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(54) CONTROL METHOD OF LAUNDRY MACHINE

STEUERVERFAHREN FÜR EINE WASCHMASCHINE

PROCÉDÉ DE COMMANDE D'UN LAVE-LINGE

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(73) Proprietor: **LG Electronics Inc.**
Yeongdeungpo-Gu
Seoul
07336 (KR)

(72) Inventors:
- **JANG, Jae Hyuk**
  Seoul 153-802 (KR)
- **KOO, Bon Kwon**
  Seoul 153-802 (KR)

(74) Representative: **Ter Meer Steinmeister & Partner Patentanwälte mbB**
Nymphenburger Straße 4
80335 München (DE)

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Description

Technical Field

[0001] The sent 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 prevent invention pertains to.

[0003] EP 1950336 A1 describes a control method of a drum type washing machine having a motor, a rotary tub, and balancers with balls, the method 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, braking the motor when the water tub is vibrated at more than a predetermined vibration level, counting a time after braking the motor, and re-increasing the number of rotations after a predetermined second time has elapsed, thereby reducing the excessive vibration of the water tub.

[0004] EP 2083109 A1 describes a drum type washing machine having ball balancers and a controlling method of the same. A controller detects the eccentricity amount of the rotary tub while controlling the rotary tub to be rotated at a first rotation speed, and, when the rotation speed of the rotary tub reaches a second rotation speed less than a resonance range rotation speed of the rotary tub, to control the rotary tub, such that the rotary tub is decelerated to a third rotation speed and a drainage process is carried out.

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

[0008] 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 a step configured to determine an irregular vibration region of the laundry machine and a balancing step implemented at least one time before a rotation speed of a drum enters the irregular vibration region, while the rotation speed is passing the irregular vibration region and after the rotation speed passes the irregular vibration region.

[0009] For example, the irregular vibration is determined to be generated, 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 a maximum drum displacement in a natural frequency is generated.

[0010] For example, a step of balancing the ball is carried out before the rotation speed of the drum belongs to the irregular vibration region. For example, the balancing speed in the step of balancing the ball is maintained at 380rpm.

[0011] For example, a step of balancing the ball is carried out while the rotation speed of the drum is passing through the irregular vibration region. For example, the balancing speed in the step of balancing the ball is maintained by at least one of 350 rpm to 1000rpm. For example, the balancing speed in the step of balancing the ball is maintained at 600rpm.

[0012] For example, a step of balancing the ball is carried out after the rotation speed of the drum passes through the irregular vibration region. For example, the balancing speed in the step of balancing the ball is selected from a speed region suitable for balancing. For example, the step of balancing the ball is carried out by the rotation speed of the drum, which belongs to at least one of 200rpm to 800rpm. For example, the step of balancing the ball is carried out by the rotation speed of the drum, which belongs to 380rpm.

[0013] For example, the laundry machine comprises 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.

[0014] For example, the laundry machine comprises a rear gasket for sealing to prevent washing water from leaking from a space between a driving unit and the tub, and enabling the driving unit movable relative to the tub.

[0015] For example, the tub is supported rigidly more than the drum being supported by a suspension assembly.

Advantageous Effects of Invention

[0016] The advantages of the aforementioned present invention can be obtained as follows.

[0017] According to the present invention, it is advantageous in that vibration of the drum can be reduced ef-

fectively even in an irregular vibration region that may occur during rotation of the drum, especially high speed rotation.

Brief Description of Drawings

[0018] 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.

[0019] In the drawings:

FIG. 1 is a sectional view illustrating a general laundry machine;
FIG. 2 is a sectional view illustrating an example of a laundry machine according to the present invention;
FIG. 3 is an exploded perspective view of FIG. 2;
FIG. 4 is a graph illustrating vibration characteristics of the laundry machine of FIG. 2;
FIG. 5 is a graph illustrating an example of a control method of a laundry machine according to the present invention;
FIG. 6 is a graph illustrating another example of a control method of a laundry machine according to the present invention;
FIG. 7 is a graph illustrating other example of a control method of a laundry machine according to the present invention; and
Fig. 8 is a graph showing a relation of mass vs. a natural frequency.

Best Mode for Carrying out the Invention

[0020] 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.

[0021] In reference to FIG. 1, a laundry machine 100 includes a cabinet 10 configured to define an exterior appearance thereof, a tub 20 mounted in the cabinet 10 to hold wash water therein and a drum 30 rotatably provided in the tub 20.

[0022] The cabinet 10 defines the exterior appearance of the laundry machine 100 and configuration elements which will be described later may be mounted in the cabinet 10. A door 11 is coupled to a front of the cabinet 10 and a user may open the door 11 to load laundry items including clothes, beddings, cloth items and the like (hereinafter, 'laundry')into the cabinet 10.

[0023] The tub 20 configured to hold wash water therein may be provided in the cabinet 10 and the drum configured to receive the laundry therein may be rotatale within the tub 20. In this case, a plurality of lifters 31 may be provided in the drum 30 to lift and drop the laundry during the rotation of the drum 30.

[0024] The tub 20 may be supported by a spring 50 provided above the tub 20. Here, a motor 40 is mounted to a rear surface of the tub 20 to rotate the drum 30. That is, the motor 40 is provided in a rear wall of the tub 20 and it rotates the drum 30. When vibration is generated in the drum 30 rotated by the motor 40, the tub 20 provided in the laundry machine according to this embodiment may be vibrated in communication with the drum 30. When the drum 30 is rotated, the vibration generated in the drum 30 and the tub 20 may be absorbed by a damper 60 provided below the tub 20.

[0025] As shown in FIG. 1, the tub 20 and the drum 30 may be provided in parallel to a base of the cabinet 10 or tilted downward although not shown in the drawing. As the user loads the laundry into the drum 30, it is advantageous that the front portions of the tub 20 and the drum 30 should be tilted upward.

[0026] To suppress the vibration of the drum in a spinning cycle that the drum is rotated, specially, at a high speed, a balancer 70 is provided in a front surface and/or rear surface to balance the drum and the balancer 70 will be described in detail later.

[0027] 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.

[0028] 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.

[0029] In reference to FIGS. 2 and 3, 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.

[0030] 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.

[0031] 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 preventing 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 'ront gasket'.

[0032] The drum 32 includes a drum front 300, a drum center and a drum back 340. Balancerss 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.

[0033] 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.

[0034] 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.

[0035] 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.

[0036] The suspension unit 180 may includes 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.

[0037] 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.

[0038] The third cylinder spring 500 is directly connected between the bearing housing 400 and the cabinet base 600.

[0039] 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.

[0040] 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.

[0041] 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.

[0042] 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.

[0043] The bearing housing 400 and the suspension brackets may be connected with each other by first and second weights 431 and 430.

[0044] 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.

[0045] 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.

[0046] 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 mov-

able 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.

[0047] A structure of balancers 310 and 330 will be described in detail.

[0048] The balancer 310 includes a race 312a, a ball 312 allowing free movement in the race 312a, and oil filled in the race 312a to control movement of the ball 312. It is general that a steel material is used as the ball, and a silicon based lubricant is used as the oil.

[0049] The operation principle of the balancers will be described as follows.

[0050] When the drum 32 is rotated, it may fail to maintain dynamic balance due to its unbalanced eccentric structure and biased distribution of laundry in the drum 32. In this case, the ball 312 may compensate for dynamic unbalance (UB), so that the drum maintains dynamic balance. Namely, if dynamic unbalance occurs in the drum 32, the ball 312 moves to a position opposite to a place where dynamic unbalance occurs, thereby compensating for unbalance of the drum 32.

[0051] However, the ball 312 is automatically located (hereinafter, "balancing") in an opposite direction of unbalance with respect to all rotation speeds of the drum 32, whereby it is difficult to substantially compensate dynamic unbalance. This is because that it is difficult for the ball 312 to reach the balancing position due to the difference sometimes occurring between the rotation speed of the drum 32 and the rotation speed of the ball 312.

[0052] Also, the position of the ball 312 is varied at an interval where the rotation speed of the drum is increased, whereby balancing may not be obtained. The position of the ball 312 may be varied even after the ball 312 is balanced. If the ball 312 is distributed separately, an unbalanced position is close to 90 , and vibration of the drum 32 is great, it is likely that balancing becomes unstable. Accordingly, for effective balancing, the size of the ball 312, a shape of the race 312a, viscosity of oil, and a filling level of oil should be selected by considering vibration characteristics of the laundry machine.

[0053] First, vibration characteristics of the laundry machine according to the embodiment of the present invention will now be described with reference to FIG. 4.

[0054] 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 transited 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.

[0055] 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.

[0056] 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.

[0057] 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.

[0058] 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 411.93mm^2. 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.

[0059] 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.

[0060] A control method of the laundry machine according to the embodiment of the present invention will be described with reference to FIG. 5 to FIG. 7. When washing is carried out by the laundry machine, the washing course generally includes a washing cycle, a rinsing cycle, and a spinning cycle. In this embodiment, the spinning cycle that is likely to cause irregular vibration due to high speed rotation of the drum will mainly be described.

[0061] FIG. 5 is a graph illustrating an example of a control method of a laundry machine according to the present invention. The graph of FIG. 5 illustrates variation of the rotation speed of the drum based on the passage of time. In FIG. 5, a horizontal axis represents time, and a vertical axis represents a target rotation speed of the drum, i.e., revolutions per minute (RPM).

[0062] For reference, before a control method for reducing irregular vibration is described, the spinning cycle will be described. The spinning cycle includes a laundry distributing step S100 and a spinning step S200. The laundry distributing step S100 serves to uniformly distribute the laundry inside the drum to reduce occurrence of unbalance. The spinning step S200 serves to substantially remove water of the laundry by increasing the rotation speed of the drum at a relatively high speed. However, it is to be understood that the laundry distributing step and the spinning step are classified for convenience based on their main functions and are not limited to their main functions. For example, even in the laundry distributing step, water may be removed from the laundry by rotation of the drum.

[0063] The laundry distributing step S100 includes a wet laundry sensing step S110, a laundry disentangling step S130, and an unbalance sensing step S150. The spinning step S200 can be divided into a main spinning step S260 for substantially carrying out spinning at a predetermined speed and an accelerating step S250 for reaching the main spinning step S260. In this case, the accelerating step S250 means that acceleration is carried out to reach the main spinning step. However, the accelerating step 250 is not intended to carry out acceleration continuously without deceleration or constant speed. In other words, the accelerating step S250 includes an acceleration step together with deceleration and constant speed steps.

[0064] First of all, the laundry distributing step S100 will be described in more detail.

[0065] If the rinsing cycle ends, the laundry inside the drum is wetted. A control part initially senses the amount of laundry inside the drum, i.e., the amount of wet laundry if the spinning cycle starts (S110). The reason why that the control part senses the amount of wet laundry is that weight of laundry containing water is different from that of dry laundry even though the control part initially senses the amount of laundry, which is not wet, i.e., the amount of dry laundry. The sensed amount of wet laundry may be used as a factor that determines an allowable condition for accelerating the drum at the spinning step S200 or determines a rotation speed Tf-RPM of the drum at the main spinning step S260.

[0066] The amount of wet laundry is sensed by accelerating the drum at a predetermined speed A-RPM, generally within the range of 108RPM and decelerating the drum by braking power. Since this sensing of the amount of wet laundry is widely known, its detailed description will be omitted. After sensing the amount of wet laundry, the control part carries out the laundry disentangling step to distribute the laundry inside the drum (S130). The laundry disentangling step is to uniformly distribute the laundry inside the drum, thereby preventing an unbalance rate of the drum from being increased by concentration of the laundry on a specific region. This is because that vibration increases when the rotation speed of the drum increases if the unbalance rate is increased. Subsequently, the control part senses the unbalance rate (S150). If the laundry inside the drum is not distributed uniformly but concentrated on a predetermined region, the unbalance rate is increased, whereby vibration may be caused when the rotation speed of the drum is increased. Accordingly, the control part determines whether to accelerate the drum by sensing the unbalance rate of the drum. Unbalance sensing is carried out using the difference in acceleration when the drum is rotated. Namely, when the drum is rotated, the difference in acceleration between the case where the drum is rotated downwardly and the case where the drum is rotated upwardly occurs depending on an unbalance level. The control part measures this difference in acceleration by using a speed sensor such as a hole sensor provided in a driving motor, thereby sensing the unbalance rate. Accordingly, if the unbalance rate is sensed, the laundry inside the drum sticks to an inner wall of the drum without dropping even though the drum is rotated. In this case, the drum is rotated in the range of 108 RPM, approximately.

[0067] The spinning step S200 will be described in

more detail.

[0068] As described above, the spinning step S200 can be divided into a main spinning step S260 for substantially carrying out spinning at a predetermined speed Tf-RPM and an accelerating step S250 for reaching the main spinning step S260. In order to reach the main spinning step, i.e., main spinning speed Tf-RPM, the rotation speed of the drum should pass through the transient vibration region R1 and the irregular vibration region R2. As described above, if the transient vibration region R1 has natural vibration characteristics determined by the structure of the laundry machine, and is in the range of 200RPM to 350RPM, approximately.

[0069] FIG. 8 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 m0 and m1 respectively and maximum holding laundry amounts are Δm, respectively. Then, the transition regions of the two laundry machines can be determined taking Δnf0 and Δnf1 into account, respectively. In this instance, amounts of water contained in the laundry will not be taken into account, for the time being.

[0070] In the meantime, referring to FIG. 8, the laundry machine with smaller mass m1 has a range of the transition region greater than the laundry machine with greater mass m0. 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.

[0071] The ranges of the transition regions will be reviewed on the related art laundry machine and the laundry machine of the embodiment.

[0072] 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 indispensible. 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.

[0073] 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.

[0074] Then, referring to FIG. 8, the related art laundry machine has mass m0 and the laundry machine of the embodiment has mass m1, leading the laundry machine of the embodiment to have a greater transition region, at the end.

[0075] Moreover, if the amounts of water contained in the laundry are taken into account simply, Δm in FIG. 8 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.

[0076] 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.

[0077] 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.

[0078] 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.

[0079] 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.

[0080] 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.

[0081] 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 balancing 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.

[0082] 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.

[0083] According to the studies of the inventor of the present invention, the irregular vibration region R2 is regarded as specific vibration characteristics of the embodiment of the present invention. Such irregular vibration is not always generated but is likely to be generated relatively. The irregular vibration was occurred in the range of 400RPM to 1000RPM, approximately.

[0084] When the rotation speed of the drum passes through the transient vibration region R1 and the irregular vibration region R2, great vibration occurs irregularly in the laundry machine. Accordingly, it is preferable that the control part appropriately controls rotation of the drum to allow the drum to effectively pass through the transient vibration region R1 and the irregular vibration region R2. Since many suggestions for the transient vibration region R1 have been provided, detailed description of the transient vibration region R1 will be omitted herein. Hereinafter, the control method of the irregular vibration region R2 will mainly be described.

[0085] In this embodiment, the control method of the irregular vibration region R2 includes an irregular vibration region determining step for determining the irregular vibration region R2 of the laundry machine and a balancing step for carrying out balancing by rotating the drum at a predetermined balancing speed for a predetermined time based on the determined irregular vibration region R2 to allow the ball to be located in an opposite position of an unbalanced position.

[0086] Preferably, the balancing step is carried out at least one time before the rotation speed of the drum belongs to the irregular vibration region R2, while the rotation speed of the drum is passing through the irregular vibration region R2, and after the rotation speed of the drum passes through the irregular vibration region R2. This is because that balanced balls may be likely to be detached from the balancing position as irregular vibration is likely to occur at the irregular vibration region R2. This is also because that greater vibration may occur due to unbalance as the ball becomes unbalanced if it is not located at the opposite position of the unbalanced position. Accordingly, if balancing is carried out at least one time before the rotation speed of the drum belongs to the irregular vibration region R2, while the rotation speed of the drum is passing through the irregular vibration region R2, and after the rotation speed of the drum passes through the irregular vibration region R2, vibration of the laundry machine due to irregular vibration that may occur can be reduced. Also, if balancing is carried out at least one time before the rotation speed of the drum belongs to the irregular vibration region R2, while the rotation speed of the drum is passing through the irregular vibration region R2, and after the rotation speed of the drum passes through the irregular vibration region R2, it is advantageous in that water is removed form the laundry as the spinning step is carried out, and that unbalancing occurring due to the difference in the spinning amount of laundry can be compensated.

[0087] Each balancing carried out before the rotation speed of the drum belongs to the irregular vibration region R2, while the rotation speed of the drum is passing through the irregular vibration region R2, and after the rotation speed of the drum passes through the irregular vibration region R2 will be described as follows.

[0088] First of all, balancing (first balancing) carried out before the rotation speed of the drum belongs to the irregular vibration region R2 will be described.

[0089] It is preferable that the drum is maintained at a predetermined balancing speed B1-RPM (hereinafter, referred to as"first balancing speed") for a predetermined time t1 before the rotation speed of the drum belongs to

the irregular vibration region R2. In this case, since the ball can be located relatively exactly at the opposite position of the unbalanced position one more time before the drum belongs to the irregular vibration region R2, unbalance can be compensated relatively exactly, whereby irregular vibration that may occur can be avoided. Also, even though the ball is detached from the compensation position while the drum is passing through the irregular vibration region R2, vibration can be reduced as compared with that balancing is not carried out before the rotation speed of the drum belongs to the irregular vibration region R2.

[0090] Preferably, the first balancing speed B1-RPM is selected such that the ball can be balanced effectively in view of the structure of the balancer. The ball is not balanced effectively at every rotation speed of the drum. If the rotation speed of the drum is too small, balancing effect is deteriorated. According to the studies of the inventor of the present invention, when the rotation speed of the drum is in the range of 200RPM to 800RPM, approximately, the ball was balanced effectively. Especially, the ball was balanced effectively in case of low speed and constant speed.

[0091] Accordingly, it is preferable that the first balancing speed B1-RPM is selected from any one of 200RPM to 800RPM. More preferably, the first balancing speed B1-RPM is selected from any one of 200RPM to 800RPM after the rotation speed of the drum passes through the transient vibration region R1. This is because that the ball may be detached from the balancing position due to transient vibration when the first balancing speed B1-RPM is selected from the speed of the transient vibration region.

[0092] Finally, if the irregular vibration region R2 is in the range of 400RPM to 1000RPM, approximately and the transient vibration region R1 is in the range of 200RPM to 350RPM, approximately, it is preferable that the first balancing speed B1-RPM is selected from the range of 350RPM to 400RPM, approximately. As a result of the studies of the inventor of the present invention, the first balancing speed was preferably in the range of 380RPM. Also, the first balancing speed B1-RPM was preferably maintained in the range of 30seconds to 60seconds.

[0093] Next, balancing (second balancing) carried out while the drum is passing through the irregular vibration region R2 will be described.

[0094] It is preferable that the drum is maintained at a predetermined balancing speed B2-RPM (hereinafter, referred to as"second balancing speed") for a predetermined time t2 even at the irregular vibration region R2. This is because that irregular vibration may be likely to occur at the irregular vibration region R2 and thus the ball may be detached from the balancing position while passing through the irregular vibration region R2. Accordingly, it is preferable that balancing is carried out one more time while the rotation speed of the drum is passing through the irregular vibration region R2, so as to allow the ball to be located exactly at the opposite position of the unbalanced position.

[0095] Preferably, the second balancing speed B2-RPM is selected such that the ball can be balanced effectively (200RPM to 800RPM) in view of the structure of the balancer. Accordingly, if the irregular vibration region R2 is in the range of 400RPM to 1000RPM, approximately, the second balancing speed B2-RPM is preferably selected from the range of 400RPM to 800RPM, approximately. As a result of the studies of the inventor of the present invention, the second balancing speed was preferably in the range of 600RPM corresponding to an intermediate level of the irregular vibration region R2.

[0096] Next, balancing (third balancing) carried out after the rotation of the drum passes through the irregular vibration region R2 will be described with reference to FIG. 6.

[0097] In this embodiment, the drum is maintained at a predetermined balancing speed B3-RPM (hereinafter, referred to as"third balancing speed") for a predetermined time t3 after it passes through the irregular vibration region R2. This is because that the ball may be detached from the balancing position after the rotation speed of the drum passes through the irregular vibration region R2 as the balanced ball is distributed due to irregular vibration occurring in the irregular vibration region R2 while the rotation speed of the drum is passing through the irregular vibration region R2. In other words, if balancing is carried out one more time after the rotation speed of the drum passes through the irregular vibration region R2, unbalancing can be compensated stably while the drum is being accelerated at a main spinning speed Tf-RPM or at the main spinning speed, whereby vibration can be reduced.

[0098] The third balancing speed B3-RPM may be selected at a specific speed, i.e., a rotation speed greater than that of the irregular vibration region R2 after the rotation speed of the drum passes through the irregular vibration region R2. However, in this case, balancing may not be carried out effectively. Accordingly, it is preferable that the third balancing speed B3-RPM is selected such that the ball can be balanced effectively in view of the structure of the balancer. In this respect, if the irregular vibration region R2 is in the range of 400RPM to 1000RPM, approximately, the third balancing speed B3-RPM is preferably selected from the range of 400RPM to 800RPM, approximately. In other words, it is preferable that the drum is decelerated at the third balancing speed B3-RPM for balancing after the rotation speed of the drum passes through the irregular vibration region R2 and then is accelerated to reach the main spinning speed Tf-RPM.

[0099] In this case, the rotation speed of the drum again passes through the irregular vibration region R2. According to the studies of the inventor of the present invention, in view of vibration reduction, it was effective that the third balancing is not carried out. In other words, irregular vibration does not always occur and weight of the laundry is reduced and unbalance is also reduced as water is

removed from the laundry in accordance with the spinning cycle. Accordingly, the probability of irregular vibration is reduced if the drum is decelerated after its rotation speed passes through the irregular vibration region R2 and then is accelerated again subsequently to balancing.

[0100] Also, for third balancing, if the drum is accelerated to reach the main spinning speed Tf-RPM after being decelerated at the third balancing speed B3-RPM, the time required for the main spinning step S260 can be reduced. In other words, when a target water content of the laundry is defined, spinning is carried out even in the case that the drum is accelerated after being decelerated at the third balancing speed B3-RPM. Accordingly, the time required for the main spinning step S260 can be reduced. Generally, a problem may occur in that vibration is caused if the drum is rotated at high speed. However, since the time required for the main spinning step S260 carried out by the drum at the highest rotation speed can be reduced, vibration can be reduced. In other words, as a result of the studies, since vibration occurring in the main spinning step S260 may cause a problem as compared with vibration that may occur when the rotation speed of the drum passes through the irregular vibration region after the third balancing, it was effective that the third balancing prevents vibration from occurring.

[0101] In the mean time, as a result of the studies of the inventor of the present invention, it was noted that the third balancing speed B3-RPM is preferably low but should be more than 350RPM so as not to be again in the range of the transient vibration region. More preferably, it was noted that the third balancing speed B3-RPM is 380RPM equally to the first balancing speed B1-RPM. In other words, it was preferably noted that the rotation speed of the drum is decelerated at the first balancing speed B1-RPM after passing through the irregular vibration region (Tm-RPM) and then accelerated to reach the main spinning speed Tf-RPM after being maintained at the first balancing speed B 1-RPM for a predetermined time.

[0102] In the mean time, as shown in FIG. 7, the rotation speed of the drum may be maintained at a predetermined constant speed Tm-RPM for a predetermined time t4 without being directly decelerated at the third balancing speed B3-RPM after passing through the irregular vibration region R2. In this case, the water content of the laundry can be more reduced when the rotation speed of the drum is maintained at the predetermined constant speed Tm-RPM for the predetermined time t4. Accordingly, the rotation speed of the drum can be more reduced when it is in the range of the main spinning speed Tf-RPM corresponding to the highest rotation speed. As a result, it is advantageous in that vibration due to high rotation speed can be reduced.

[0103] 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.

List of Embodiments

[0104]

Embodiment 1	A control method of a laundry machine comprising a balancer, the control method comprising: a step configured to determine an irregular vibration region of the laundry machine; and a balancing step implemented at least one time before a rotation speed of a drum enters the irregular vibration region, while the rotation speed is passing the irregular vibration region and after the rotation speed passes the irregular vibration region.
Embodiment 2	The control method of embodiment 1, wherein the irregular vibration region is determined to be generated if a maximum drum displacement or more in a RPM band lower than the transient region or a maximum drum displacement or more of a steady state step in a RPM band higher than the transient region is generated.
Embodiment 3	The control method of embodiment 2, wherein the irregular vibration is generated in a RPM band higher than the transient region.
Embodiment 4	The control method of embodiment 1, wherein the irregular vibration is generated in a RPM band of 350 to 100 RPM.
Embodiment 5	The control method of embodiment 1, wherein the irregular vibration is determined to be generated, if an average drum displacement in the trans ient region, +20% to -20% of the average drum displacement in the transient region or 1/3 or more of a maximum drum displacement in a natural frequency is generated.
Embodiment 6	The control method of embodiment 1, wherein the step of balancing the ball is carried out before the rotation speed of the drum belongs to the irregular vibration region.
Embodiment 7	The control method of embodiment 6, wherein the balancing speed in the step of balancing the ball is maintained at any one of 350rpm to 400rpm.
Embodiment 8	The control method of embodiment

6, wherein the balancing speed in the step of balancing the ball is maintained at 380rpm.

Embodiment 9 The control method of embodiment 1, wherein the step of balancing the ball is carried out while the rotation speed of the drum is passing through the irregular vibration region.

Embodiment 10 The control method of embodiment 9, wherein the balancing speed in the step of balancing the ball is maintained by at least one of 350 rpm to 1000rpm.

Embodiment 11 The control method of embodiment 10, wherein the balancing speed in the step of balancing the ball is maintained at 600rpm.

Embodiment 12 The control method of embodiment 1, wherein the step of balancing the ball is carried out after the rotation speed of the drum passes through the irregular vibration region.

Embodiment 13 The control method of embodiment 12, wherein the balancing speed in the step of balancing the ball is selected from a speed region suitable for balancing.

Embodiment 14 The control method of embodiment 13, wherein the step of balancing the ball is carried out by the rotation speed of the drum, which belongs to at least one of 200rpm to 800rpm.

Embodiment 15 The control method of embodiment 14, wherein the step of balancing the ball is carried out by the rotation speed of the drum, which belongs to 380rpm.

Embodiment 16 The control method of embodiment 14, wherein the drum is rotated at a constant speed for a predetermined time after the rotation speed of the drum passes through the irregular vibration region.

Embodiment 17 The control method of embodiment 1, wherein the laundry machine comprises 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.

Embodiment 18 The control method of embodiment 1, wherein the laundry machine comprises 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.

Embodiment 19 The control method of embodiment 1, wherein a tub is supported rigidly more than a drum being supported by a suspension assembly.

Claims

1. A control method of a laundry machine (100) including a tub (12) connected with a vibration source via a rear gasket (250), a drum (30) rotatably provided in the tub (12), and a ball balancer (70; 310; 330) comprising a ball (312), the laundry machine (100) having an irregular vibration region (R2) in which irregular vibration is generated after passing through a transient region (R1), the transient region (R1) being a region of a rotation speed of the drum (30) where irregular transient vibration occurs,
wherein irregular vibration is determined to be generated in the irregular vibration region (R2) if a drum displacement is the maximum drum displacement or more generated in an RPM band lower than the transient region (R1), or is the maximum drum displacement or more of a steady state step where vibration becomes steady in a RPM band higher than the transient region (R1),
the control method comprising:

a step configured to determine an irregular vibration region of the laundry machine;
a first balancing step of rotating the drum at a constant speed (B1-RPM) for a predetermined time period (t1) performed after passing through the transient region (R1) and before entering the irregular vibration region (R2); and
a second balancing step of rotating the drum at a constant speed (B2-RPM; B3-RPM) for a predetermined time period (t2; t3), wherein the second balancing step is performed after the first balancing step and after entering the irregular vibration region (R2) and increasing the rotation speed of the drum (30) to be higher than the rotation speed (B1-RPM) of the drum (30) in the first balancing step.

2. The control method as claimed in claim 1, wherein the irregular vibration is generated in a RPM band higher than the transient region (R1).

3. The control method as claimed in claim 1, wherein the irregular vibration is generated in a RPM band of 3 50 to 1000 RPM.

4. The control method as claimed in claim 1, wherein the balancing speed in the first balancing step is maintained at any one of 350rpm to 400rpm.

5. The control method as claimed in claim 1, wherein

the second balancing step is carried out while the rotation speed of the drum (30) is passing through the irregular vibration region (R2).

6. The control method as claimed in claim 5, wherein the balancing speed (B2-RPM) in the second balancing step is maintained by at least one of 350 rpm to 1000rpm.

7. The control method as claimed in claim 1, wherein the second balancing step is carried out after the rotation speed of the drum (30) passes through the irregular vibration region (R2).

8. The control method as claimed in claim 7, wherein the balancing speed (B2-RPM) in the second balancing step is selected from a speed region suitable for balancing.

9. The control method as claimed in claim 8, wherein the second balancing step is carried out by the rotation speed of the drum (30), which belongs to at least one of 200rpm to 800rpm.

10. The control method as claimed in claim 9, wherein the drum is rotated at a constant speed (T_m-RPM) for a predetermined time (t4) after the rotation speed of the drum (30) passes through the irregular vibration region (R2).

Patentansprüche

1. Steuerverfahren für eine Waschmaschine (100), die einen Bottich (12), der mit einer Schwingungsquelle über eine hintere Dichtung (250) verbunden ist, eine Trommel (30), die in dem Bottich (12) drehbar vorgesehen ist, und ein Kugel-Ausgleichselement (70; 310; 330), das eine Kugel (312) aufweist, umfasst, wobei die Waschmaschine (100) einen Bereich (R2) einer ungleichmäßigen Schwingung, in dem nach dem Durchlaufen eines Übergangsbereichs (R1) eine ungleichmäßige Schwingung erzeugt wird, aufweist, wobei der Übergangsbereich (R1) ein Drehzahlbereich der Trommel (30) ist, in dem eine ungleichmäßige Übergangsschwingung auftritt,
wobei festgestellt wird, dass eine ungleichmäßige Schwingung in dem Bereich (R2) einer ungleichmäßigen Schwingung erzeugt wird, wenn eine Trommelverlagerung mindestens die maximale Trommelverlagerung ist, die in einem Drehzahlband erzeugt wird, das niedriger als der Übergangsbereich (R1) ist, oder mindestens die maximale Trommelverlagerung einer Gleichgewichtsstufe ist, bei der eine Schwingung in einem Drehzahlband, das höher als der Übergangsbereich (R1) ist, gleichmäßig wird,
wobei das Steuerverfahren die folgenden Schritte umfasst:
einen Schritt, der konfiguriert ist, einen Bereich einer ungleichmäßigen Schwingung der Waschmaschine festzustellen;
einen ersten Ausgleichsschritt zum Drehen der Trommel mit einer konstanten Drehzahl (B1-RPM) für eine vorgegebene Zeitdauer (t1), der nach dem Durchlaufen des Übergangsbereichs (R1) und vor dem Eintritt in den Bereich (R2) einer ungleichmäßigen Schwingung durchgeführt wird; und
einen zweiten Ausgleichsschritt zum Drehen der Trommel mit einer konstanten Drehzahl (B2-RPM; B3-RPM) für eine vorgegebene Zeitdauer (t2; t3), wobei der zweite Ausgleichsschritt nach dem ersten Ausgleichsschritt und nach dem Eintritt in den Bereich (R2) einer ungleichmäßigen Schwingung und einer Erhöhung der Drehzahl der Trommel (30), so dass sie höher als die Drehzahl (B1-RPM) der Trommel (30) in dem ersten Ausgleichsschritt ist, durchgeführt wird.

2. Steuerverfahren nach Anspruch 1, wobei die ungleichmäßige Schwingung in einem Drehzahlband erzeugt wird, das höher als der Übergangsbereich (R1) ist.

3. Steuerverfahren nach Anspruch 1, wobei die ungleichmäßige Schwingung in einem Drehzahlband im Bereich von 350 min^{-1} bis 1000 min^{-1} erzeugt wird.

4. Steuerverfahren nach Anspruch 1, wobei die Drehzahl zum Ausgleichen in dem ersten Ausgleichsschritt auf einer Drehzahl von 350 min^{-1} bis 400 min^{-1} gehalten wird.

5. Steuerverfahren nach Anspruch 1, wobei der zweite Ausgleichsschritt ausgeführt wird, während die Drehzahl der Trommel (30) durch den Bereich (R2) einer ungleichmäßigen Schwingung läuft.

6. Steuerverfahren nach Anspruch 5, wobei die Drehzahl (B2-RPM) zum Ausgleichen in dem zweiten Ausgleichsschritt auf einer Drehzahl von wenigstens 350 min^{-1} bis 1000 min^{-1} gehalten wird.

7. Steuerverfahren nach Anspruch 1, wobei der zweite Ausgleichsschritt ausgeführt wird, nachdem die Drehzahl der Trommel (30) durch den Bereich (R2) einer ungleichmäßigen Schwingung gelaufen ist.

8. Steuerverfahren nach Anspruch 7, wobei die Drehzahl (B2-RPM) zum Ausgleichen in dem zweiten Ausgleichsschritt aus einem Drehzahlbereich ausgewählt wird, der zum Ausgleichen geeignet ist.

9. Steuerverfahren nach Anspruch 8, wobei der zweite Ausgleichsschritt durch die Drehzahl der Trommel (30) ausgeführt wird, die zu dem Bereich von we-

nigstens 200 min^{-1} bis 800 min^{-1} gehört.

10. Steuerverfahren nach Anspruch 9, wobei die Trommel mit einer konstanten Drehzahl (T_m-RPM) für eine vorgegebene Zeitdauer (t4) gedreht wird, nachdem die Drehzahl der Trommel (30) durch den Bereich (R2) einer ungleichmäßigen Schwingung gelaufen ist.

Revendications

1. Procédé de commande d'une machine à laver le linge (100) incluant une cuve (12) connectée avec une source de vibrations via un joint arrière (250), un tambour (30) prévu en rotation dans la cuve (12), et un équilibreur à bille (70 ; 310 ; 330) comprenant une bille (312), la machine à laver (100) ayant une région de vibration irrégulière (R2) dans laquelle une vibration irrégulière est générée après avoir passé via une région transitoire (R1), la région transitoire (R1) étant une région d'une vitesse de rotation du tambour (30) dans laquelle se produit une vibration transitoire irrégulière,
dans lequel on détermine qu'une vibration irrégulière est générée dans la région à vibration irrégulière (R2) si un déplacement du tambour est le déplacement maximum du tambour ou plus, généré dans une bande de vitesses de rotation plus basse que la région transitoire (R1), ou est le déplacement maximum du tambour ou plus d'une étape en état permanent dans laquelle la vibration devient stable dans une bande de vitesses de rotation plus haute que la région transitoire (R1),
le procédé de commande comprenant :

une étape configurée pour déterminer une région de vibration irrégulière de la machine à laver ;
une première étape d'équilibrage consistant à mettre le tambour en rotation à une vitesse constante (B1-TPM) pendant une période temporelle prédéterminée (t1) exécutée après être passé à travers la région transitoire (R1) et avant d'entrer dans la région à vibration irrégulière (R2) ; et
une seconde étape d'équilibrage consistant à mettre le tambour en rotation à une vitesse constante (B2-TPM ; B3-TPM) pendant une période temporelle prédéterminée (t2 ; t3), dans lequel la seconde étape d'équilibrage est exécutée après la première étape d'équilibrage et après être entré dans la région à vibration irrégulière (R2) et en augmentant la vitesse de rotation du tambour (30) pour qu'elle soit plus élevée que la vitesse de rotation (B1-TPM) du tambour (30) dans la première étape d'équilibrage.

2. Procédé de commande selon la revendication 1, dans laquelle la vibration irrégulière est générée dans une bande de vitesses de rotation plus haute que la région transitoire (R1).

3. Procédé de commande selon la revendication 1, dans lequel la vibration irrégulière est générée dans une bande de vitesses de rotation de 350 à 1000 TPM.

4. Procédé de commande selon la revendication 1, dans lequel la vitesse d'équilibrage dans la première étape d'équilibrage est maintenue à un régime quelconque de 350 TPM à 400 TPM

5. Procédé de commande selon la revendication 1, dans lequel la seconde étape d'équilibrage est effectuée alors que la vitesse de rotation du tambour (30) traverse la région à vibration irrégulière (R2).

6. Procédé de commande selon la revendication 5, dans lequel la vitesse d'équilibrage (B2-TPM) dans la seconde étape d'équilibrage est maintenue à au moins un régime de 350 TPM à 1000 TPM.

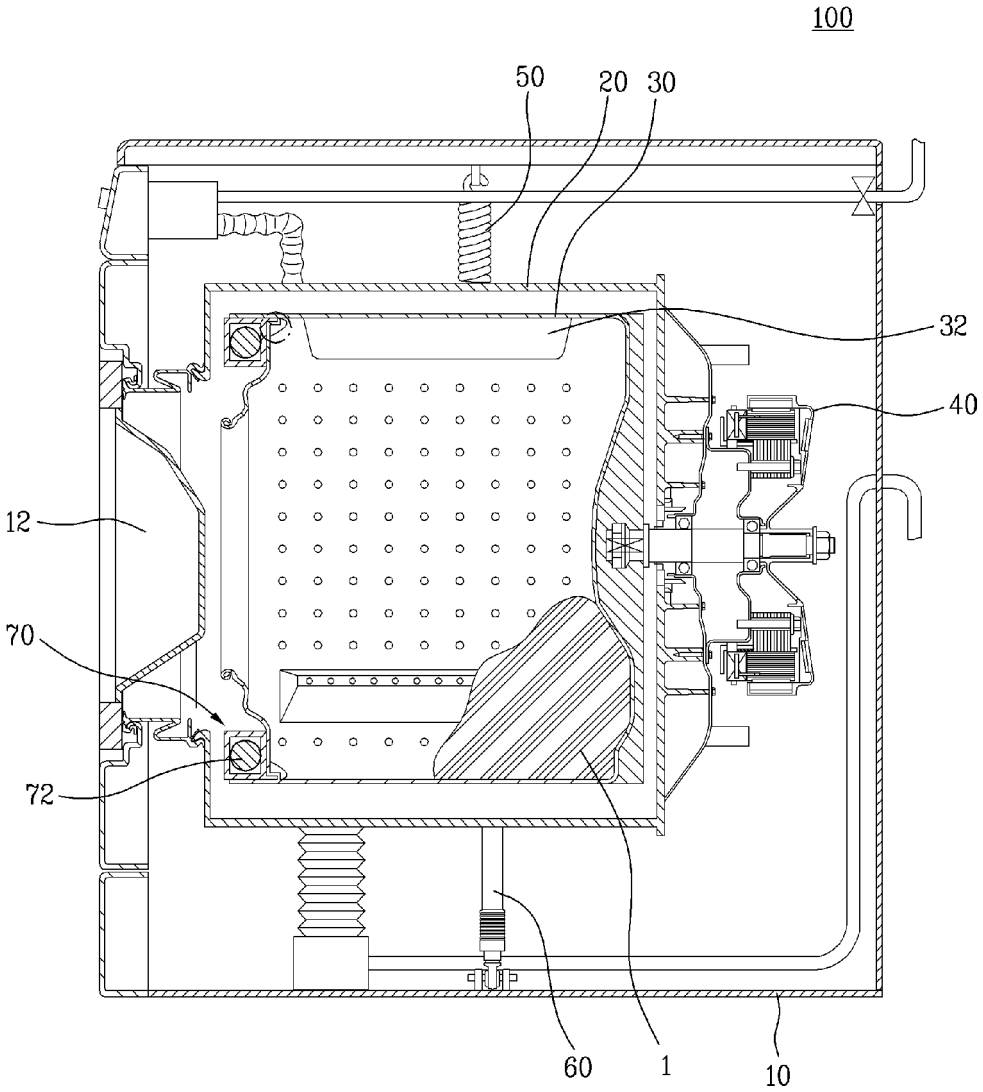
7. Procédé de commande selon la revendication 1, dans lequel la seconde étape d'équilibrage est effectuée après que la vitesse de rotation du tambour (30) soit passée à travers la région à vibration irrégulière (R2).

8. Procédé de commande selon la revendication 7, dans lequel la vitesse d'équilibrage (B2-TPM) dans la seconde étape d'équilibrage est sélectionnée depuis une région de vitesses convenable pour l'équilibrage.

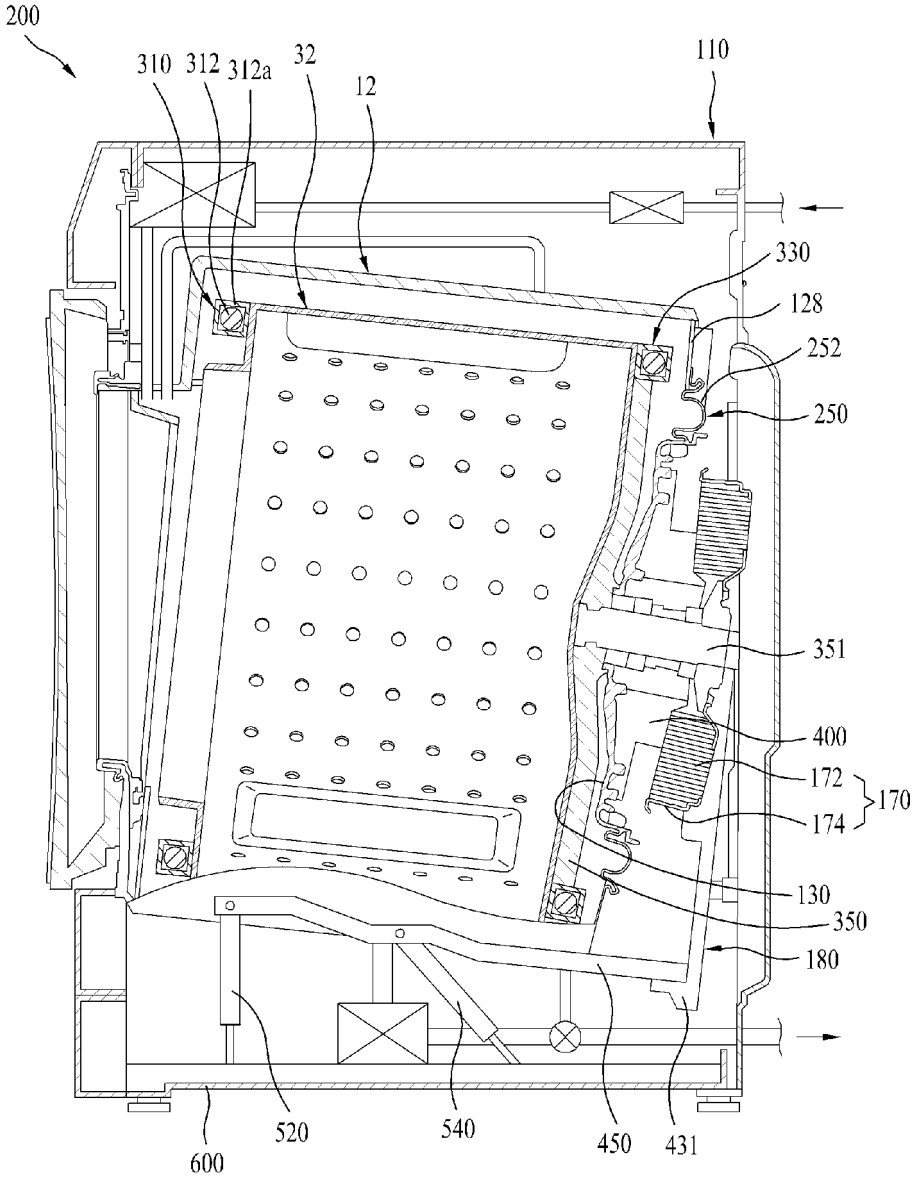
9. Procédé de commande selon la revendication 8, dans lequel la seconde étape d'équilibrage est effectuée à une vitesse de rotation du tambour (30) qui appartient à au moins un régime de 200 TPM à 800 TPM.

10. Procédé de commande selon la revendication 9, dans lequel le tambour est mis en rotation à une vitesse constante (Tm-TPM) pendant un temps prédéterminé (t4) après que la vitesse de rotation du tambour (30) soit passée à travers la région à vibration irrégulière (R2).

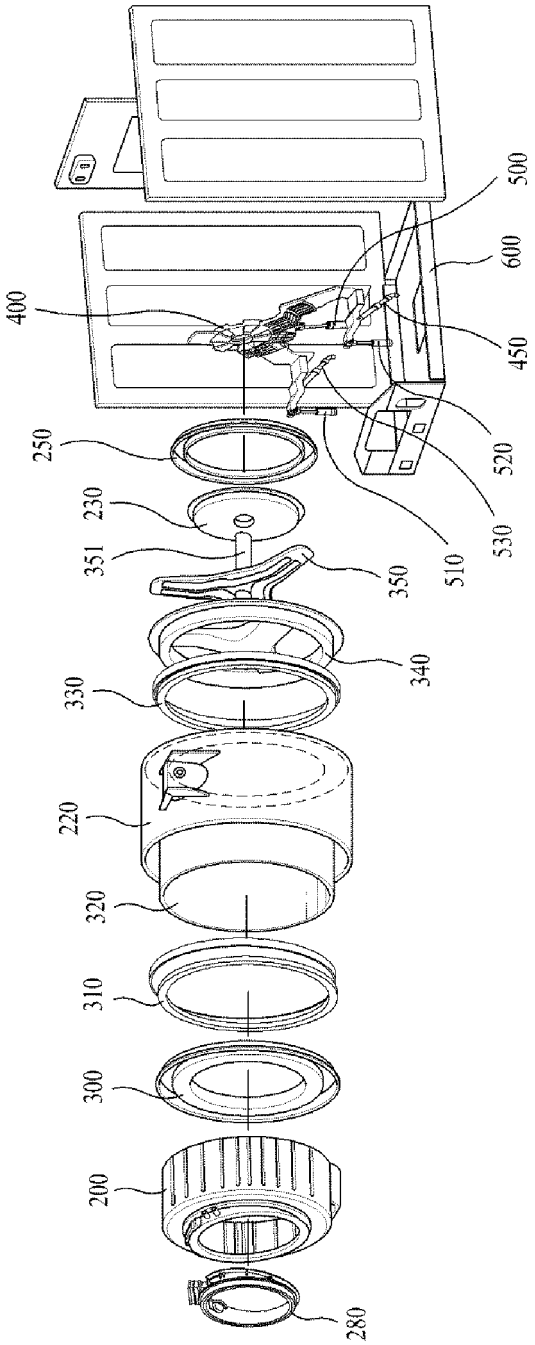
[Fig. 1]



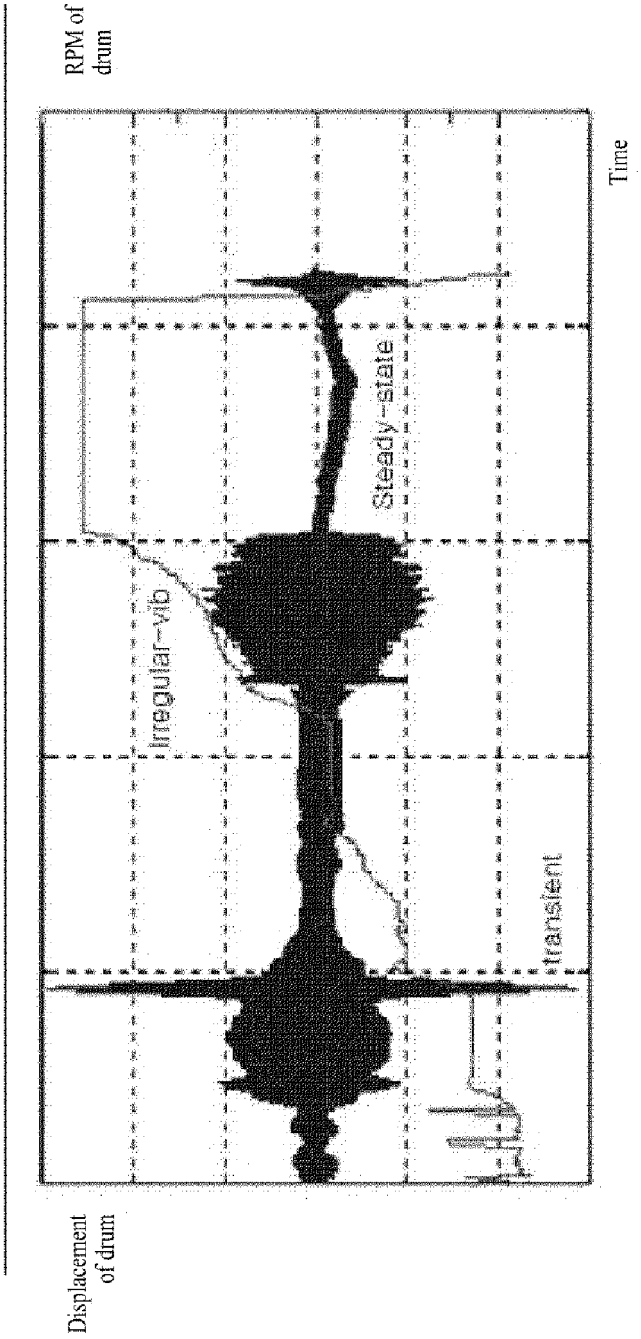
[Fig. 2]


200
310
312
312a
32
12
110
330
128
252
250
351
400
172
174
170
130
350
180
520
540
450
431
600

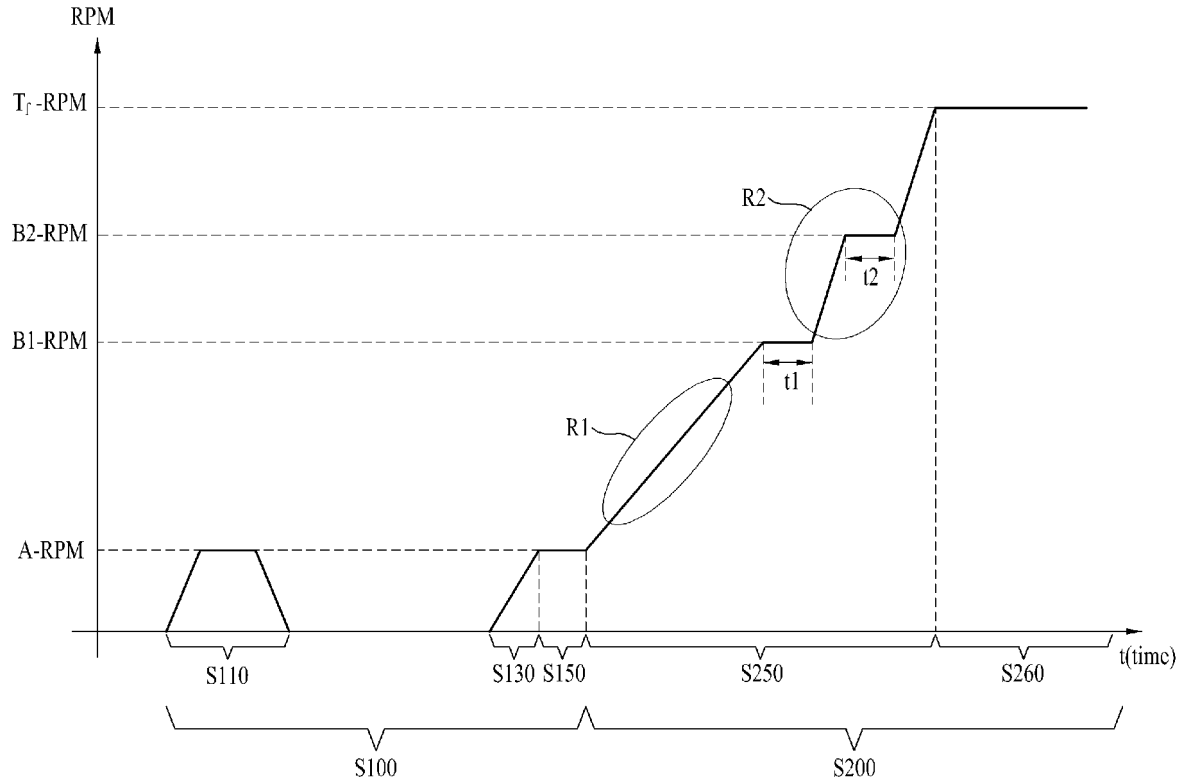
[Fig. 3]


500
600
400
450
520
530
510
250
230
351
350
340
330
220
320
310
300
200
280

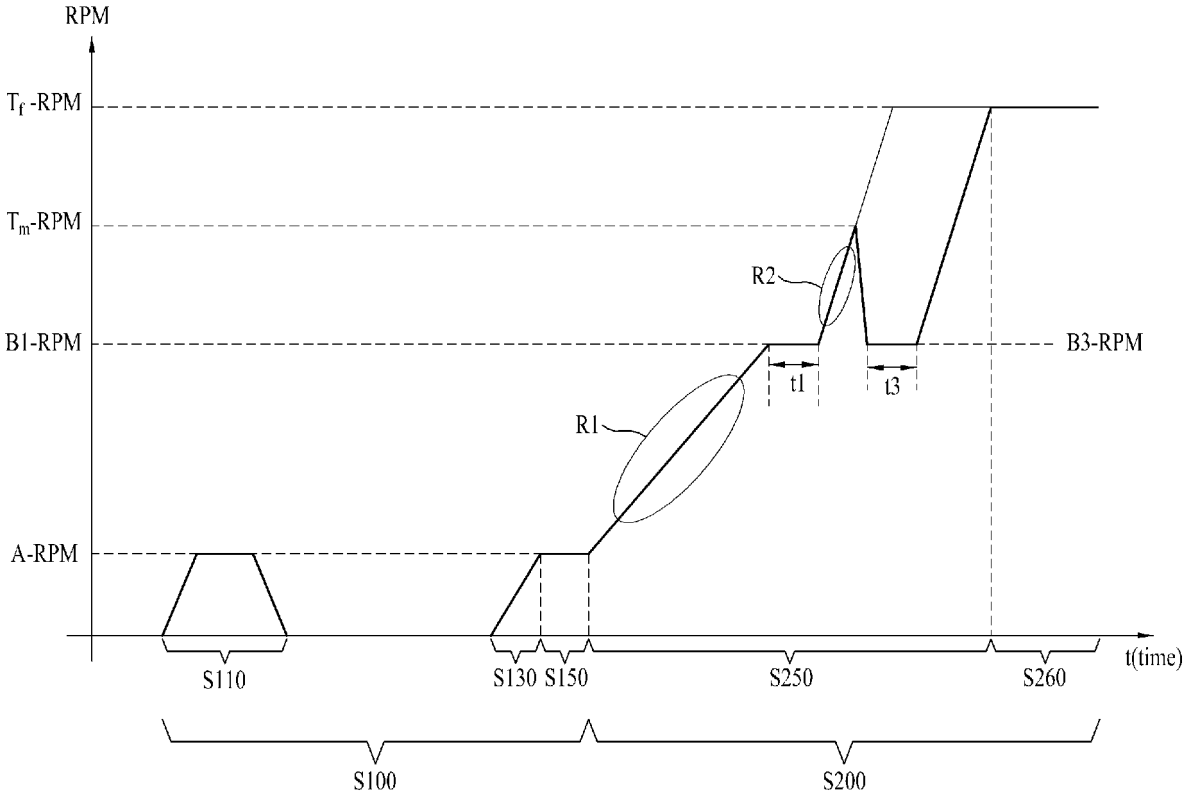
[Fig. 4]


RPM of drum
Time
Steady-state
Irregular-vib
transient
Displacement of drum

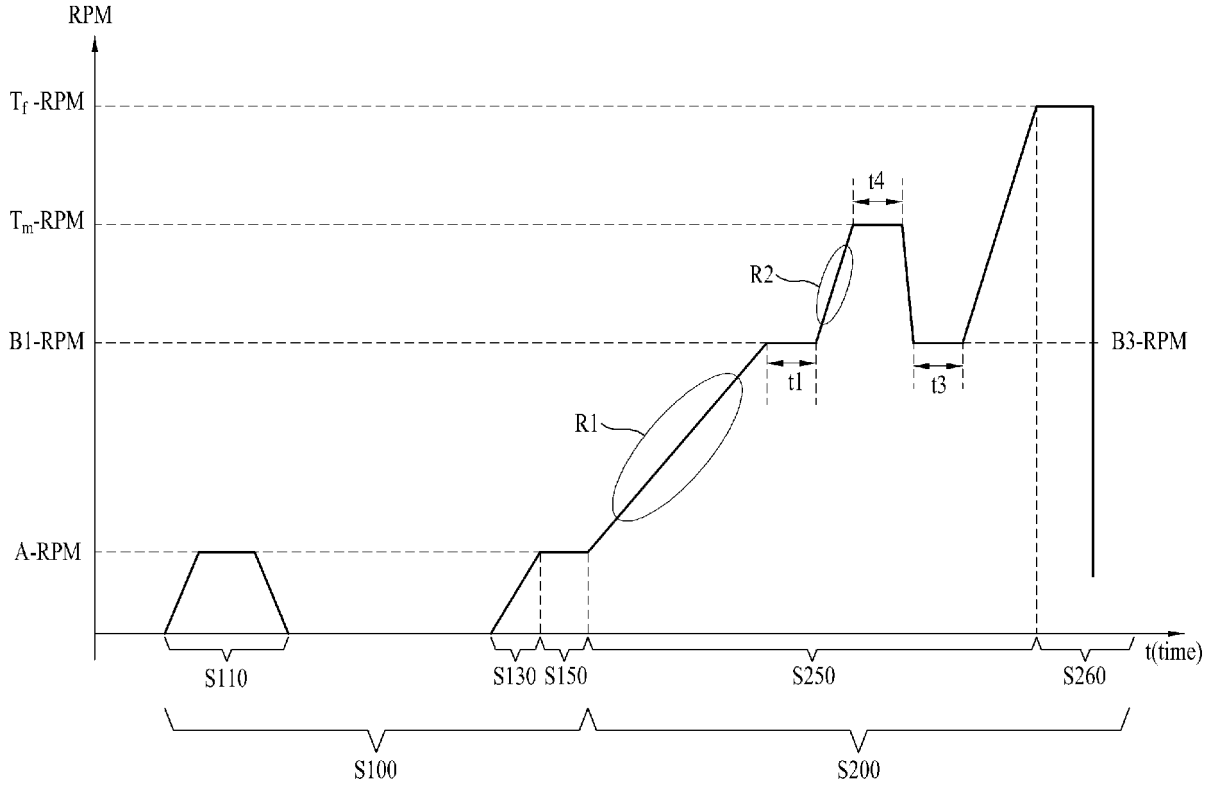
[Fig. 5]


RPM
T_f -RPM
B2-RPM
B1-RPM
A-RPM
R2
t2
t1
R1
S110
S130 S150
S250
S260
t(time)
S100
S200

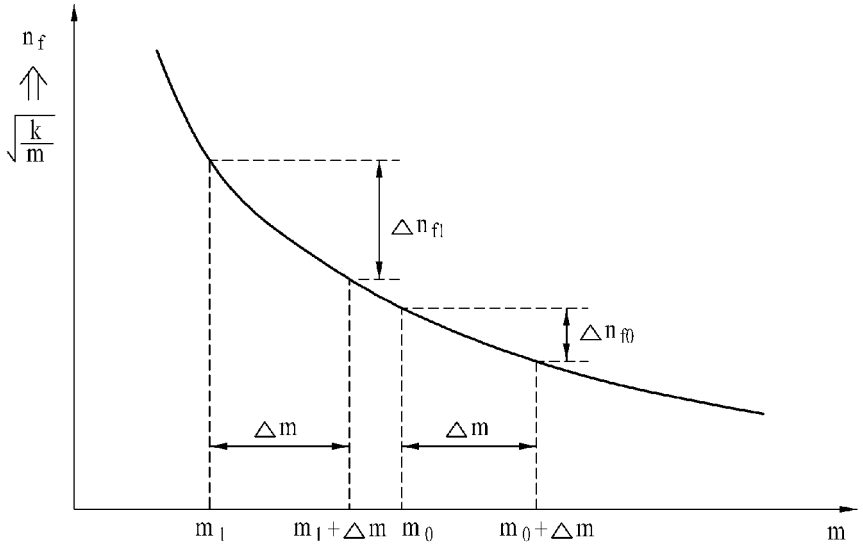
[Fig. 6]


RPM
T_f -RPM
T_m-RPM
B1-RPM
B3-RPM
A-RPM
R2
t1
t3
R1
S110
S130 S150
S250
S260
t(time)
S100
S200

[Fig. 7]


RPM
Tf -RPM
Tm-RPM
B1-RPM
A-RPM
B3-RPM
t4
R2
t1
t3
R1
t(time)
S110
S130 S150
S250
S260
S100
S200

[Fig. 8]


nf
k/m
△nf1
△nf0
△m
△m
m1
m1+△m
m0
m0+△m
m

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 1950336 A1 **[0003]**
- EP 2083109 A1 **[0004]**