(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 568 813 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
31.08.2005 Bulletin 2005/35

(51) Int Cl.[7]: **D06F 37/20**, D06F 35/00

(21) Application number: **04257173.7**

(22) Date of filing: **19.11.2004**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LU MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL HR LT LV MK YU

(30) Priority: **27.02.2004 KR 2004013268**
27.02.2004 KR 2004013269

(71) Applicant: **LG ELECTRONICS INC.**
Seoul 150-721 (KR)

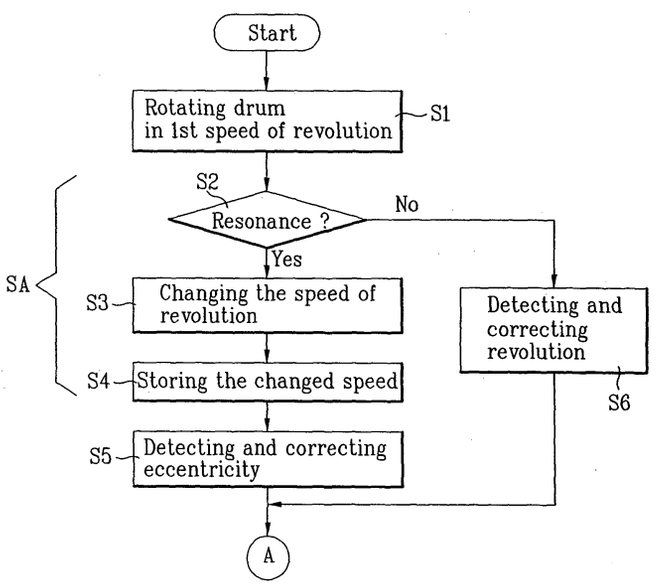
(72) Inventors:
- **Son, Kweon**
  Changwon-si Gyeongsangnam-do (KR)
- **No, Yang Hwan**
  Changwon-shi 641-091, Kyongsangam-do (KR)
- **Kang, Jung Hoon, Ducksan 1-cha APT**
  641-758, Gyeongsangnam-do (KR)
- **Choi, Hyo Sik**
  110-1102 Hakjang-dong Sasang-gu Busan (KR)

(74) Representative: **Hale, Peter et al**
Kilburn & Strode
20 Red Lion Street
London WC1R 4PJ (GB)

(54) Washing machine and method for controlling the same

(57) Method for controlling a washing machine having a drum of which rotation speed is adjustable, including a first step for rotating the drum at a first rotation speed set at control unit, a second step for detecting whether resonance occurs or not at the drum rotating at the first rotation speed, and a third step for changing the rotation speed of the drum if the resonance is detected at the drum.

FIG. 4



EP 1 568 813 A1

Description

[0001] The present invention relates to washing machines and methods for controlling the same. More particularly the invention relates to a method and device for preventing resonance from occurring during spinning of a washing machine.

[0002] In general, a washing machine washes laundry by the softening action of detergent, and friction of the laundry with water circulation caused by rotation of a pulsator or drum. Recently, the demand for drum type washing machines has increased, which can reduce an entire height compared to a pulsator type washing machine, and prevent wrinkles from forming.

[0003] FIG 1 illustrates a section of a prior art drum type washing machine.

[0004] Referring to FIG 1, the prior art drum type washing machine is provided with a tub 3 inside of a cabinet 5 which forms an outer appearance of the drum type washing machine, and a drum 9 rotatably mounted on an inside of the tub 3. The cabinet 5 has a door 1 on a front for introduction of laundry, with a gasket 2 between the door 1 and the tub 3.

[0005] The tub 3 has springs 4 each with one end secured to an upper outside circumference thereof and the other end secured to the cabinet 5, and a friction damper 10 thereunder for damping vibration.

[0006] On a rear of the tub 3, there is a motor 6 directly coupled to the drum 9 with a rotation shaft 13. On front and rear portion of the rotation shaft 13, there are bearings 12 provided thereto, and on a rear surface of the tub 3, there is a bearing housing for supporting the bearing 12.

[0007] The motor 6 is provided with a stator 7 and a rotor 8, wherein the stator 7 is mounted to the rear surface of the tub 3, and the rotor 8 is fixed to the rotation shaft 13. Therefore, when the rotor 8 rotates, the drum 9 connected to the rotor 8 rotates at the same time.

[0008] There is a sensor (not shown) at one side of the motor 6 for detecting a rotation speed of the rotor 8, and on an upper portion of a front surface of the cabinet 5, there is a control panel having various buttons for controlling operation of the washing machine.

[0009] Upon introduction of the laundry into the drum 9, and selecting a washing course, a washing cycle and a rinsing cycle are performed, and a spinning cycle is performed after the above cycles are finished.

[0010] In the spinning cycle of the laundry, the rotation speed of the motor 6 is increased gradually until the rotation speed reaches a preset speed when the preset speed is maintained for a preset time period. In this instance, even though a water extraction performance is proportional to the rotation speed of the motor 6, the rotation speed may vary with the extent of eccentricity of the laundry. That is, if the eccentricity of the laundry is great, the rotation speed of the drum 9 drops, or the rotation shaft 13 suffers damage. Therefore, it is required to measure the eccentricity before the spinning of the washing machine starts.

[0011] During the spinning, there can be resonance of the washing machine installed on a floor at a particular rotation speed of the motor 6. That is, if the rotation speed of the motor and the drum approaches close to a natural frequency of the frame, such as the cabinet and the like, resonance occurs, and once the resonance occurs, vibration and noise become very considerable.

[0012] The considerable or "heavy" vibration and noise significantly inconveniences measuring the eccentricity of the laundry or in spinning the laundry, or damages the laundry. Moreover, the heavy vibration and noise reduces reliability of use of the product.

[0013] Accordingly, the present invention is directed to a washing machine, and a method for controlling the same that substantially obviates one or more problems due to limitations and disadvantages of the prior art.

[0014] The present invention is set out in the independent claims. Some optional features are set out in the claims dependent thereto.

[0015] According to one embodiment there is provided a washing machine for preventing resonance from occurring during spinning of the washing machine, and a method for controlling the same.

[0016] According to one aspect of the present invention there is provided a method for controlling a washing machine having a drum of which rotation speed is adjustable includes a first step for rotating the drum at a first rotation speed set at control unit, a second step for detecting whether resonance occurs or not at the drum rotating at the first rotation speed, and a third step for changing the rotation speed of the drum if the resonance is detected at the drum.

[0017] Preferably, the third step includes the step of storing the changed rotation speed in the control unit. The drum is rotated at the changed rotation speed when the washing machine is put into operation again after the washing machine is stopped.

[0018] The third step may further include the step of measuring eccentricity of laundry held in the drum rotating at the changed rotation speed. The step of decreasing the rotation speed of the drum again after increasing the rotation speed of the drum is repeated, if the eccentricity is greater than a preset value.

[0019] The drum may be rotated in regular/reverse directions alternately for a plurality of times, if the eccentricity exceeds a preset value.

[0020] When the eccentricity is below the preset value, the third step may further include the steps of rotating the drum at the set second rotation speed for extracting water from the laundry, detecting whether the resonance occurs at the drum rotating at the second rotation speed or not, changing the rotation speed of the drum, if the resonance is detected at the drum, and storing the changed rotation speed in the control unit.

[0021] The method may further include the step of measuring the eccentricity of the laundry held in the drum, if no resonance occurs in the second step. The

step of decreasing the rotation speed of the drum again after increasing the rotation speed of the drum is repeated, if the eccentricity is greater than a preset value. The drum is rotated in regular/reverse directions alternately for a plurality of times, if the eccentricity exceeds a preset value.

[0022] When the eccentricity is below the preset value, the method may further include the steps of rotating the drum at the set second rotation speed for extracting water from the laundry, detecting whether the resonance occurs at the drum rotating at the second rotation speed or not, changing the rotation speed of the drum, if the resonance is detected at the drum, and storing the changed rotation speed in the control unit.

[0023] The rotation speed of the drum may increase in the third step. The rotation speed of the drum may decrease in the third step. The rotation speed of the drum may change by predetermined magnitudes each greater than 50rpm in the third step.

[0024] The resonance of the drum may be detected by a resonance detecting device automatically in the second step. The third step may be performed automatically by the control unit which receives a signal from the resonance detecting device.

[0025] The second step may include the step of sounding alarm through a speaker if the resonance of the drum is detected. The steps are performed in a state a test mode is selected.

[0026] In another aspect of the present invention, there is provided a method for controlling a washing machine having a drum of which rotation speed is adjustable for extracting water from laundry, includes a first step for rotating the drum at a second rotation speed set at a control unit, a second step for increasing the rotation speed from the second rotation speed by predetermined magnitudes of rpm in succession, and whether resonance occurs or not at every rotation speed section is detected, a third step for changing the rotation speed of the drum when resonance of the drum is detected, and a fourth step for storing the changed rotation speed in the control unit.

[0027] The first step may include the steps of selecting one of course relevant to a kind of laundry, and rotating the drum at the second rotation speed for the selected course.

[0028] The rotation speed of the drum may increase in the third step. The rotation speed of the drum may decrease in the third step. The rotation speed of the drum may change by predetermined magnitudes each greater than 50rpm in the third step.

[0029] Preferably, the steps are performed in a state a test mode is selected. The drum may be rotated at the changed rotation speed when the washing machine is put into operation again after the test mode is finished.

[0030] Preferably, not the changed rotation speed, but the second rotation speed is displayed on a display, when the washing machine is put into operation again after the washing machine is stopped. The fourth step may include the step of sounding an alarm from a speaker when the changed rotation speed is stored.

[0031] Preferably, the third step is performed automatically by the control unit having the signal received from a resonance detecting device. The second step may include the step of automatic detection of resonance occurrence at the drum by the resonance detecting device.

[0032] The second step may further include the step of storing a preset maximum rotation speed in the control unit in a case no resonance occurs until the drum rotates up to the preset maximum speed. The second step may further include the step of sounding an alarm from a speaker if the resonance of the drum is detected.

[0033] According to another aspect of the present invention, a washing machine includes a motor for generating rotating force, a drum for being rotated upon receiving driving force from the motor, a sensor for sensing rotation speed of the drum, a vibration detecting device for transmitting a signal if vibration greater than a preset value is detected at the drum, and a control unit for adjusting the rotation speed of the motor to prevent the resonance of the drum from occurring upon reception of the signal.

[0034] The washing machine may further include a rotary key electrically connected to the control unit for a user to turn to change the rotation speed of the drum. The washing machine may further include a selection button connected to the control unit for selecting a course for a kind of laundry. The washing machine may further include a storage button connected to the control unit for storing an adjusted rotation speed.

[0035] The washing machine may further include a test mode button connected to the control unit for performing a test mode to search a rotation speed at which the resonance of the drum occurs. The washing machine may further include a speaker connected to the control unit for sounding an alarm when a working rotation speed is stored. The washing machine may further include a display for displaying a rotation speed of the drum sensed at the sensor.

[0036] According to another aspect there is provided a washing machine or method for controlling the same as described herein, wherein the washing machine is a pulsator type.

[0037] It is to be understood that both the foregoing general description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

[0038] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention and together with the description serve to explain the principle of the invention. In the drawings;

FIG 1 illustrates a section of a prior art drum type

washing machine;

FIG 2A illustrates a frontal perspective view of a washing machine;

FIG 2B illustrates a graph showing variation of rotation speed during progress of spinning of a washing machine;

FIGS. 3A - 3C illustrate control systems of a washing machine in accordance with preferred embodiments of the present invention;

FIG 4 illustrates a flow chart showing the steps of a method for controlling spinning of a washing machine of the present invention;

FIG 5 illustrates a flow chart showing the steps of a method for controlling spinning of a washing machine in accordance with a preferred embodiment of the present invention; and

FIG 6 illustrates a flow chart showing a method for controlling spinning of a washing machine in accordance with another preferred embodiment of the present invention.

[0039] Reference will now be made in detail to the preferred 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.

[0040] FIG 2A illustrates a perspective view of a washing machine, having a control panel 100 on a front. The control panel 100 includes various buttons, a rotary key 200, and a display 300. The rotary keys 200 and buttons are connected to a control unit 103. As the user rotates the rotary key 200, rotation speeds of the motor and the drum are adjusted.

[0041] The buttons include a selection button 101, and a storage button 102. The selection button 101 is provided for selecting an operation course at various speeds depending on the kind of laundry, and the storage button 102 is provided to store the adjusted speed in the control unit. Moreover, a test mode button 110 is provided additionally, for selecting a test mode in which the rotation speed is set separately to avoid the resonance of the drum.

[0042] Referring to FIG 2B, the spinning step of the washing machine additionally includes an eccentricity detecting step. That is, in the spinning step, the eccentricity of the laundry and a foam quantity are detected. It is preferable that the detection of the eccentricity is performed at a rotation speed in the vicinity of 108 rpm at which the laundry starts to be in close contact with an inside surface of the drum.

[0043] In this instance, the eccentricity is detected by detecting variation of the rotation speed. The eccentricity is small when the rotation speed of the drum is uniform, and the eccentricity is great if the rotation speed of the drum varies sharply and periodically.

[0044] It is preferable that the eccentricity is detected, and corrected before performing the spinning step. The spinning of the drum in a state of great laundry eccentricity might damage to the drum and the rotation shaft.

[0045] If a resonance occurs between the drum and the rotation shaft, which spin, and the cabinet which supports them, detection of the eccentricity is difficult. That is, when the rotation speed of the drum is the same as the natural frequency of the frame, resonance occurs. Since the vibration and noise produced from the drum increase sharply, and the rotation speed of the drum becomes erratic, accurate measurement of the eccentricity is not possible.

[0046] Therefore, it is necessary to know a rotation speed of the drum at which the resonance occurs in advance, for measuring the eccentricity in a range outside of the rotation speed at which the resonance occurs.

[0047] Referring to FIG 3A, the washing machine includes a control unit, a motor 104, a sensor 105, a selection button 101, a storage button 102, a rotary key 200, a display 300, and a speaker 400.

[0048] The selection button 101 is connected to the control unit 103, for selecting an operation course according to the kind of laundry. Therefore, if one course is selected with the selection button 101, the motor 104 rotates at a rotation speed set to meet the course requirement. The rotation speed of the motor 104 is measured at the sensor 105, and provided to the control unit 103, and displayed on the display 300. The rotary key 200 is provided for the user to change the rotation speed.

[0049] If resonance occurs at the drum, vibration or noise increase sharply. In this instance, for avoiding resonance, the user turns the rotary key 200 to adjust the rotation speed, and presses the storage button 102, to store the adjusted rotation speed in the control unit 103.

[0050] The washing machine further includes the speaker 400 connected to the control unit 103, so that the speaker 400 sounds an alarm when the resonance of the drum is detected, or the adjusted rotation speed is stored.

[0051] Referring to FIG. 3B, the washing machine can detect the resonance at the drum by means of a resonance detecting device 150, automatically.

[0052] The resonance detecting device 150 includes a spring and a grounding part. If the spring vibrates more than a preset level, the spring comes into contact with the grounding part, when a signal indicating that the resonance is occurred is generated.

[0053] That is, if the resonance occurs at the drum, an amplitude of the vibration becomes great suddenly, and the resonance detecting device 150 provides the signal that the resonance occurs to the control unit 103 when a vibration value exceeds a preset value. In this

instance, the control unit 103 having received the signal adjusts the rotation speed of the drum, automatically. Of course, the adjustment of the rotation speed may be made by the user manually by turning the rotary key.

[0054] When the speaker 400 connected to the control unit 103 sounds an alarm when resonance of the drum is detected, or the adjusted rotation speed is stored. It is preferable that the adjusted rotation speed is stored automatically by the control unit 103.

[0055] When referring to FIG 3C, the washing machine further includes test mode buttons 110 connected to the control unit 103.

[0056] It is preferable that the step of adjusting the rotation speed for avoiding the resonance of the drum is made before a regular spinning operation of the washing machine. Therefore, the step of adjusting the rotation speed is performed after the user selects the test mode button 110. The adjusted rotation speed is stored in the control unit before the test mode is finished.

[0057] Accordingly, when the regular spinning operation is performed again after the test mode is finished, the drum rotates at the adjusted rotation speed.

[0058] A method for controlling spinning of the washing machine will now be described.

[0059] At first, the drum is rotated at a first rotation speed set at the control unit (S1). In order to detect the eccentricity of the laundry, it is preferable that the first rotation speed is in the vicinity of 108 rpm. As described before, it is preferable that the detection of the eccentricity is made when no resonance occurs at the drum.

[0060] Occurrence of resonance at the drum rotating at the first rotation speed is detected (S2). If the resonance is detected at the drum, the rotation speed of the drum is changed, automatically, or manually (S3). It is preferable that an alarm sounds from the speaker if the resonance occurs at the drum for the user to know.

[0061] It is preferable that the rotation speed is increased or decreased, by a preset unit greater than 50 rpm. The resonance range of the drum varies at a certain level with a small variation of the eccentricity of the laundry, for changes of the rotation speed of the drum greater than a variation range. That is, for securer avoidance of the resonance occurrence, the rotation speed is changed by a predetermined magnitude each greater than a certain rpm.

[0062] Even if the user can know the occurrence of resonance at the drum from sudden increase of vibration and noise in the step (S2) of detecting resonance of the drum, it is preferable that the occurrence of resonance is detected automatically by the resonance detecting device.

[0063] The resonance detecting device provides the signal that the resonance has occurred to the control unit, automatically. It is preferable that the rotation speed is changed by the control unit which received the signal for avoiding the resonance, and the changed rotation speed is stored in the control unit as a new first rotation speed. Accordingly, when the washing machine is put into operation again, after the washing machine is stopped, the drum is controlled to rotate at the changed rotation speed.

[0064] After a change of the rotation speed, step (S5) to measure the eccentricity of the laundry held in the drum is performed.

[0065] If the eccentricity is greater than a preset value, the step of decreasing the rotation speed of the drum after increasing the rotation speed of the drum is repeated. That is, by repeating the step of varying the rotation speed, the laundry is made to be spread evenly on an inside surface of the drum, so that the eccentricity of the laundry is corrected to an appropriate level.

[0066] Alternatively, for correcting the eccentricity to a desired level, the drum may be rotated in regular/reverse directions alternately a plurality of times. When the eccentricity is corrected to a value below the preset level, or the detected eccentricity is below the preset level, the rotation speed of the drum is increased, to progress the spinning.

[0067] When no resonance occurs at the drum rotating at the first rotating speed, instead of changing the rotation speed of the drum, a step (S6) for measuring eccentricity of the laundry held in the drum is progressed, directly.

[0068] In this instance, as described before, if the measured eccentricity is greater than the preset value, the step of decreasing the rotation speed of the drum after increasing the rotation speed of the drum is repeated, or the drum is rotated in regular/reverse directions alternately a plurality of times.

[0069] When the eccentricity is corrected to a value below the preset level, or the detected eccentricity is below the preset level, the rotation speed of the drum is increased, to progress the spinning.

[0070] It is preferable that the step (SA) of changing the rotation speed to avoid resonance, and the detection (S5, and S6) of eccentricity of the laundry are performed in a state when the test mode is selected.

[0071] As described before, after detection and correction of the eccentricity of the laundry held in the drum is finished, the spinning step is progressed.

[0072] Referring to FIG 5, the drum is rotated at a constant speed of a preset second rotation speed for extraction of water from the laundry (S7).

[0073] The second rotation speeds corresponding to kinds of laundry, such as lingerie, blue jeans, general clothes, and blankets, are set at the control unit. Therefore, once a desired course is selected by the user by pressing the selection button according to the kind of the laundry initially, the drum is rotated at the second rotation speed of the selected course. It is preferable that the second rotation speed is higher than 600 rpm for smooth extraction of water from the laundry.

[0074] Referring to FIG. 2B, it is preferable that a step is further performed, for detecting a volume of foam inside of the drum while rotating the drum at a constant speed of a third rotation speed (W12) before the rotation

speed is increased from the first rotation speed W1 to the second rotation speed W2.

[0075] Then, if resonance occurs at the drum rotating at the second rotation speed W2 detected (S8), if the resonance is detected, the rotation speed of the drum is changed (S9). The changed rotation speed is stored in the control unit (S10).

[0076] It is preferable that the change of the rotation speed is made by predetermined magnitudes each greater than 50 rpm. This is for changing the rotation speed of the drum greater than a change range of a resonance range of the drum caused by a minute change of the eccentricity of the laundry.

[0077] It is preferable that the rotation speed change for avoidance of the resonance is made in a state when the test mode is selected. After the finish of the rotation speed change, the test mode is finished automatically, and, then, the spinning step proceeds for a preset time period by spinning the drum.

[0078] For an example, if the initially set second rotation speed is 700 rpm for a selected course, and the resonance occurs at the rotation speed, the rotation speed is changed by turning the rotary key, or automatically by the control unit. Then, the rotation speed is changed to 650rpm, and stored in the control unit. Thereafter, when the test mode is finished, and the washing machine is put into operation again, the drum performs the spinning at the 650rpm which is newly stored second rotation speed.

[0079] In this instance, the rotation speed of the drum is displayed on the display 300, wherein, even if the spinning is progressed at 650rpm, it is preferable that the rotation speed is displayed on the display as 700rpm as set initially. That is, at a time the washing machine is put into operation again after the washing machine is stopped, not the changed rotation speed, but the second rotation speed set initially is displayed on the display 300. This is for preventing the user from being confused by the rotation speed.

[0080] When the display may display the changed rotation speed and the initially set second rotation speed alternately at regular time intervals.

[0081] A method for controlling a washing machine will be described with reference to FIG 6, in which a rotation speed of a drum is controlled for extraction of water from the laundry.

[0082] At first, the drum is rotated at the second rotation speed set at the control unit (S 12). In the spinning step, it is preferable that the second rotation speed is set different from each other according to the kind of laundry. For this, the spinning step further includes a step for selecting a courses corresponding to a kind of the laundry, and a step for rotating the drum at a second rotation speed relevant to the selected course.

[0083] That is, second rotation speeds are set at the control unit for various kinds of laundry, such as lingerie, blue jeans, general clothes, and blankets, respectively. Therefore, once the user selects a desired course by pressing the selection button according to the kind of the laundry, the drum is rotated at the second rotation speed of the selected course.

[0084] The rotation speed is increased in succession by a predetermined magnitude of rpm from the second rotation speed (S 15, and S17), and whether the resonance occurs at the drum or not is detected at every rotation speed section (S 14, S16, and S 18). It is preferable that the predetermined magnitude of rpm is 50rpm or 100rpm.

[0085] That is, if the resonance is detected at any one section of the rotation speed, the rotation speed of the drum is changed (S20), and if no resonance is detected, after the rotation speed is increased by predetermined magnitudes of rpm, whether the resonance occurs or not is again detected.

[0086] For an example, a case is assumed in which the drum rotates at 500rpm which is initially set second rotation speed. If no resonance occurs, the rotation speed is increased to 600rpm. If the resonance occurs at the increased rotation speed, the rotation speed is decreased to 650rpm or increased to 700rpm.

[0087] When resonance is detected at the drum, the rotation speed of the drum is increased or decreased, preferably by predetermined magnitudes each greater than 50rpm. According to this, occurrence of the resonance at the changed rotation speed can be prevented, securely.

[0088] Thus, the rotation speed is adjusted for preventing occurrence of the resonance at the drum, and the adjusted rotation speed is stored in the control unit. If the resonance of the drum is detected, an alarm sounds from the speaker, by which the user can easily know occurrence of the resonance.

[0089] In the meantime, the control unit has a maximum rotation speed set therein, and, when no resonance occurs until the drum rotates up to the set maximum rotation speed, the maximum speed is stored in the control unit.

[0090] It is preferable that the detection of resonance at the drum S14, S16, and S18, the change of the rotation speed S20, and the storage of the changed rotation speed S21 are performed in a state when the test mode is selected S21.

[0091] Since the changed rotation speed is stored as a newly set second rotation speed in the control unit, when the washing machine is put into operation again after the test mode is finished, the drum is rotated at the changed rotation speed directly, instead of increasing the rotation speed gradually.

[0092] In the meantime, an alarm sounds from the speaker when the changed rotation speed is stored in the control unit, and the storage of the changed rotation speed is performed automatically by the control unit in response to the signal from the resonance detecting device. Moreover, it is preferable that the occurrence of the resonance at the drum is detected by the resonance detecting device, automatically.

[0093] It is preferable that the washing machine is provided with a reset button for returning the rotation speed to the initial set second rotation speed, for making the next operation by the user in performing the test mode easy.

[0094] As has been described, the washing machine and the method for controlling the same have the following advantages.

[0095] First, the method for controlling a washing machine of the present invention permits more accurate measurement of an eccentricity by detecting resonance and adjusting the rotation speed in measuring eccentricity of the laundry held in the drum.

[0096] Second, the detection of resonance at a rotation speed of the drum and adjustment of the rotation speed to avoid the resonance in the spinning step permits to enhanced reliability of the product.

[0097] The foregoing method for controlling spinning in a washing machine is applicable not only to the drum type washing machine, but also other general washing machines, such as a pulsator type washing machine.

[0098] 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 covers the modifications and variations provided they come within the scope of the appended claims and their equivalents.

Claims

1. A method for controlling a washing machine having a drum with adjustable rotation speed, comprising:

a first step of rotating the drum at a first rotation speed set at a control unit;
a second step of detecting whether resonance of the drum occurs or not at the first rotation speed; and
a third step of changing the rotation speed of the drum if resonance is detected.

2. The method as claimed in claim 1, wherein the third step includes storing the changed rotation speed in the control unit; and preferably wherein the drum is rotated at the changed rotation speed when the washing machine is put into operation again after the washing machine is stopped.

3. The method as claimed in claim 1, wherein the third step further includes measuring an eccentricity of laundry held in the drum rotating at the changed rotation speed.

4. The method as claimed in claim 3, further including changing the rotation speed of the drum again after the third step change in rotation speed, if the eccentricity is greater than a preset value; and/or wherein the further change of speed comprises decreasing the rotation speed, and the third step change comprises increasing the rotation speed; and/or wherein the drum is rotated in regular/reverse directions alternately a plurality of times, if the eccentricity exceeds a preset value; and/or wherein, when the eccentricity is below the preset value, the third step further includes; rotating the drum at the set second rotation speed for extracting water from the laundry, detecting whether the resonance occurs with the drum rotating at the second rotation speed or not, changing the rotation speed of the drum, if resonance is detected at the drum, and storing the changed rotation speed in the control unit.

5. The method as claimed in claim 1, further comprising the step of measuring the eccentricity of the laundry held in the drum, if no resonance occurs in the second step.

6. The method as claimed in claim 5, wherein the step of changing the rotation speed of the drum again after increasing the second step change of rotation speed of the drum is repeated, if the eccentricity is greater than a preset value; and/or wherein the step of changing the rotation speed of the drum again comprises decreasing the speed, and the second stage change of rotation comprises increasing the speed; and/or wherein the drum is rotated in regular/reverse directions alternately a plurality of times, if the eccentricity exceeds a preset value; and/or wherein, when the eccentricity is below the preset value, the method further includes rotating the drum at the set second rotation speed for extracting water from the laundry, detecting whether resonance occurs with the drum rotating at the second rotation speed or not, changing the rotation speed of the drum, if the resonance is detected at the drum, and storing the changed rotation speed in the control unit.

7. The method as claimed in claim 1, wherein the rotation speed of the drum increases in the third step; and or wherein the rotation speed of the drum decreases in the third step; and/or wherein the rotation speed of the drum changes by predetermined magnitudes each greater than 50rpm in the third step; and/or wherein the second step includes the step of sounding an alarm through a speaker if the resonance of the drum is detected; and/or wherein the steps are performed when a test mode is selected.

8. The method as claimed in claim 1, wherein the resonance of the drum is detected by a resonance detecting device automatically in the second step; and/or wherein the third step is performed automatically by the control unit which receives a signal from

the resonance detecting device.

9. A method for controlling a washing machine having a drum with adjustable rotation speed for extracting water from laundry, comprising:

a first step of rotating the drum at a second rotation speed set at a control unit;
a second step of increasing the rotation speed from the second rotation speed by predetermined magnitudes of rpm in succession, and whether resonance occurs or not at every rotation speed is detected;
a third step of changing the rotation speed of the drum when resonance of the drum is detected; and
a fourth step of storing the changed rotation speed in the control unit.

10. The method as claimed in claim 9, wherein the first step includes the steps of;
selecting a course for rotation speeds relevant to a kind of laundry, and
rotating the drum at the second rotation speed for the selected course; and/or
wherein the rotation speed of the drum increases in the third step; and/or
wherein the rotation speed of the drum decreases in the third step; and/or
wherein the rotation speed of the drum changes by predetermined magnitudes each greater than 50rpm in the third step; and/or wherein the fourth step includes the step of sounding an alarm from a speaker when the changed rotation speed is stored; and/or wherein the third step is performed automatically by the control unit having the signal received from a resonance detecting device; and/or wherein the second step includes the step of automatic detection of resonance occurrence at the drum by the resonance detecting device; and/or wherein the second step further includes the step of storing a preset maximum rotation speed in the control unit when no resonance occurs until the drum rotates up to the preset maximum speed; and/or wherein the second step further includes the step of sounding an alarm from a speaker if the resonance of the drum is detected.

11. The method as claimed in claim 9, wherein the steps are performed when a test mode is selected.

12. The method as claimed in claim 11, wherein the drum is rotated at the changed rotation speed when the washing machine is put into operation again after the test mode is finished; and preferably wherein, not the changed rotation speed, but the second rotation speed is displayed on a display, when the washing machine is put into operation again after the washing machine is stopped.

13. A washing machine comprising:

a motor to generate a rotating force;
a drum arranged to be rotated upon receiving a driving force from the motor;
a sensor to sense a rotation speed of the drum;
a vibration detecting device to transmit a signal if vibration greater than a preset value is detected at the drum; and
a control unit to adjust the rotation speed of the motor to prevent the resonance of the drum from occurring upon reception of the signal.

14. The washing machine as claimed in claim 13, further comprising a rotary key electrically connected to the control unit for a user to turn to change the rotation speed of the drum; and/or further comprising a selection button connected to the control unit for selecting a course of rotation speeds for a kind of laundry; and/or further comprising a storage button connected to the control unit for storing an adjusted rotation speed; and/or further comprising a test mode button connected to the control unit for performing a test mode to search a rotation speed at which the resonance of the drum occurs; and/or further comprising a speaker connected to the control unit for sounding an alarm when a working rotation speed is stored; and/or further comprising a display for displaying a rotation speed of the drum sensed at the sensor.

FIG. 1

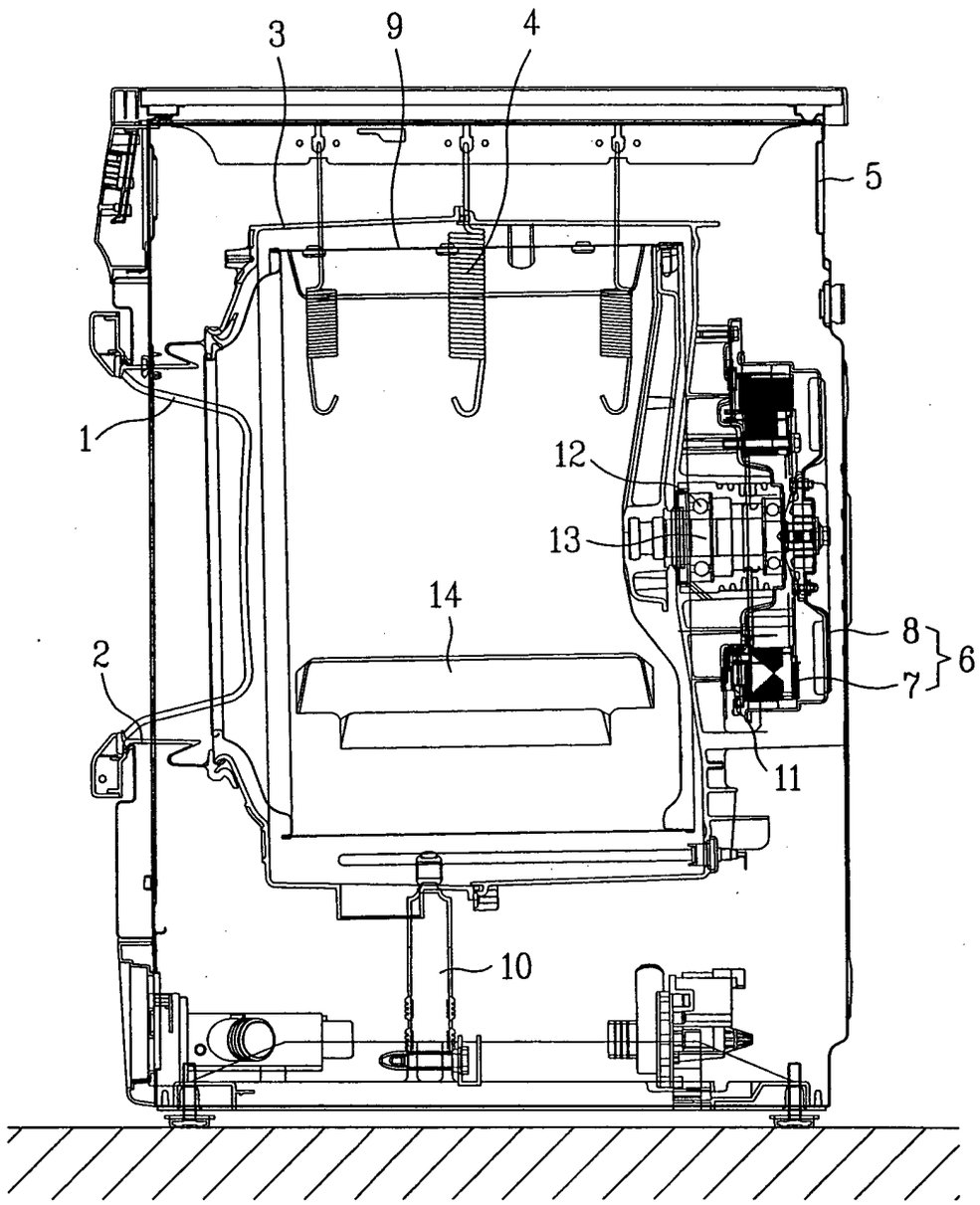


FIG. 2A

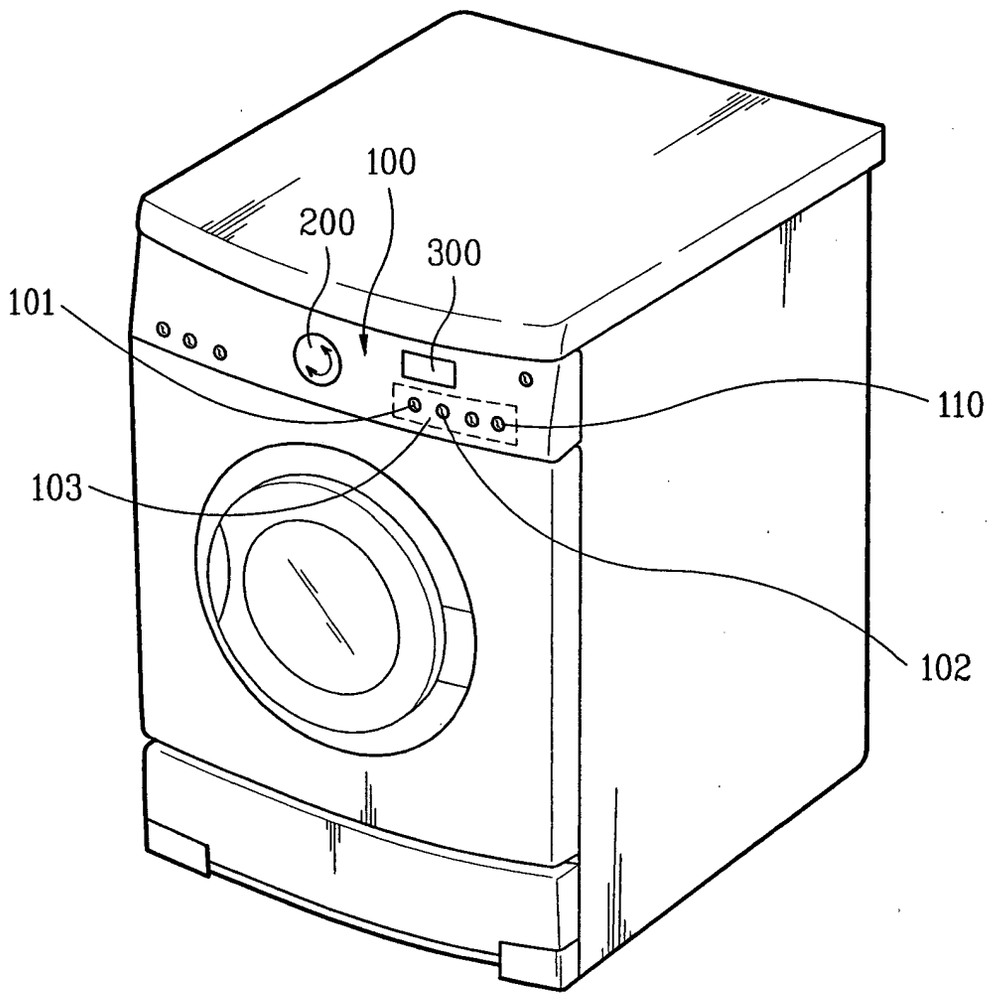


FIG. 2B

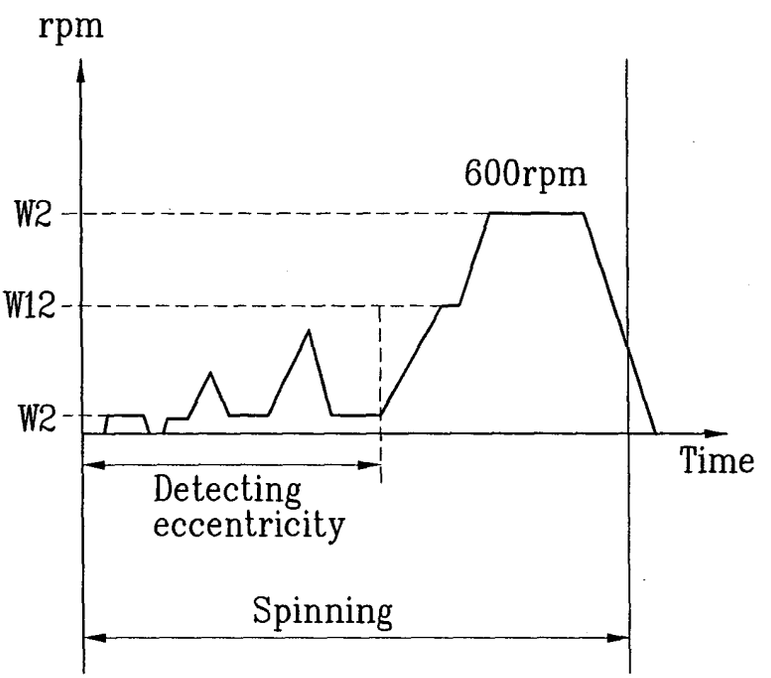


FIG. 3A

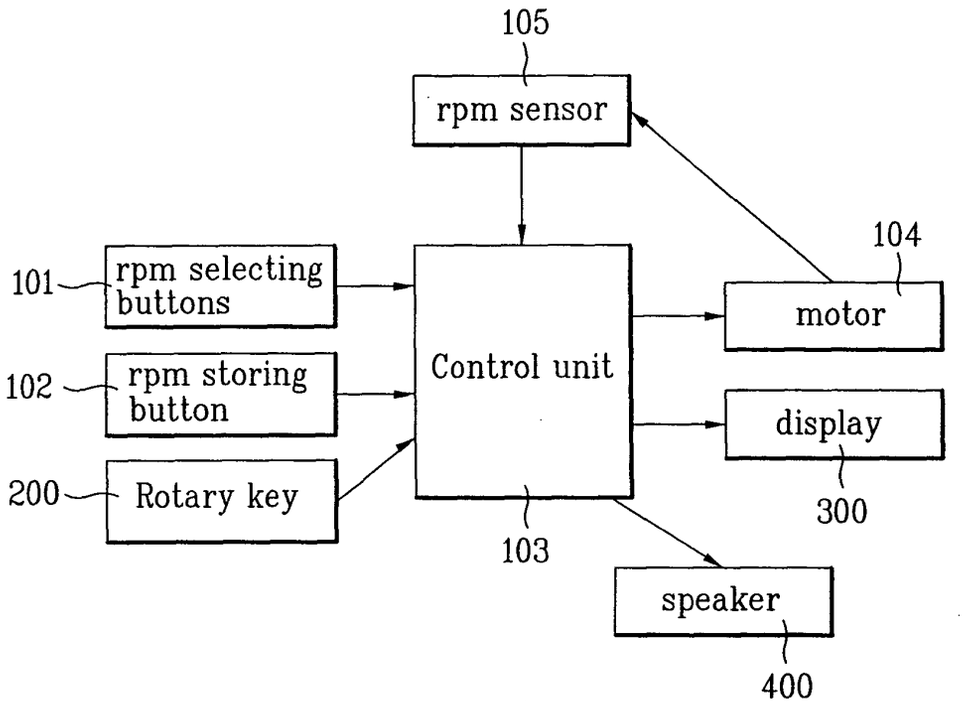

105
rpm sensor
104
101
rpm selecting buttons
motor
Control unit
102
rpm storing button
display
200
Rotary key
300
103
speaker
400

FIG. 3B

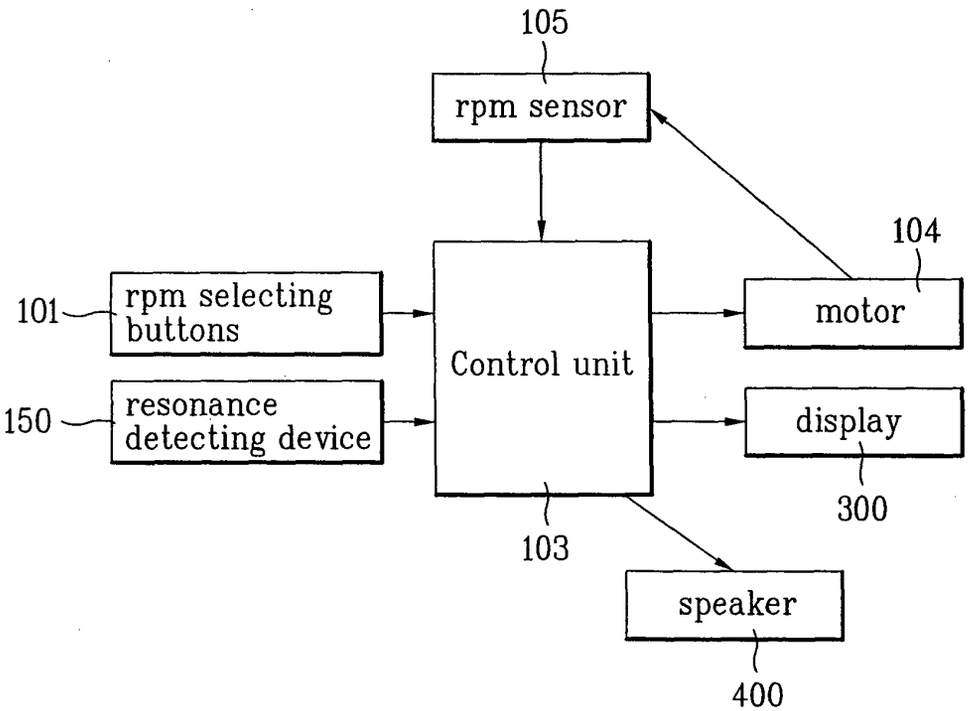

105
rpm sensor
104
101
rpm selecting buttons
motor
Control unit
150
resonance detecting device
display
300
103
speaker
400

FIG. 3C

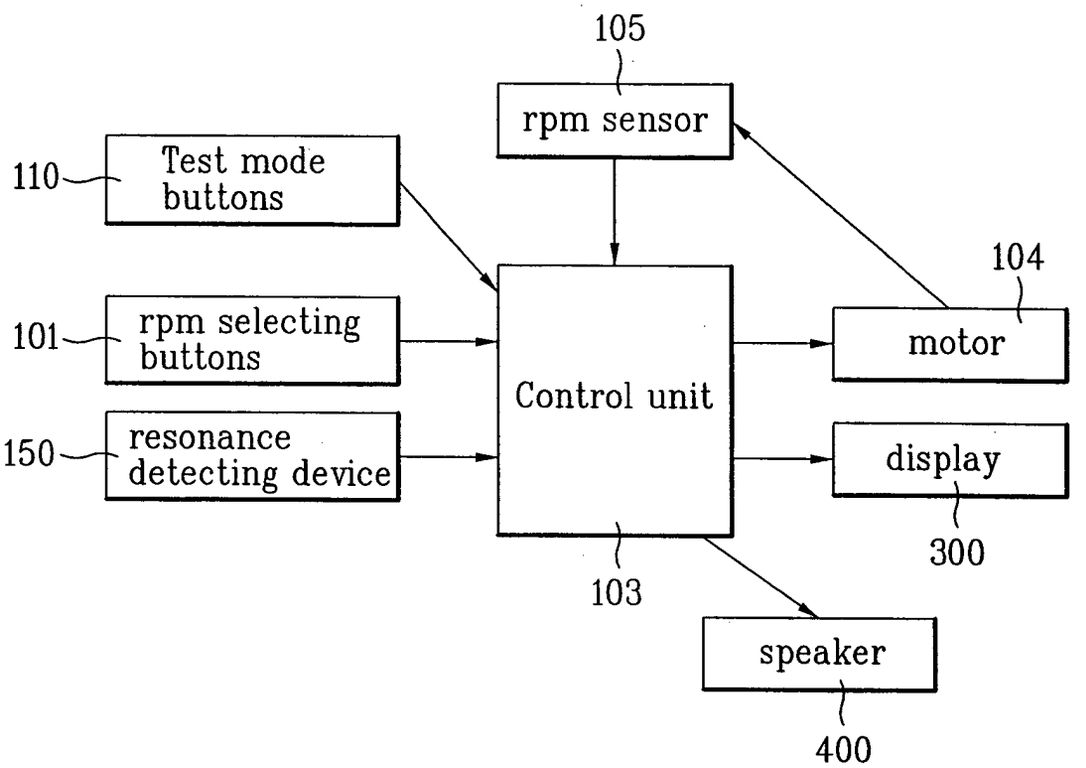

105
rpm sensor
110
Test mode buttons
104
101
rpm selecting buttons
Control unit
motor
150
resonance detecting device
display
300
103
speaker
400

FIG. 4

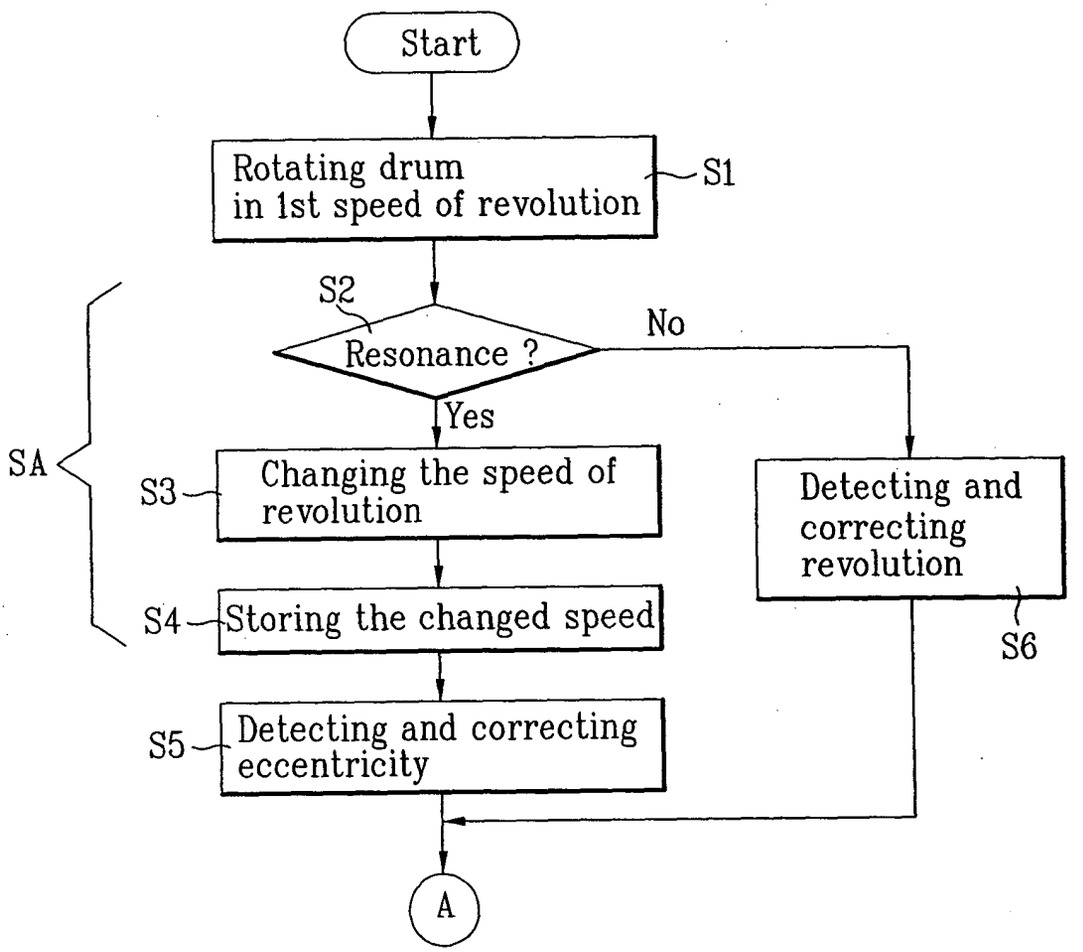

Start
Rotating drum in 1st speed of revolution
S1
S2
Resonance ?
No
Yes
SA
S3
Changing the speed of revolution
S4
Storing the changed speed
S5
Detecting and correcting eccentricity
Detecting and correcting revolution
S6
A

FIG. 5

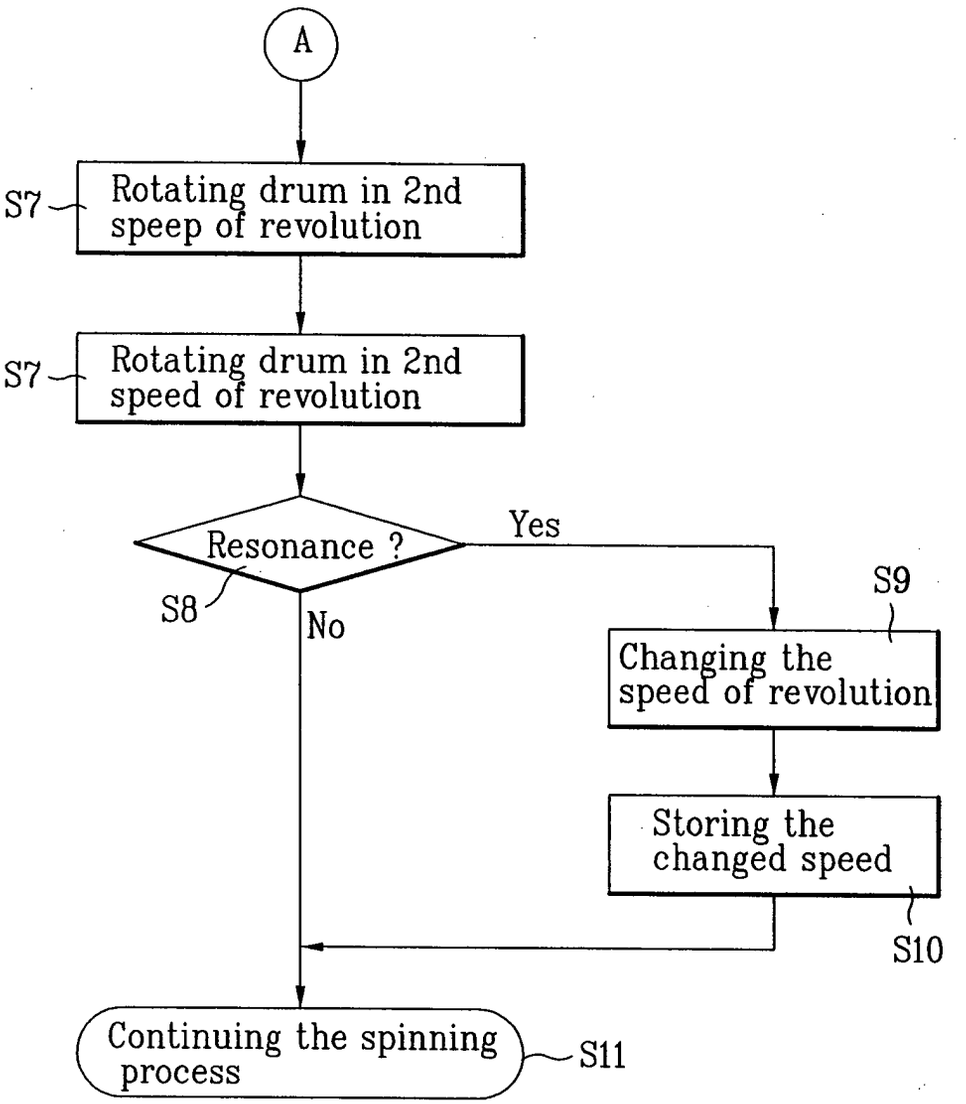
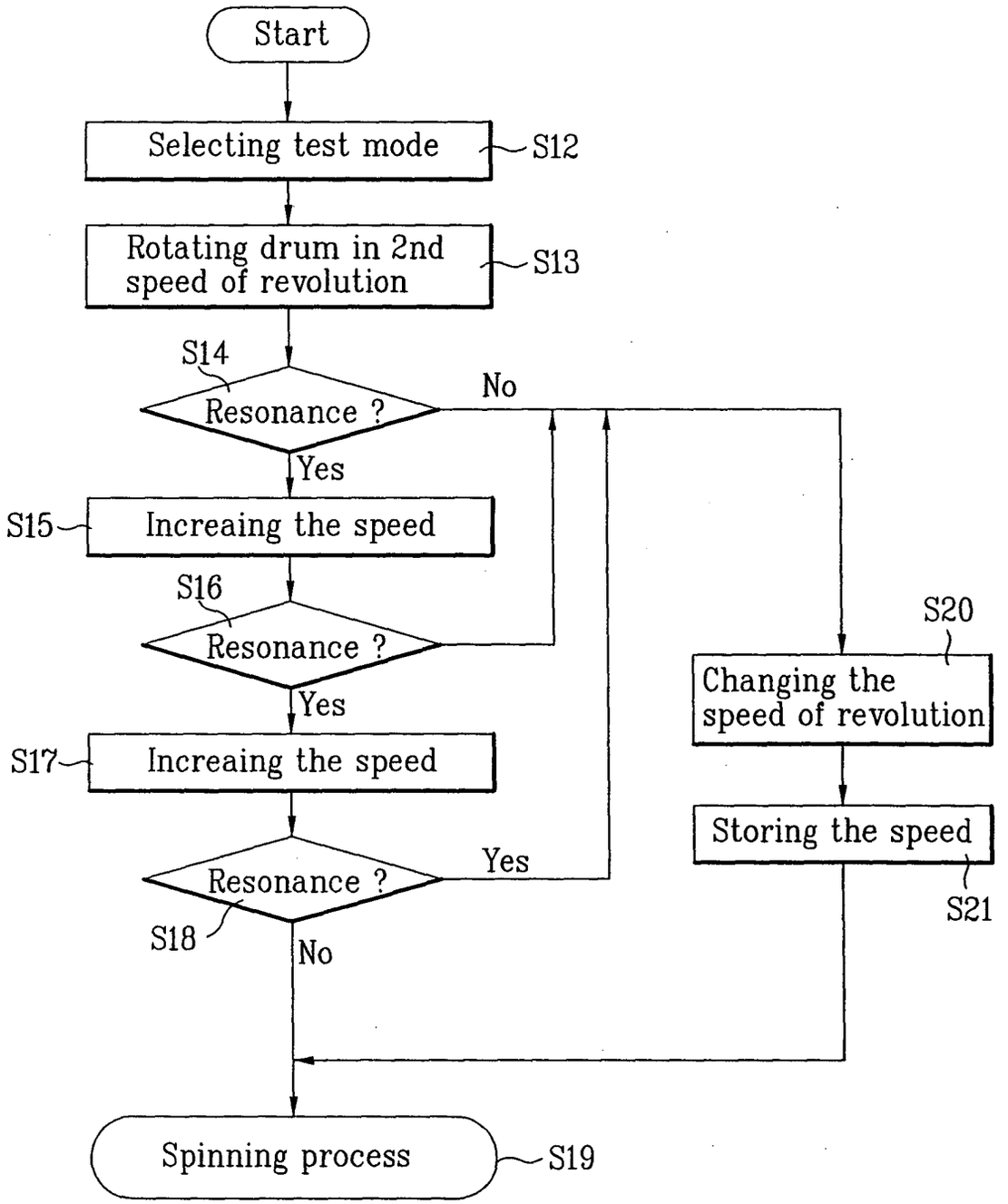

A
S7
Rotating drum in 2nd speep of revolution
S7
Rotating drum in 2nd speed of revolution
Resonance ?
S8
Yes
No
S9
Changing the speed of revolution
Storing the changed speed
S10
Continuing the spinning process
S11

FIG. 6


Start
Selecting test mode
S12
Rotating drum in 2nd speed of revolution
S13
S14
Resonance ?
No
Yes
S15
Increaing the speed
S16
Resonance ?
Yes
S17
Increaing the speed
Resonance ?
Yes
S18
No
S20
Changing the speed of revolution
Storing the speed
S21
Spinning process
S19

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 25 7173

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 6 546 354 B1 (GAYME DENNICE F) 8 April 2003 (2003-04-08)	1,3-14	D06F37/20 D06F35/00
A	* the whole document *	2	
X	GB 2 174 513 A (* HOOVER PLC) 5 November 1986 (1986-11-05)	1,3-8, 13,14	
A	* the whole document *	2,9-12	
X	DE 40 22 715 A1 (LICENTIA PATENT-VERWALTUNGS-GMBH, 6000 FRANKFURT, DE) 23 January 1992 (1992-01-23)	1,3-7, 13,14	
A	* the whole document *	2,8-12	
X	EP 1 362 946 A (LG ELECTRONICS INC) 19 November 2003 (2003-11-19)	1,3-7, 13,14	
A	* the whole document *	2,8-12	
X	WO 00/28128 A (ELECTROLUX ZANUSSI S.P.A; CAUZ, MIRCO) 18 May 2000 (2000-05-18)	1,3-8, 13,14	
A	* the whole document *	9-12	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

D06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	20 May 2005	Spitzer, B

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 04 25 7173

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

20-05-2005

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6546354 B1	08-04-2003	NONE	
GB 2174513 A	05-11-1986	DE 3614894 A1	06-11-1986
DE 4022715 A1	23-01-1992	FR 2664915 A3	24-01-1992
		IT 1251795 B	26-05-1995
EP 1362946 A	19-11-2003	KR 2003089350 A	21-11-2003
		CN 1459529 A	03-12-2003
		EP 1362946 A2	19-11-2003
		EP 1516952 A2	23-03-2005
		RU 2230843 C1	20-06-2004
		US 2005076456 A1	14-04-2005
		US 2003213070 A1	20-11-2003
WO 0028128 A	18-05-2000	IT PN980081 A1	10-05-2000
		WO 0028128 A1	18-05-2000

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82