancing. Until the sensed vibration value is less than the predetermined value, the control part re-implements the second balancing continuously. However, if the second balancing step is continued a predetermined number of times or more, the spinning cycle cannot be completed and the spinning cycle time may be lengthened. Because of that, the control part controls the drum 32 to stop without accelerating the drum, in case the irregular vibration is generated in the drum even after implementing the second balancing three times. After that, the control part notifies the user of an abnormal state of the laundry machine.

[0096] As described above, when the drum is accelerated in the accelerating step, the irregular vibration of the drum may be sensed by using the unbalance of the drum, rather than using the vibration sensor. That is, if the vibration sensor is not provided in the laundry machine or it is out of function, the control part may sense the unbalance of the drum to determine whether the irregular vibration is generated in the drum. Specifically, the control part senses the unbalance amount of the drum. If the sensed unbalance amount is increased to a predetermined value or more, with maintained for a predetermined time period or longer simultaneously, the control part determines that the irregular vibration is generated in the drum.

[0097] 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 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.

[0098] The present invention has an industrial applica-

bility.

[0099] According to the spinning cycle control method of the laundry machine described above, if the vibration of the drum is a predetermined value or more at the RPM higher than the transient region, the vibration of the drum may be reduced in the laundry machine having the vibration of the drum separated from that of the tub.

Claims

1. A spinning cycle control method of a laundry machine comprising a drum (32) and a balancer (70; 310; 330) having a movable gravity center and being mounted to the drum (32), the control method comprising:

implementing a first balancing (S232) after a speed of a drum passes a transient region of the laundry machine and before the drum enters into an accelerating step (S230);

decreasing the speed of a drum when vibration of the drum sensed in the accelerating step (S230) is a predetermined value or more; and rotating the drum at a constant speed for a predetermined time period to implement a second balancing (S234),

wherein the transient region is a predetermined RPM band including at least one resonance frequency which generates resonance according to the system of the laundry machine.

2. The control method as claimed in claim 1, wherein the accelerating step (S230) comprises two accelerating steps, and each of the two steps sense the vibration of the drum (32) configured to implement the second balancing.

3. The control method as claimed in claim 2, wherein the accelerating step (S230) comprises a first accelerating step and a second accelerating step and each of the first and second accelerating steps has a different target RPM.

4. The control method as claimed in any one of the preceding claims, further comprising:

completing the spinning cycle and notifying a user of the completion of the spinning cycle, when the vibration of the drum (32) is sensed a predetermined number of times or more.

Patentansprüche

1. Verfahren zum Steuern eines Schleudergangs einer Waschmaschine, die eine Trommel (32) und ein Gleichselement (70; 310; 330), das einen beweg-

lichen Schwerpunkt hat und an der Trommel (32) angebracht ist, umfasst, wobei das Steuerverfahren die folgenden Schritte umfasst:

Ausführen eines ersten Ausgleichsvorgangs (S232), nachdem eine Drehzahl einer Trommel einen Übergangsbereich der Waschmaschine durchlaufen hat und bevor die Trommel in einen Beschleunigungsschritt (S230) eintritt;

Verringern der Drehzahl einer Trommel, wenn eine Schwingung der Trommel, die in dem Beschleunigungsschritt (S230) gemessen wird, einen zuvor festgelegten Wert oder mehr aufweist; und

Drehen der Trommel mit einer konstanten Drehzahl für eine zuvor festgelegte Zeitdauer, um einen zweiten Ausgleichsvorgang (S234) auszuführen,

wobei der Übergangsbereich ein zuvor festgelegtes Drehzahlband ist, das wenigstens eine Resonanzfrequenz umfasst, die eine Resonanz entsprechend dem System der Waschmaschine erzeugt.

2. Steuerverfahren nach Anspruch 1, wobei der Beschleunigungsschritt (S230) zwei Beschleunigungsschritte umfasst und wobei jeder der zwei Schritte die Schwingung der Trommel (32) misst und konfiguriert ist, den zweiten Ausgleichsvorgang auszuführen.

3. Steuerverfahren nach Anspruch 2, wobei der Beschleunigungsschritt (S230) einen ersten Beschleunigungsschritt und einen zweiten Beschleunigungsschritt umfasst und wobei der erste und der zweite Beschleunigungsschritt jeweils eine unterschiedliche Solldrehzahl aufweisen.

4. Steuerverfahren nach einem der vorhergehenden Ansprüche, das ferner den folgenden Schritt umfasst:

Beenden des Schleudergangs und Benachrichtigen eines Benutzers über das Beenden des Schleudergangs, wenn die Schwingung der Trommel (32) so oft gemessen wurde, das eine zuvor festgelegte Anzahl oder mehr erreicht worden ist.

Revendications

1. Procédé de commande de cycle d'essorage d'un lave-linge comprenant un tambour (32) et un équilibreur (70 ; 310 ; 330) présentant un centre de gravité mobile et étant monté sur le tambour (32), le procédé de commande comprenant :

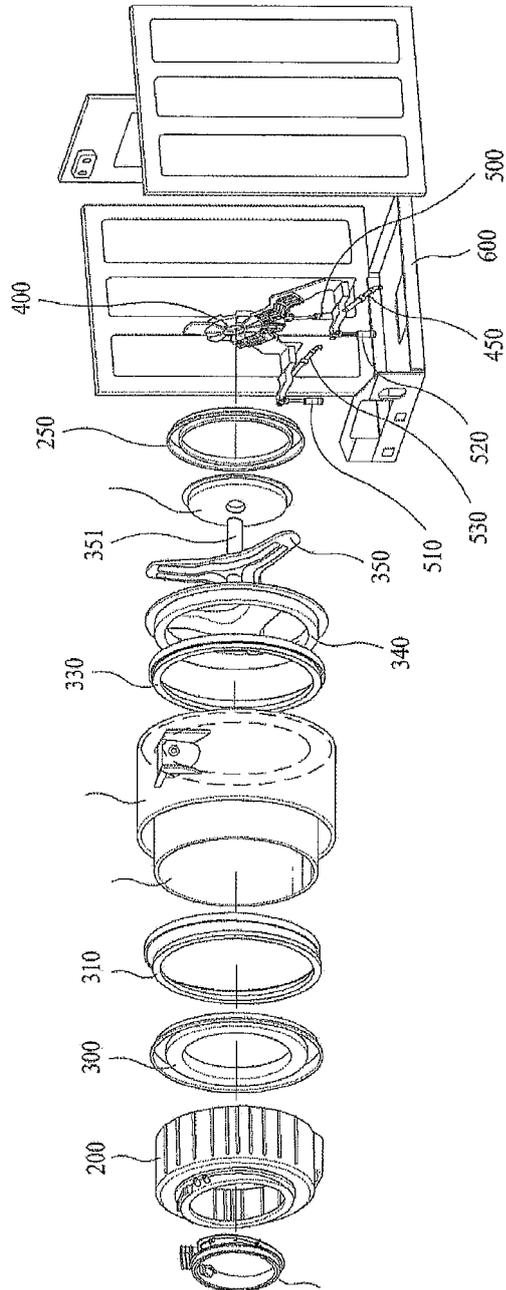
- la mise en oeuvre d'un premier équilibrage (S232) après qu'une vitesse d'un tambour passe une région transitoire du lave-linge et avant que le tambour ne passe à l'étape d'accélération (S230) ; 5
- la réduction de la vitesse d'un tambour lorsqu'une vibration du tambour détectée à l'étape d'accélération (S230) est supérieure ou égale à une valeur prédéterminée ; et 10
- la rotation du tambour à une vitesse constante pendant une période de temps prédéterminée pour mettre en oeuvre un deuxième équilibrage (S234), 15
- dans lequel la région transitoire est une bande de régime prédéterminée comprenant au moins une fréquence de résonance qui génère une résonance en fonction du système du lave-linge.
2. Procédé de commande selon la revendication 1, dans lequel l'étape d'accélération (S230) comprend deux étapes d'accélération, et chacune des deux étapes détecte la vibration du tambour (32) configuré pour mettre en oeuvre le deuxième équilibrage. 20
3. Procédé de commande selon la revendication 2, dans lequel l'étape d'accélération (S230) comprend une première étape d'accélération et une deuxième étape d'accélération et chacune des première et deuxième étapes d'accélération présente un régime cible différent. 25 30
4. Procédé de commande selon l'une quelconque des revendications précédentes, comprenant en outre :
- l'achèvement du cycle d'essorage et la notification, à un utilisateur, de l'achèvement du cycle d'essorage, lorsque la vitesse du tambour (32) est détectée un nombre prédéterminé de fois ou plus. 35 40

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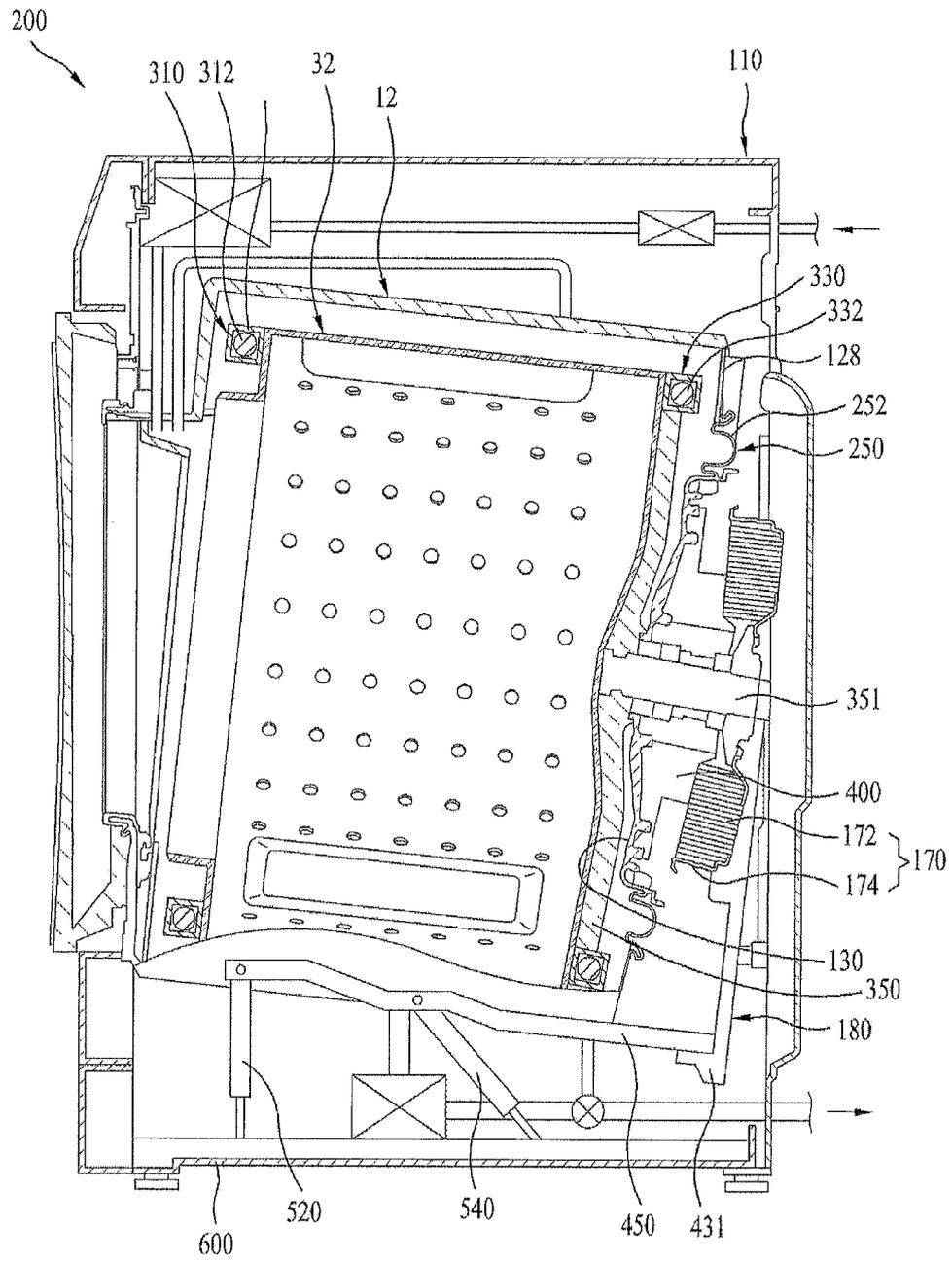
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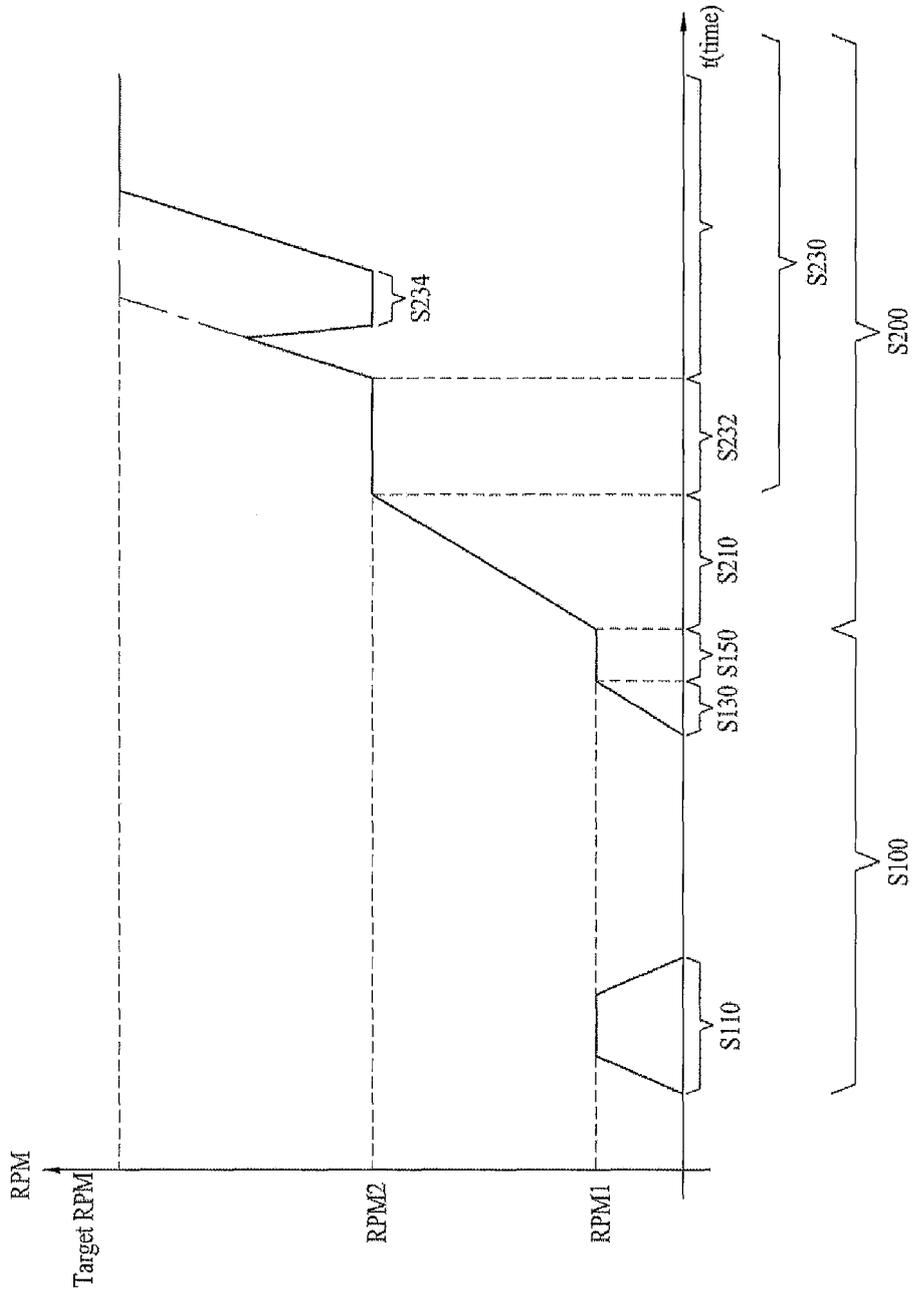
[Fig. 1]



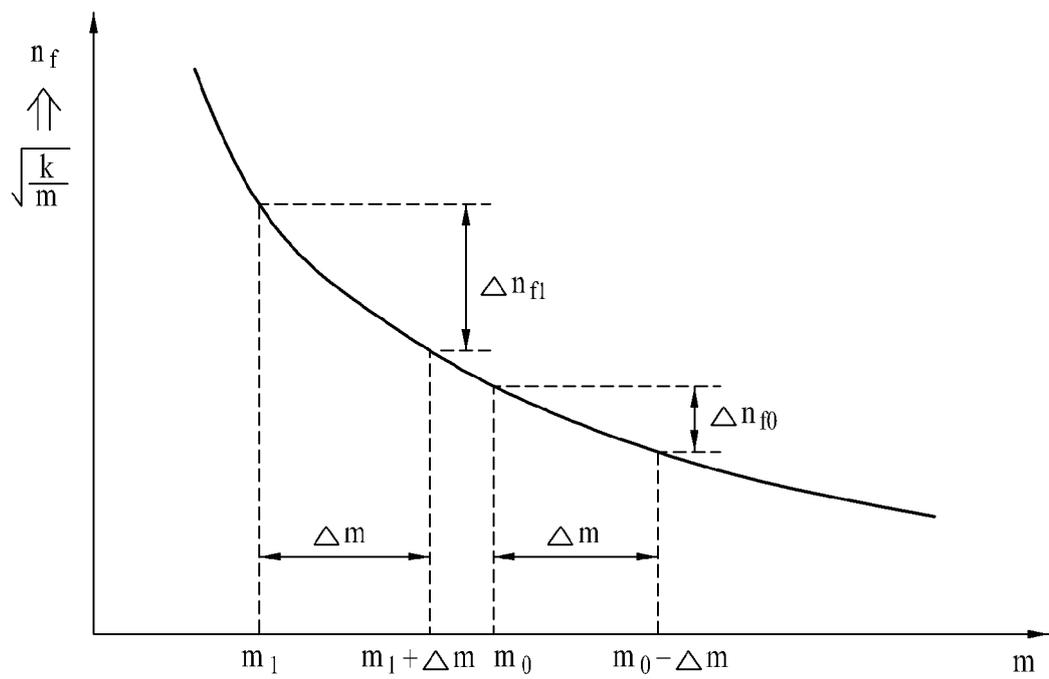
[Fig. 2]



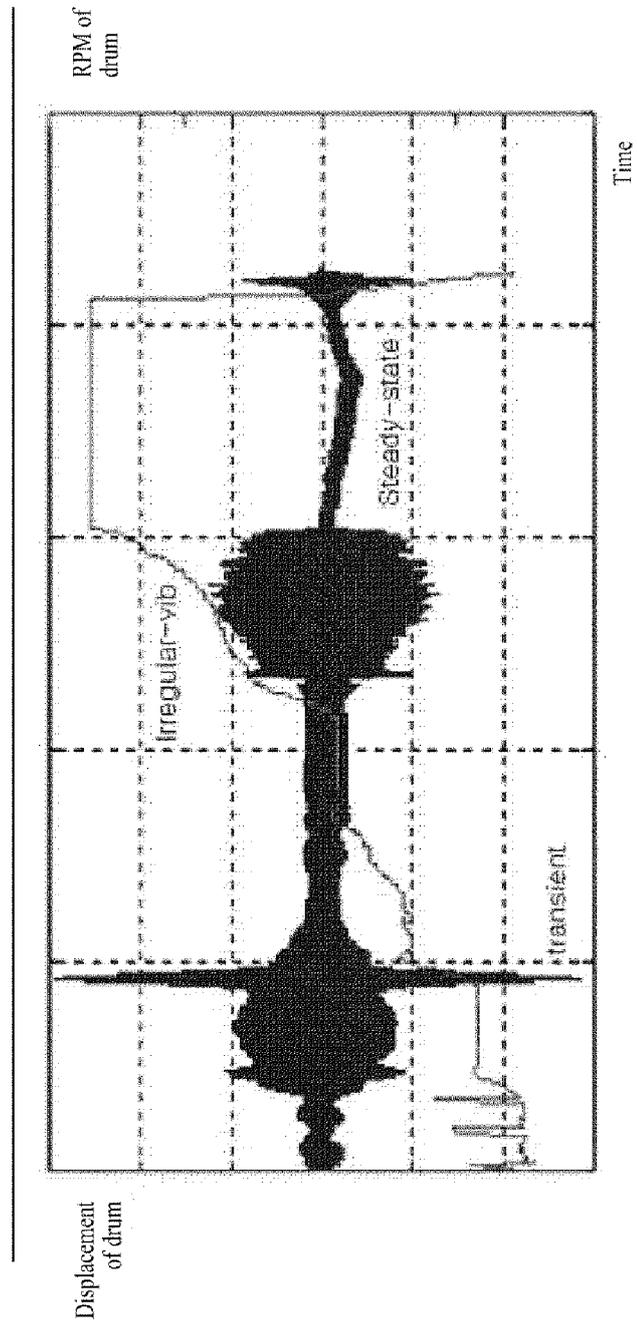
[Fig. 3]



[Fig. 5]



[Fig. 6]



REFERENCES CITED IN THE DESCRIPTION

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