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

(11) **EP 2 325 366 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
13.04.2016 Bulletin 2016/15

(21) Application number: **09811249.3**

(22) Date of filing: **28.08.2009**

(51) Int Cl.:
D06F 33/02 *(2006.01)* ***D06F 37/20*** *(2006.01)*

(86) International application number:
PCT/JP2009/004193

(87) International publication number:
WO 2010/026719 (11.03.2010 Gazette 2010/10)

(54) WASHING MACHINE

WASCHMASCHINE

MACHINE À LAVER

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

(30) Priority: **02.09.2008 JP 2008224415**
12.06.2009 JP 2009140783

(43) Date of publication of application:
25.05.2011 Bulletin 2011/21

(73) Proprietor: **Panasonic Corporation**
Kadoma-shi
Osaka 571-8501 (JP)

(72) Inventors:
- **WAKITA, Katsuya**
  Osaka 540-6207 (JP)
- **GAMO, Ken**
  Osaka 540-6207 (JP)
- **HIROTA, Hiromi**
  Osaka 540-6207 (JP)
- **MINAYOSHI, Hiroko**
  Osaka 540-6207 (JP)
- **NOMURA, Hiroyoshi**
  Osaka 540-6207 (JP)

(74) Representative: **Schwabe - Sandmair - Marx**
Patentanwälte
Stuntzstraße 16
81677 München (DE)

(56) References cited:
EP-A1- 2 090 686
EP-A2- 0 716 178
JP-A- 2006 034 755
JP-A- 2006 034 755
JP-A- 2006 346 270
JP-A- 2008 142 231
JP-A- 2008 142 231
JP-A- 2009 189 677

EP 2 325 366 B1

Description

TECHNICAL FIELD

[0001] The present invention relates to a drum type washing machine that includes a rotatable drum inside an elastically supported accommodation tub and washes, rinses, and spins or dries laundry inside the drum.

BACKGROUND ART

[0002] Both now and in the past, in a drum type washing machine, an unbalancing detecting control for a spin cycle or a laundry movement amount detecting control for a laundry cycle is conducted in order to detect and estimate a movement of a drum or a movement of the laundry inside the drum during the laundry cycle. By changing a rotation speed of the drum using the detection/estimation result, the unbalancing during the spin cycle is controlled or the movement amount of the laundry during the laundry cycle is controlled, so that the washing state is appropriately improved.

[0003] For example, Patent Document 1 discloses a configuration in which a semiconductor acceleration sensor is attached to an accommodation tub of a drum, and a movement of washing fabrics (laundry) is estimated on the basis of a variation amount 61 in the output of the acceleration sensor and a variation amount 62 in the torque current component of a motor as shown in Fig. 6. In accordance with the estimated movement of the washing fabrics, control unit 63 changes a rotation speed of the motor that rotates the drum.

[0004] However, in the configuration of the existing washing machine, it is difficult to detect the movement of the washing fabrics and to appropriately control the rotation speed of the drum for the purpose of achieving a washing operation having an excellent cleaning performance. That is, since various vibrations may be applied to the accommodation tub, it is difficult to accurately detect the movement of the fabrics by using a variation amount of the output value of the simple acceleration sensor. For example, in addition to the vibration caused by the movement of the fabrics, a vibration caused by the motor or the cabinet may be applied to the accommodation tub. Further, different vibrations are applied to the accommodation tub depending on the amount of fabrics, the weight thereof, and the quality thereof. For this reason, it is difficult to highly precisely detect the movement of the washing fabrics by using a variation in the magnitude of the output value of the simple acceleration sensor.

[0005] Further, the same applies when detecting the movement of the washing fabrics by using a current value representing the torque component of the motor. For example, when the amount of water is large and the weight of fabrics formed of chemical fibers is light during the laundry cycle, a correlation may not be present between the motor torque and the agitating movement amount of the fabrics using baffles provided inside the drum. For this reason, it is difficult to precisely estimate the movement of the washing fabrics on the basis of the torque current component of the motor.

[0006] Patent document 2 relates to a washing machine which reduces vibrations at dewatering and noises due to the vibrations. The washing machine includes: a receiving cylinder supported in a case body; a rotary drum rotatably provided in the receiving cylinder; a motor for rotating and operating the rotary drum; a control means for controlling drive of the motor; a supporting means for supporting the receiving cylinder; a vibration sensor for detecting vibration; and a vibration control means for inputting an output signal of vibration detected by the vibration sensor to the control means as a motor control signal.

Patent Document 1: Japanese Patent Unexamined Publication No. 2006-346270

Patent Document 2: JP 2008 142231 A

SUMMARY OF THE INVENTION

[0007] The invention is defined by the subject-matter of the independent claims. The dependent claims are directed to advantageous embodiments.

ADVANTAGES OF THE INVENTION

[0008] Advantageously, it is provided a washing machine having an excellent cleaning performance and rotating a drum at a rotation speed optimal for a washing operation by highly precisely detecting a washing state.

[0009] The washing machine includes: a drum for rotating laundry accommodated therein; an accommodation tub for accommodating the drum; elastic suspending portions for allowing an accommodation tub to be suspended from the upper side of a cabinet; an antivibration damper for supporting the accommodation tub from the lower side of the cabinet; and a motor for rotating the drum. The washing machine of the invention further includes: a vibration detecting unit for detecting a vibration of the accommodation tub; a frequency component calculating unit for calculating a frequency component from a vibration detected by the vibration detecting unit; and a rotation speed control unit for changing a rotation speed of the motor in accordance with the magnitude of the frequency component calculated by the frequency component calculating unit. The elastic suspending portions are located at the symmetrical positions with respect to a rotation axis of the drum so as to allow the accommodation tub to be suspended therefrom, and the vibration detecting unit detects a vibration of the accommodation tub in the front/rear direction. Further, the rotation speed control unit changes a rotation speed of the motor in accordance with the magnitude of the frequency component calculated from the vibration in the front/rear direction.

[0010] The washing machine includes: a drum for rotating laundry accommodated therein; an accommodation tub for accommodating the drum; elastic suspending portions for allowing an accommodation tub to be suspended from the upper side of a cabinet; an antivibration damper for supporting the accommodation tub from the lower side of the cabinet; and a motor for rotating the drum. The washing machine of the invention further includes: a vibration detecting unit for detecting a vibration of the accommodation tub; a frequency component calculating unit for calculating a frequency component from a vibration detected by the vibration detecting unit; and a rotation speed control unit for changes a rotation speed of the motor in accordance with the magnitude of the frequency component calculated by the frequency component calculating unit. The elastic suspending portion is located at a position on a rotation axis of the drum so as to allow the accommodation tub to be suspended therefrom, and the vibration detecting unit detects a vibration of the accommodation tub in the left/right direction. Further, the rotation speed control unit changes a rotation speed of the motor in accordance with the magnitude of the frequency component calculated from the vibration in the left/right direction.

[0011] According to this configuration, the washing machine determines the direction of the vibration component caused by the vibration of the accommodation tub with the movement of laundry depending on a difference in the support position of the accommodation tub with respect to the cabinet. That is, the direction of the vibration component used for the calculation of the calculation value in the frequency component calculating unit is determined. Accordingly, the cleaning performance may be improved by highly precisely detecting the movement of laundry inside the drum and controlling the rotation of the drum so as to be appropriate for the washing of fabrics.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

Fig. 1 is a schematic configuration diagram illustrating a side surface of a washing machine of a first embodiment of the invention.

Fig. 2 is a schematic plan view illustrating a support structure of the washing machine of the first embodiment of the invention.

Fig. 3A is a graph illustrating an analysis result of a component in a front/rear direction obtained from a vibration of an accommodation tub of the washing machine of the first embodiment of the invention.

Fig. 3B is a graph illustrating an analysis result of a component in a left/right direction obtained from the vibration of the accommodation tub of the washing machine of the first embodiment of the invention.

Fig. 3C is a graph illustrating an analysis result of a component in an up/down direction obtained from the vibration of the accommodation tub of the washing machine of the first embodiment of the invention.

Fig. 4 is an explanatory diagram illustrating a washing state inside a drum of the washing machine of the first embodiment of the invention.

Fig. 5 is a schematic plan view illustrating a support structure of a washing machine of a second embodiment of the invention.

Fig. 6 is a diagram illustrating control of a rotation speed of a motor of the existing washing machine.

PREFERRED EMBODIMENTS FOR CARRYING OUT THE INVENTION

[0013] Hereinafter, preferred embodiments of the invention will be described by referring to the drawings, but the invention is not limited thereto.

(First embodiment)

[0014] A first embodiment of the invention will be described by referring to Fig. 1. Fig. 1 is a schematic configuration diagram illustrating a side surface of a washing machine of the first embodiment.

[0015] As shown in Fig. 1, the washing machine of the embodiment has a configuration in which accommodation tub 2 having rotatable drum 1 is supported by cabinet 5 through elastic suspending portion 3 and antivibration damper 4. Motor 6 is fixed to the bottom portion of accommodation tub 2, and rotates drum 1 at a predetermined rotation speed through belt 7.

[0016] Washing fabrics 9 as laundry input into drum 1 through fabric input/extraction opening 8 provided at the front surface of the washing machine are lifted upward by baffles 10 provided inside drum 1 in accordance with the rotation of drum 1, and are dropped from the top portion of the drum to the bottom portion thereof. By movement energy generated when the washing fabrics strike against the bottom portion of the drum, the cleaning effect may be improved. A vibration of accommodation tub 2 generated by the movement of washing fabrics 9 is detected by vibration detecting unit 11, and the detection result is transmitted to frequency component calculating unit 12. Further, the value calculated by frequency component calculating unit 12 is transmitted to rotation speed control unit 13, and motor 6 is controlled by rotation speed control unit 13 so as to rotate at a rotation speed at which appropriate striking washing may be performed.

[0017] Here, it is preferable that the support position of antivibration damper 4 is located on the perpendicular line or the substantially perpendicular line in relation to the central point while drum 1 and accommodation tub 2 are combined with each other. This is because the vibration of the bottom portion of the drum is large when washing fabrics 9 are dropped from the top portion of drum 1 and the bottom portion is continuously impacted. For this reason, when the bottom portion of accommodation tub 2 is stabilized, a signal detected by vibration detecting

unit 11 does not include shaking except for the movement of washing fabrics 9. Further, vibration detecting unit 11 of the embodiment is configured as an acceleration sensor, and any one of a semiconductor acceleration sensor, a piezoelectric acceleration sensor, and the like may be used as the acceleration sensor.

[0018] Fig. 2 is a schematic plan view illustrating an example of a support structure of the embodiment. In Fig. 2, central point 14 indicates the center when drum 1 and accommodation tub 2 are combined with each other. Accommodation tub 2 is supported at two support points 15 by elastic suspending portions 3. Central axis 16 indicates the rotation axis of drum 1.

[0019] That is, in the embodiment, accommodation tub 2 is suspended at two positions symmetrical to each other with respect to central axis 16 of drum 1 by elastic suspending portions 3. More specifically, elastic suspending portions 3 allow accommodation tub 2 to be suspended from symmetrical positions with respect to a plane including central point 14 while drum 1 and accommodation tub 2 are combined with each other and extending in the perpendicular direction so as to include central axis 16 of drum 1.

[0020] Like the embodiment, when elastic suspending portions 3 connecting the upper portions of accommodation tub 2 and cabinet 5 are supported at the symmetrical positions or the substantially symmetrical positions with respect to central point 14 on central axis 16, the elastic suspending portions are suspended with a balance. For this reason, a vibration is periodically generated in accordance with the movement of washing fabrics 9 inside drum 1. The vibration is detected by vibration detecting unit 11, and the result thereof is transmitted to frequency component calculating unit 12 shown in Fig. 1. Here, vibration detecting unit 11 detects at least one vibration component in the up/down direction, the left/right direction, and the front/rear direction of accommodation tub 2. The acceleration in the detected direction is transmitted to frequency component calculating unit 12 as a signal value, and is used as an output to rotation speed control unit 13.

[0021] Frequency component calculating unit 12 calculates the magnitude (Fourier amplitude spectrum and power spectrum) of the frequency component by performing discrete Fourier transform (DFT) or fast Fourier transform (FFT) on the transmitted acceleration value. The rotation speed of the drum is increased or decreased by rotation speed control unit 13 on the basis of the magnitude of the specific frequency component or the magnitude of the sum of the frequency components calculated in frequency component calculating unit 12, so that the cleaning performance of cleaning the laundry may be improved.

[0022] Here, in the support structure shown in Fig. 2, the vibration having a specific period and generated from accommodation tub 2 when the movement of washing fabrics 9 is in the striking washing state which effectively separates dirt therefrom during the washing operation is alleviated by elastic suspending portions 3 in the left/right direction, and is alleviated by antivibration damper 4 in the up/down direction. For this reason, the frequency component may not be accurately detected. Accordingly, in this case, the vibration in the front/rear direction reflects the movement of washing fabrics 9 moving inside drum 1 while having the least alleviation. Therefore, in the embodiment, it is sufficient to provide the acceleration sensor of vibration detecting unit 11 capable of detecting the vibration in the front/rear direction. However, a configuration may be adopted in which the vibrations in three axes (the front/rear direction, the left/right direction, and the up/down direction) may be detected, and only the vibration in the front/rear direction is used.

[0023] As in the embodiment shown in Fig. 2, Figs. 3A to 3C illustrate an analysis result in which the vibration of accommodation tub 2 is divided by the component in each direction while elastic suspending portions 3 connecting the upper portions of accommodation tub 2 and cabinet 5 are supported at the symmetrical positions with respect to central point 14 on central axis 16. In Figs. 3A to 3C, the cleaning performance was evaluated on the assumption that the rotation speed of drum 1 was set to 45 rpm and the weight of washing fabrics 9 was set to 2.0 kg. Fig. 3A is a graph illustrating the analysis result of the component in the front/rear direction obtained from the vibration of accommodation tub 2, Fig. 3B is a graph illustrating the analysis result of the component in the left/right direction, and Fig. 3C is a graph illustrating the analysis result of the component in the up/down direction.

[0024] Further, the frequency peak as an index controlling the rotation speed to improve the cleaning performance will be described by referring to Fig. 4. The circle of Fig. 4 indicates an opening of drum 1, the bottom surface is set to 0°, and the top portion is set to 180°. Regarding 90° and 270°, the directions may be switched to each other since the drum also rotates in the reverse direction. Here, in order to improve the cleaning performance, the striking washing (locus b) may be optimally used which lifts washing fabrics 9 upward by baffles 10 (refer to Fig. 1), and drops the washing fabrics from the top portion of the drum. The case where washing fabrics 9 move while being adhered to drum 1 (locus c) or washing fabrics 9 rotate in a rolling manner at the bottom portion of drum 1 (locus a) is not appropriate for improving the cleaning performance.

[0025] The cleaning performance may be optimally improved when the laundry is dropped from the position between 90° and 180° in Fig. 4 so as to collide with the surface of drum 1 at the bottom portion. For this reason, in the embodiment, the frequency component corresponding to the rotation speed different from the rotation speed of drum 1 is detected, and the rotation speed of drum 1 is controlled in accordance with the magnitude thereof. Specifically, in the washing machine of the embodiment, a large variation of the frequency component of the rotation speed is detected in the range between the rotation speed obtained by multiplying the rotation

speed of drum 1 by the number obtained by adding one to the number of baffles 10 and the rotation speed obtained by multiplying the rotation speed of drum 1 by the number obtained by subtracting one from the number of baffles 10. In the embodiment, the rotation speed of drum 1 is set to 45 rpm, and three baffles 10 are provided. Accordingly, the amplitude component (amplitude spectrum) having the frequency of 45x2/60=1.5 Hz to 45×4/60=3.0 Hz is mainly used as a calculation value necessary for the control of the rotation speed.

[0026] As apparently understood from the result of Figs. 3A to 3C, in the results of the left/right direction (Fig. 3B) and the up/down direction (Fig. 3C) except for the front/rear direction (Fig. 3A), generally many peaks are observed in a range except for the frequency range (1.5 Hz to 3.0 Hz). That is, since a variation of the frequency component caused by the specific movement of washing fabrics 9 is mixed with many peaks as shown in the frequency analysis results in the left/right direction and the up/down direction, the variation of the frequency component may not be observed. Accordingly, it is difficult to detect the fabric state using such patterns of the frequencies, and to control the rotation speed of drum 1 on the basis of the result. However, according to the frequency analysis result in the front/rear direction, a large variation of the frequency component may be observed. Therefore, the rotation speed of drum 1 may be easily controlled on the basis of the result.

[0027] As shown in the description above, in the washing condition that the weight of washing fabrics 9 shown in Figs. 3A to 3C is set to 2.0 kg and the rotation speed of the drum is set to 45 rpm, the fabric striking washing is conducted in the condition that the frequency is 1.5 Hz to 3.0 Hz. When the frequency is less than 1.5 Hz, washing fabrics 9 rotate in a rolling manner at the bottom portion. When the frequency is more than 3.0 Hz, washing fabrics 9 are adhered to drum 1.

[0028] Here, for each component in the vibration direction, the total amount of the peak value for each specific frequency interval (for example, 0.15 Hz) in each frequency range was calculated as the ratio with respect to the total amount of the peak value for each specific frequency interval (for example, 0.15 Hz in the same manner as above) in the entire frequency range. As a result, when the vibration direction was the front/rear direction, the striking washing state was 48%, the rolling state was 16%, and the adhered state was 36%. When the vibration direction was the left/right direction, the striking washing state was 35%, the rolling state was 33%, and the adhered state was 32%. When the vibration direction was the up/down direction, the striking washing state was 36%, the rolling state was 39%, and the adhered state was 25%.

[0029] By using the result, the vibration component in the front/rear direction may most largely reflect the striking washing state, and be apparently distinguished from the signals in the other ranges. Accordingly, even when the value changes with time, it may be determined that the vibration component in the front/rear direction corresponds to the movement change of the fabrics inside the drum.

[0030] In the control of the rotation speed of drum 1 of the embodiment, it is controlled as above so that the amplitude spectrum of the frequency component caused by the striking washing becomes larger. When there are many components of the frequency (that is, the frequency range larger than 3.0 Hz) longer than the frequency component range (for example, 1.5 Hz to 3.0 Hz when the rotation speed of the drum is 45 rpm) caused by the striking washing, it is thought that the rotation speed of the drum is fast, and washing fabrics 9 rotate while being adhered to the wall surface of drum 1 without being dropped from the top portion of drum 1. Accordingly, it is predicted that the frequency of the vibration applied to drum 1 is small. For this reason, the rotation speed of drum 1 is controlled to become slower so that washing fabrics 9 are dropped from the wall surface of drum 1.

[0031] On the contrary, when there are many components of the frequency (that is, the frequency range smaller than 1.5 Hz) shorter than the frequency component range caused by the striking washing, it is thought that the rotation speed of drum 1 is slow, and wet washing fabrics 9 are not sufficiently lifted upward by baffles 10 due to their weight, so that washing fabrics 9 rotate in a rolling manner in accordance with the rotation of drum 1 at the bottom portion of drum 1. Accordingly, it is predicted that the washing fabrics cause vibration several times in drum 1 in a short time. For this reason, the rotation speed of drum 1 is controlled to become faster so that washing fabrics 9 are sufficiently lifted upward by baffles 10 in accordance with the movement of drum 1.

[0032] In this way, when the rotation speed of drum 1 is controlled, the striking washing dropping washing fabrics 9 from the high position and improving the cleaning performance may be performed.

[0033] As described above, the washing machine of the embodiment includes: drum 1 for rotating laundry accommodated therein; accommodation tub 2 for accommodating drum 1; elastic suspending portions 3 for allowing accommodation tub 2 to be suspended from the upper side of cabinet 5; antivibration damper 4 for supporting accommodation tub 2 from the lower side of cabinet 5; motor 6 for rotating drum 1; vibration detecting unit 11 for detecting a vibration of accommodation tub 2; frequency component calculating unit 12 for calculating a frequency component from a vibration detected by vibration detecting unit 11; and rotation speed control unit 13 for changing a rotation speed of motor 6 in accordance with the magnitude of the frequency component calculated by frequency component calculating unit 12, wherein elastic suspending portions 3 are located at the symmetrical positions with respect to rotation axis 16 of drum 1 so as to allow accommodation tub 2 to be suspended therefrom, wherein vibration detecting unit 11 detects a vibration of accommodation tub 2 in the front/rear direction, and wherein rotation speed control unit 13 changes

a rotation speed of motor 6 in accordance with the magnitude of the frequency component calculated from the vibration in the front/rear direction.

[0034] According to this configuration, the fabrics are rotated in accordance with the rotation of drum 1, and the fabrics are lifted upward and dropped from the upper position. Here, a vibration is generated when the fabrics collide with the lower position of the drum. Elastic suspending portions 3 are located at the symmetrical positions with respect to rotation axis 16 of accommodation tub 2, and allow accommodation tub 2 to be suspended therefrom. For this reason, the movement of the accommodation tub in the left/right direction is alleviated by the elastic force of elastic suspending portions 3, and becomes a vibration not involved with the movement of the fabrics. Further, the movement of accommodation tub 2 in the up/down direction is also alleviated by an elastic force or a damping force of antivibration damper 4 in the same manner. However, the vibration of accommodation tub 2 in the front/rear direction may be sufficiently detected without being alleviated by elastic suspending portions 3 or antivibration damper 4.

[0035] Accordingly, the vibration of accommodation tub 2 moving along with the movement of the fabrics inside drum 1 may be highly precisely detected. Therefore, the washing machine may be obtained which has an excellent cleaning performance and maintains the optimal striking washing state during a laundry cycle by controlling the rotation speed when the optimal striking washing is not sufficiently performed during the laundry cycle or the fabrics are rotated while being adhered to the drum.

(Second embodiment)

[0036] Next, a second embodiment of the invention will be described. Fig. 5 is a schematic plan view illustrating a support structure of the second embodiment of the invention. The same reference numeral will be given to the same component as that of the first embodiment, and the description thereof will not be repeated.

[0037] Unlike the first embodiment, the embodiment has a configuration in which elastic suspending portion 3 connecting the upper portions of accommodation tub 2 and cabinet 5 is supported at support point 15 on central axis 16 or substantially central axis 16 including central point 14 as shown in Fig. 5. In this case, the elastic suspending portion is maintained in a suspended state with a balance together with antivibration damper 4 supporting the lower portion of accommodation tub 2. For this reason, a periodical vibration is generated in accordance with the movement of washing fabrics 9 inside drum 1. The other configurations of the washing machine are the same as those of the first embodiment.

[0038] The vibration is detected by vibration detecting unit 11, and the result thereof is transmitted to frequency component calculating unit 12 of Fig. 1. Here, vibration detecting unit 11 detects at least one vibration component in the up/down direction, the left/right direction, and the front/rear direction of accommodation tub 2. The acceleration in the detected direction is transmitted to frequency component calculating unit 12 as a signal value, and is used as an output to rotation speed control unit 13. Frequency component calculating unit 12 calculates the magnitude (Fourier amplitude spectrum and power spectrum) of the frequency component by performing discrete Fourier transform (DFT) or fast Fourier transform (FFT) on the transmitted acceleration value. The rotation speed of the drum is increased or decreased by rotation speed control unit 13 on the basis of the magnitude of the calculated specific frequency component or the magnitude of the sum of the frequency components, so that the cleaning performance of cleaning washing fabrics 9 may be improved.

[0039] In the embodiment, elastic suspending portion 3 allows accommodation tub 2 to be suspended from a position on rotation axis 16 of drum 1 as shown in Fig. 5. More specifically, elastic suspending portion 3 allows accommodation tub 2 to be suspended from a position on a plane extending in the perpendicular direction so as to include rotation axis 16 of drum 1. Here, the number of the support positions of elastic suspending portion 3 may be one as shown in Fig. 5 or may be two positions in the front/rear direction on the plane. The number of the support positions is not particularly limited.

[0040] Here, in the support structure of the embodiment shown in Fig. 5, the vibration having a specific period and generated from accommodation tub 2 when the movement of washing fabrics 9 is in the striking washing state which effectively separates dirt therefrom during the washing operation is alleviated by elastic suspending portions 3 in the front/rear direction, and is alleviated by antivibration damper 4 in the up/down direction. For this reason, in this case, the vibration in the left/right direction is reflected without the alleviation of the movement of washing fabrics 9 moving inside drum 1. Therefore, in the embodiment, it is sufficient to provide the acceleration sensor of vibration detecting unit 11 capable of detecting the vibration in the left/right direction. However, a configuration may be adopted in which the vibrations in three axes (the front/rear direction, the left/right direction, and the up/down direction) may be detected, and only the vibration in the left/right direction is used.

[0041] Further, even when washing fabrics 9 rotate along with drum 1 during the laundry cycle and are dropped from the upper portion of the drum or rotate in a rolling manner, in fact, the vibrations in both the up/down direction and the left/right direction become relatively larger than the vibration in the front/rear direction with respect to central axis 16 of drum 1. For this reason, it is advantageous to detect the vibration in the left/right direction when detecting the movement of washing fabrics 9 in drum 1. Accordingly, in the support structure shown in Fig. 5, the cleaning performance may be improved by controlling the rotation speed of the drum in the same manner as the first embodiment on the basis of the vibration component in the left/right direction of

accommodation tub 2.

[0042] That is, when there are many components of the frequency longer than the frequency component range caused by the striking washing, the rotation speed of drum 1 is controlled to become slower so that washing fabrics 9 are dropped from the wall surface of drum 1.

[0043] On the contrary, when there are many components of the frequency shorter than the frequency component range caused by the striking washing, the rotation speed of drum 1 is controlled to become faster so that washing fabrics 9 are sufficiently lifted upward by baffles 10 along with the movement of drum 1.

[0044] In this way, when the rotation speed of drum 1 is controlled, the striking washing dropping washing fabrics 9 from the high position and improving the cleaning performance may be performed.

[0045] As described above, the washing machine of the embodiment includes: drum 1 for rotating laundry accommodated therein; accommodation tub 2 for accommodating drum 1; elastic suspending portion 3 for allowing accommodation tub 2 to be suspended from the upper side of cabinet 5; antivibration damper 4 for supporting accommodation tub 2 from the lower side of cabinet 5; motor 6 for rotating drum 1; vibration detecting unit 11 for detecting a vibration of accommodation tub 2; frequency component calculating unit 12 for calculating a frequency component from a vibration detected by vibration detecting unit 11; and rotation speed control unit 13 for changing a rotation speed of motor 6 in accordance with the magnitude of the frequency component calculated by frequency component calculating unit 12, wherein elastic suspending portion 3 is located at a position on rotation axis 16 of drum 1 so as to allow accommodation tub 2 to be suspended therefrom, wherein vibration detecting unit 11 detects a vibration of accommodation tub 2 in the left/right direction, and wherein rotation speed control unit 13 changes a rotation speed of motor 6 in accordance with the magnitude of the frequency component calculated from the vibration in the left/right direction.

[0046] According to this configuration, the fabrics are rotated in accordance with the rotation of drum 1, and the fabrics are lifted upward and dropped from the upper position. Here, a vibration is generated when the fabrics collide with the lower position of drum 1. Elastic suspending portion 3 is located at the position on rotation axis 16 of accommodation tub 2, and allows accommodation tub 2 to be suspended therefrom. For this reason, the movement of accommodation tub 2 in the front/rear direction is alleviated by the elastic force of elastic suspending portion 3, and becomes a vibration not involved with the movement of the fabrics. Further, the movement of accommodation tub 2 in the up/down direction is also alleviated by an elastic force or a damping force of antivibration damper 4 in the same manner. However, the vibration of accommodation tub 2 in the left/right direction may be sufficiently detected without being alleviated by elastic suspending portion 3 or antivibration damper 4.

[0047] Accordingly, the vibration of accommodation tub 2 moving along with the movement of the fabrics inside drum 1 may be highly precisely detected. Therefore, the washing machine may be obtained which has an excellent cleaning performance and maintains the optimal striking washing state during a laundry cycle by controlling the rotation speed when the optimal striking washing is not sufficiently performed during the laundry cycle or the fabrics are rotated while being adhered to drum 1.

[0048] As described above, the washing machine of the invention determines the direction of the vibration component caused by the vibration of the accommodation tub with the movement of the laundry depending on a difference in the support position of the accommodation tub with respect to the cabinet. That is, the direction of the vibration component used for the calculation of the calculation value in the frequency component calculating unit is determined. Accordingly, the cleaning performance may be improved by highly precisely detecting the movement of laundry inside the drum and controlling the rotation of the drum so as to be appropriate for the washing of fabrics.

INDUSTRIAL APPLICABILITY

[0049] As described above, the washing machine of the invention may improve the cleaning performance by controlling the rotation speed of the drum to be optimal for the washing state of the fabrics. The washing machine may be widely applied to not only a home washing machine, but also a professional washing machine or a drying machine.

DESCRIPTION OF REFERENCE NUMERALS AND SIGNS

[0050]

1: DRUM
2: ACCOMMODATION TUB
3: PLASTIC SUSPENDING PORTION
4: ANTIVIBRATION DAMPER
5: CABINET
6: MOTOR
7: BELT
8: FABRIC INPUT/EXTRACTION OPENING
9: WASHING FABRIC (LAUNDRY)
10: BAFFLE
11: VIBRATION DETECTING UNIT
12: FREQUENCY COMPONENT CALCULATING UNIT
13: ROTATION SPEED CONTROL UNIT
14: CENTRAL POINT
15: SUPPORT POINT
16: CENTRAL AXIS (ROTATION AXIS)

Claims

1. A washing machine comprising:

   a drum (1) for rotating laundry (9) accommodated therein;
   an accommodation tub (2) for accommodating the drum (1);
   an elastic suspending portions (3) for allowing the accommodation tub (2) to be suspended from the upper side of a cabinet (5);
   an antivibration damper (4) for supporting the accommodation tub (2) from the lower side of the cabinet (5);
   a motor (6) for rotating the drum (1);
   a vibration detecting unit (11) for detecting a vibration of the accommodation tub (2);

   characterized by:

   a frequency component calculating unit (12) for calculating a frequency component from a vibration detected by the vibration detecting unit (11); and
   a rotation speed control unit (13) for changing a rotation speed of the motor (6) in accordance with the magnitude of the frequency component calculated by the frequency component calculating unit (12),
   wherein the elastic suspending portions (3) are located at two positions (15) symmetrical to each other with respect to the rotation axis (16) of the drum (1) so as to allow the accommodation tub (2) to be suspended therefrom,
   wherein the vibration detecting unit (11) detects a vibration of the accommodation tub (2) in the front/rear direction, and
   wherein the rotation speed control unit (13) changes a rotation speed of the motor (6) in accordance with the magnitude of the frequency component calculated from the vibration in the front/rear direction.

2. The washing machine of claim 1, wherein the elastic suspending portions (3) allow the accommodation tub (2) to be suspended from symmetrical positions (15) with respect to a plane including a central point (14) while the drum (1) and the accommodation tub (2) are combined with each other and extending in the perpendicular direction so as to include the rotation axis (16) of the drum (1).

3. A washing machine comprising:

   a drum (1) for rotating laundry (9) accommodated therein;
   an accommodation tub (2) for accommodating the drum (1);
   an elastic suspending portion (3) for allowing the accommodation tub (2) to be suspended from the upper side of a cabinet (5);
   an antivibration damper (4) for supporting the accommodation tub (2) from the lower side of the cabinet (5);
   a motor (6) for rotating the drum (1);
   a vibration detecting unit (11) for detecting a vibration of the accommodation tub (2);

   characterized by:

   a frequency component calculating unit (12) for calculating a frequency component from a vibration detected by the vibration detecting unit (11); and
   a rotation speed control unit (13) for changing a rotation speed of the motor (6) in accordance with the magnitude of the frequency component calculated by the frequency component calculating unit (12),
   wherein the elastic suspending portion (3) is located at a position (15) on the rotation axis (16) of the drum (1) so as to allow the accommodation tub (2) to be suspended therefrom,
   wherein the vibration detecting unit (11) detects a vibration of the accommodation tub (2) in the left/right direction, and
   wherein the rotation speed control unit (13) changes a rotation speed of the motor (6) in accordance with the magnitude of the frequency component calculated from the vibration in the left/right direction.

4. The washing machine of claim 3, wherein the elastic suspending portion (3) allows the accommodation tub (2) to be suspended from a position on a plane extending in the perpendicular direction so as to include the rotation axis (16) of the drum (1).

Patentansprüche

1. Waschmaschine, die Folgendes umfasst:

   eine Trommel (1) zum Drehen von darin aufgenommener Wäsche (9);
   einen Aufnahmebottich (2) zum Aufnehmen der Trommel (1);
   elastische Aufhängeabschnitte (3), damit der Aufnahmebottich (2) an der oberen Seite eines Gehäuses (5) aufgehängt werden kann;
   ein Schwingungsdämpfungselement (4) zum Halten des Aufnahmebottichs (2) von der unteren Seite des Gehäuses (5);
   einen Motor (6) zum Drehen der Trommel (1);
   eine Schwingungsdetektionseinheit (11) zum Detektieren einer Schwingung des Aufnahme-

bottichs (2);
gekennzeichnet durch:

eine Frequenzkomponenten-Berechnungseinheit (12) zum Berechnen einer Frequenzkomponente einer Schwingung, die **durch** die Schwingungsdetektionseinheit (11) detektiert wurde; und
eine Drehzahl-Steuerungseinheit (13) zum Ändern einer Drehzahl des Motors (6) in Übereinstimmung mit dem Betrag der Frequenzkomponente, die **durch** die Frequenzkomponenten-Berechnungseinheit (12) berechnet wurde,
wobei die elastischen Aufhängeabschnitte (3) an zwei Positionen (15) symmetrisch zueinander in Bezug auf die Drehachse (16) der Trommel (1) so angeordnet sind, dass der Aufnahmebottich (2) daran aufgehängt werden kann,
wobei die Schwingungsdetektionseinheit (11) eine Schwingung des Aufnahmebottichs (2) in Vorwärts- bzw. Rückwärtsrichtung detektiert, und
wobei die Drehzahl-Steuerungseinheit (13) eine Drehzahl des Motors (6) in Übereinstimmung mit dem Betrag der Frequenzkomponente, die von der Schwingung in die Vorwärts- bzw. Rückwärtsrichtung berechnet wurde, ändert.

2. Waschmaschine nach Anspruch 1, wobei die elastischen Aufhängeabschnitte (3) ermöglichen, dass der Aufnahmebottich (2) an symmetrischen Positionen (15) in Bezug auf eine Ebene, die einen zentralen Punkt (14) umfasst, aufgehängt wird, wobei die Trommel (1) und der Aufnahmebottich (2) miteinander kombiniert sind und sich so in senkrechter Richtung erstrecken, dass die Drehachse (16) der Trommel (1) einbezogen ist.

3. Waschmaschine, die Folgendes umfasst:

eine Trommel (1) zum Drehen von darin aufgenommener Wäsche (9);
einen Aufnahmebottich (2) zum Aufnehmen der Trommel (1);
einen elastischen Aufhängeabschnitt (3), damit der Aufnahmebottich (2) an der oberen Seite eines Gehäuses (5) aufgehängt werden kann;
ein Schwingungsdämpfungselement (4) zum Halten des Aufnahmebottichs (2) von der unteren Seite des Gehäuses (5);
einen Motor (6) zum Drehen der Trommel (1);
eine Schwingungsdetektionseinheit (11) zum Detektieren einer Schwingung des Aufnahmebottichs (2);
gekennzeichnet durch:

eine Frequenzkomponenten-Berechnungseinheit (12) zum Berechnen einer Frequenzkomponente einer Schwingung, die **durch** die Schwingungsdetektionseinheit (11) detektiert wurde; und
eine Drehzahl-Steuerungseinheit (13) zum Ändern einer Drehzahl des Motors (6) in Übereinstimmung mit dem Betrag der Frequenzkomponente, die **durch** die Frequenzkomponenten-Berechnungseinheit (12) berechnet wurde,
wobei der elastische Aufhängeabschnitt (3) an einer Positionen (15) an der Drehachse (16) der Trommel (1) so angeordnet ist, dass der Aufnahmebottich (2) daran aufgehängt werden kann,
wobei die Schwingungsdetektionseinheit (11) eine Schwingung des Aufnahmebottichs (2) in Links- bzw. Rechtsrichtung detektiert und
wobei die Drehzahl-Steuerungseinheit (13) eine Drehzahl des Motors (6) in Übereinstimmung mit dem Betrag der Frequenzkomponente, die von der Schwingung in Links- bzw. Rechtsrichtung berechnet wurde, ändert.

4. Waschmaschine nach Anspruch 3, wobei es der elastische Aufhängeabschnitt (3) ermöglicht, dass der Aufnahmebottich (2) von einer Position auf einer Ebene, die sich in senkrechter Richtung erstreckt, so aufgehängt werden kann, dass die Drehachse (16) der Trommel (1) einbezogen ist.

Revendications

1. Lave-linge comportant :

un tambour (1) pour mettre en rotation le linge (9) qu'il contient;
un cylindre de réception (2) pour recevoir le tambour (1) ;
des parties de suspension élastique (3) permettant la suspension du cylindre de réception (2) au côté supérieur d'un carter (5) ;
un amortisseur anti-vibrations (4) pour supporter le cylindre de réception (2) sur le côté inférieur du carter (5) ;
un moteur (6) pour mettre en rotation le tambour (1) ;
une unité de détection de vibrations (11) pour détecter une vibration du cylindre de réception (2) ;

caractérisé par :

une unité de calcul de composante de fréquence

(12) pour calculer une composante de fréquence à partir d'une vibration détectée par l'unité de détection de vibration (11) ; et
une unité de commande de vitesse de rotation (13) pour modifier une vitesse de rotation du moteur (6) conformément à la magnitude de la composante de fréquence calculée par l'unité de calcul de composante de fréquence (12),
où les parties de suspension élastique (3) sont situées à deux positions (15) symétriques par rapport à l'axe de rotation (16) du tambour (1) de manière à pouvoir y suspendre le cylindre de réception (2),
où l'unité de détection de vibrations (11) détecte une vibration du cylindre de réception (2) dans la direction avant/arrière, et
où l'unité de commande de vitesse de rotation (13) modifie une vitesse de rotation du moteur (6) conformément à la magnitude de la composante de fréquence calculée à partir de la vibration dans la direction avant/arrière.

2. Lave-linge selon la revendication 1, où les parties de suspension élastique (3) permettent de suspendre le cylindre de réception (2) à partir de positions (15) symétriques par rapport à un plan comprenant un point central (14) quand le tambour (1) et le cylindre de réception (2) sont combinés et s'étendent dans la direction perpendiculaire de manière à inclure l'axe de rotation (16) du tambour (1).

3. Lave-linge comportant :

un tambour (1) pour mettre en rotation le linge (9) qu'il contient;
une cylindre de réception (2) pour recevoir le tambour (1) ;
une partie de suspension élastique (3) permettant la suspension du cylindre de réception (2) au côté supérieur d'un carter (5) ;
un amortisseur anti-vibrations (4) pour supporter le cylindre de réception (2) sur le côté inférieur du carter (5) ;
un moteur (6) pour mettre en rotation le tambour (1) ;
une unité de détection de vibrations (11) pour détecter une vibration du cylindre de réception (2) ;

caractérisé par

une unité de calcul de composante de fréquence (12) pour calculer une composante de fréquence à partir d'une vibration détectée par l'unité de détection de vibration (11) ; et
une unité de commande de vitesse de rotation (13) pour modifier une vitesse de rotation du moteur (6) conformément à la magnitude de la composante de fréquence calculée par l'unité de calcul de composante de fréquence (12),
où la partie de suspension élastique (3) est située à une position (15) sur l'axe de rotation (16) du tambour (1) de manière à pouvoir y suspendre le cylindre de réception (2),
où l'unité de détection de vibrations (11) détecte une vibration du cylindre de réception (2) dans la direction gauche/droite, et
où l'unité de commande de vitesse de rotation (13) modifie une vitesse de rotation du moteur (6) conformément à la magnitude de la composante de fréquence calculée à partir de la vibration dans la direction gauche/droite.

4. Lave-linge selon la revendication 3, où la partie de suspension élastique (3) permet de suspendre le cylindre de réception (2) à partir d'une position dans un plan s'étendant dans la direction perpendiculaire de manière à inclure l'axe de rotation (16) du tambour (1).

FIG. 1

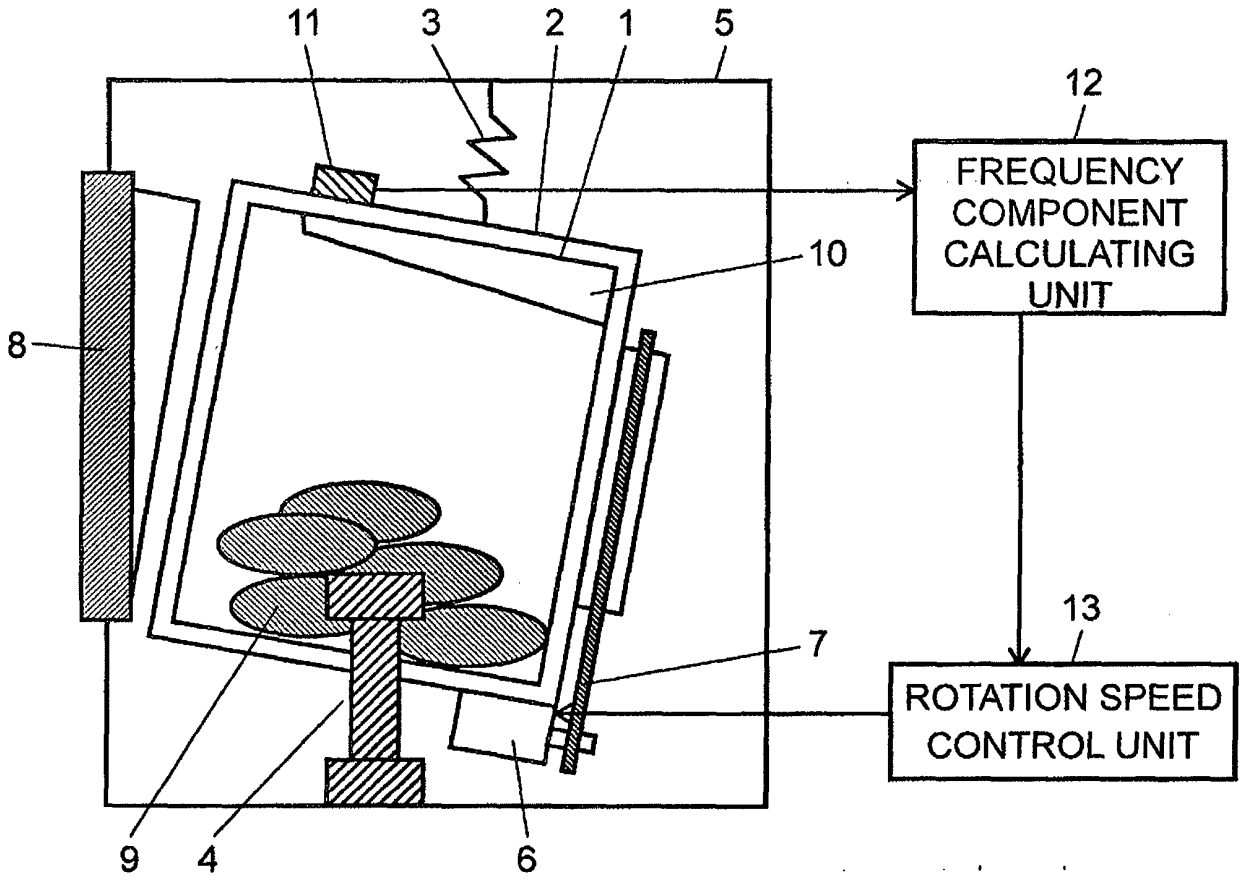

11
3
2
1
5
12
FREQUENCY COMPONENT CALCULATING UNIT
10
8
13
7
ROTATION SPEED CONTROL UNIT
9
4
6

FIG. 2

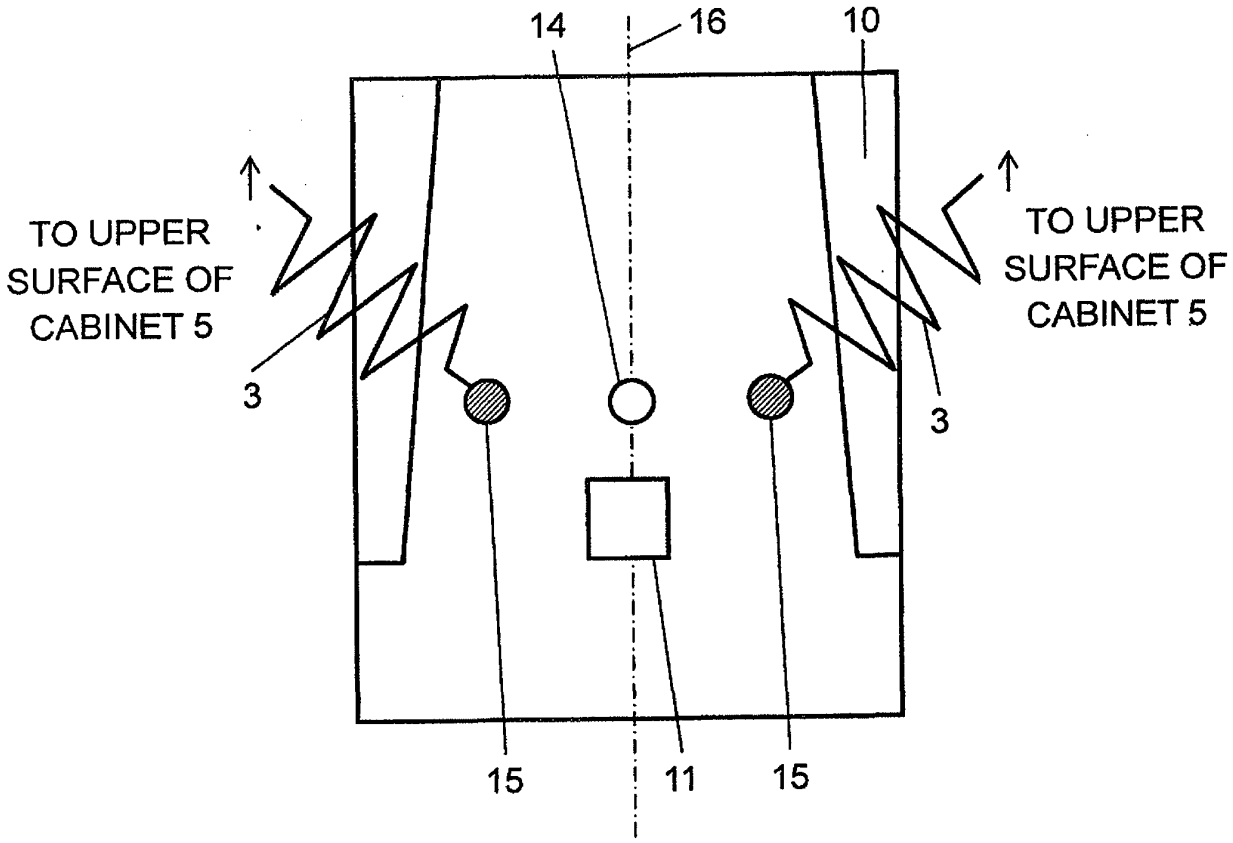

14
16
10
TO UPPER SURFACE OF CABINET 5
TO UPPER SURFACE OF CABINET 5
3
3
15
11
15

FIG. 3A

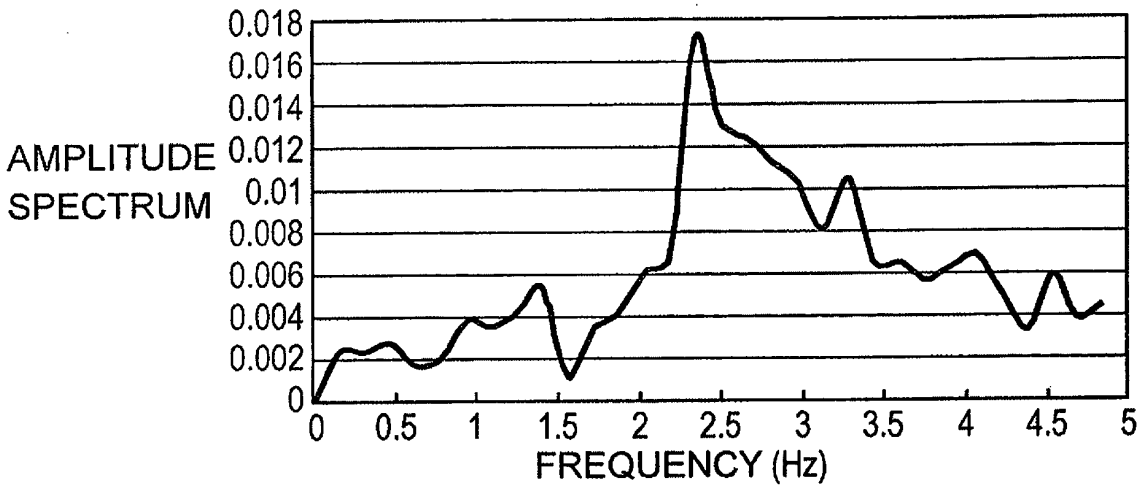


FIG. 3B

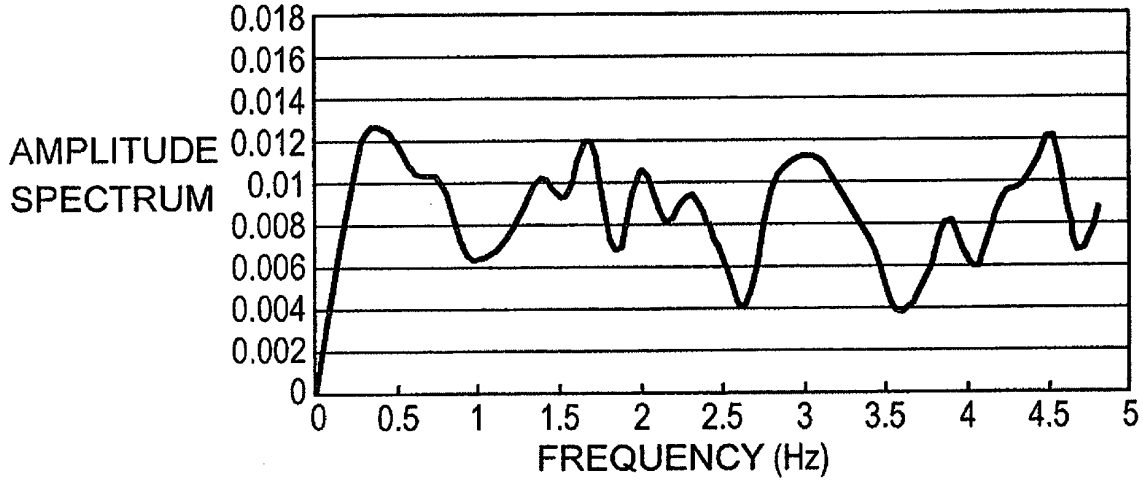


FIG. 3C

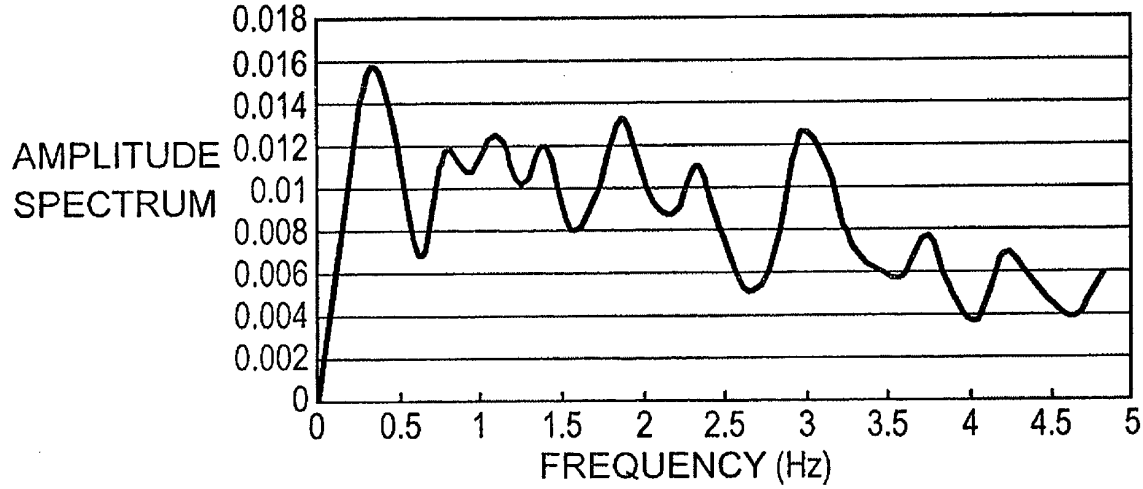


FIG. 4

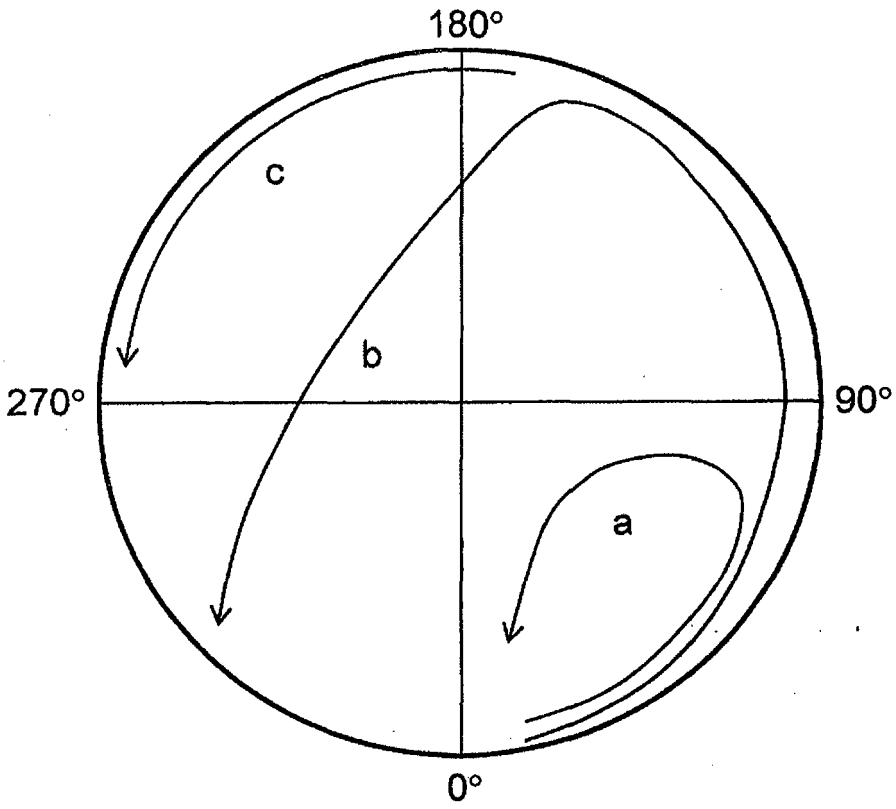


FIG. 5

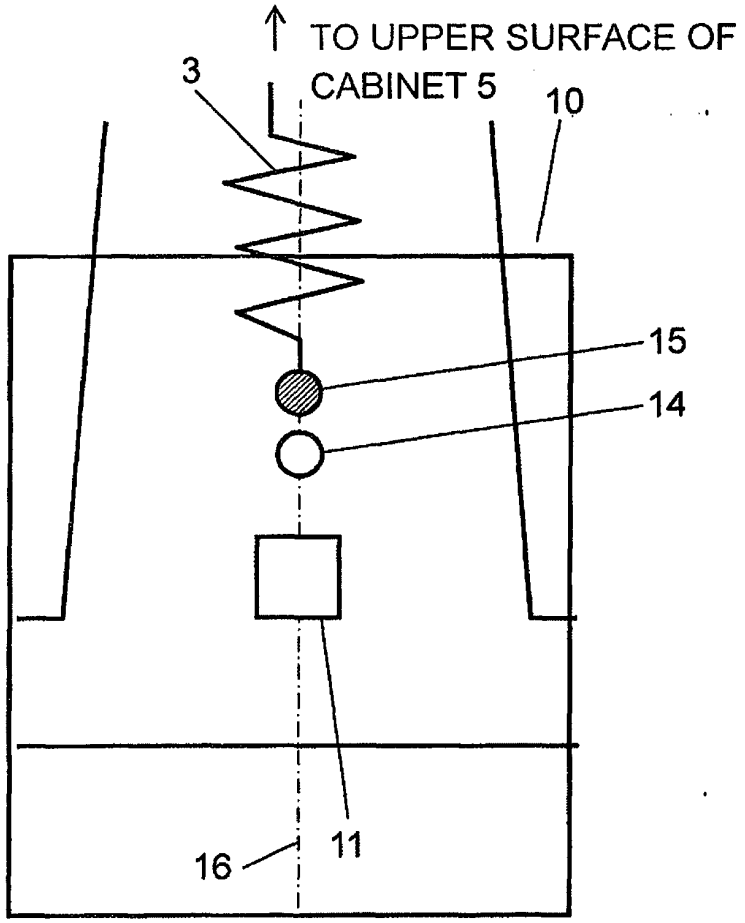
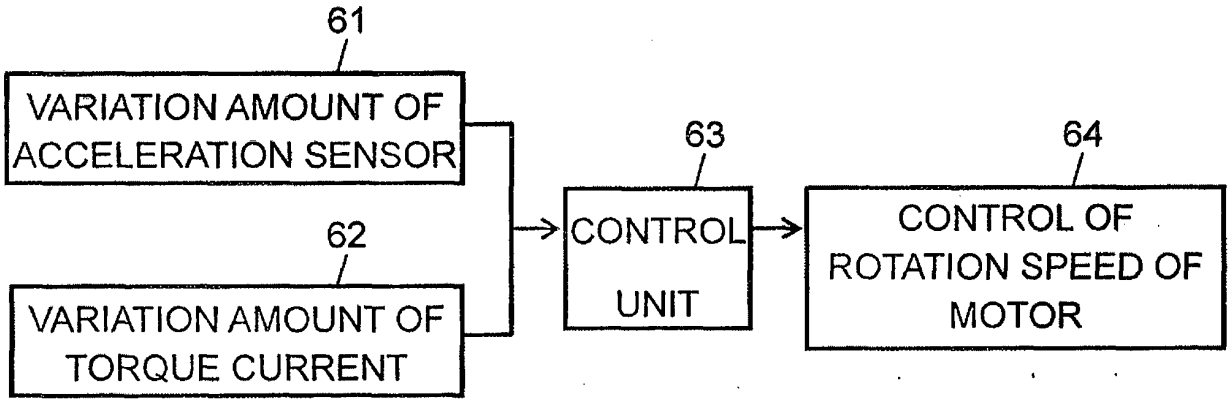

TO UPPER SURFACE OF CABINET 5
3
10
15
14
11
16

FIG. 6


61
VARIATION AMOUNT OF ACCELERATION SENSOR
62
VARIATION AMOUNT OF TORQUE CURRENT
63
CONTROL UNIT
64
CONTROL OF ROTATION SPEED OF MOTOR

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2006346270 A **[0006]**
- JP 2008142231 A **[0006]**