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(54) ## DEHYDRATOR

(57) Provided is a dewatering machine for improving the accuracy for detecting whether washings are biased. The dewatering machine (1) includes an electric motor (6) and a control part (30) for rotating a dewatering drum (4). When the dewatering drum (4) starts to rotate, the control part (30) measures a load of the washings (Q) in the dewatering drum (4). After the load is measured, the control part (30) rotates the motor (6) at a constant speed of a first rotating speed by controlling a duty ratio of a voltage applied to the motor (6) and then rotates the motor (6) at a constant speed of a second rotating speed higher than the first rotating speed. When the motor (6) is in an acceleration state of accelerating to the first rotating speed, the control part (30) acquires a reference duty ratio at timing determined according to the measured load. After the reference duty ratio is acquired, within a specified period, the control part (30) determines whether the washings (Q) in the dewatering drum (4) are biased according to an index indicating the change of the duty ratio with respect to the reference duty ratio.

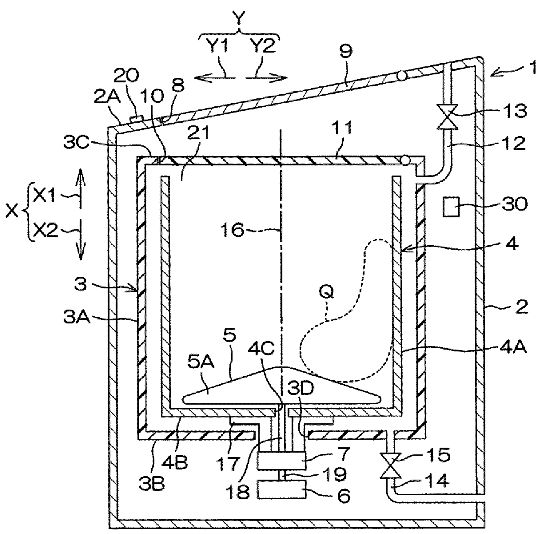

Fig. 1

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Description

TECHNICAL FIELD

[0001] The present invention relates to a dewatering machine.

BACKGROUND

[0002] A patent literature 1 discloses a washing machine with a dewatering function. During the dewatering of washings in the washing machine, a motor, which rotates a washing and dewatering drum accommodating the washings and to which a voltage with a controlled duty ratio is applied, rotates at a constant speed of 120 rpm, then rotates at a constant speed of 240 rpm, and finally rotates at a constant speed of 800 rpm.

[0003] When the washings in the washing and dewatering drum are subjected to the dewatering operation in an imbalance state of being biased and configured in a circumferential direction of the washing and dewatering drum, vibration and noise are increased. Therefore, whether the washings in the washing and dewatering drum are biased is detected in the washing machine.

[0004] Specifically, the duty ratio at a time point when 3.6 seconds are elapsed after the motor starts to accelerate from 120 rpm to 240 rpm is taken as a reference duty ratio. In addition, a target value related to the duty ratio which changes over time in a state that the motor rotates at the constant speed of 240 rpm is used as a comparative duty ratio and is calculated based on the reference duty ratio. Moreover, when a difference between an actual duty ratio obtained once at every specified timing and the comparative duty ratio at the same timing in the state where the motor rotates at the constant speed of 240 rpm is greater than a specified threshold value, it is determined that the washings are biased, and the rotation of the motor is stopped.

Current Technical Literature

Patent Literature

[0005] Patent Literature 1: Japanese Laid-Open Patent Publication No. 2011-240040

Problems to be solved by invention

[0006] The washing machine in the patent literature 1 determines that a rotating speed of the motor reaches 240 rpm at the time point when 3.6 seconds are elapsed after the motor starts to accelerate from 120 rpm to 240 rpm, and the duty ratio at the time point is regarded as the reference duty ratio.

[0007] However, since time required for the rotating speed of the motor to reach 240 rpm may change based on the load of the washings in the washing and dewatering drum, the time is not necessarily limited to the above 3.6 seconds.

[0008] The reference duty ratio is an important factor which affects accuracy for detecting whether the washings are biased. However, in the case of the patent literature 1, the duty ratio at the time point when 3.6 seconds are elapsed after the motor starts to accelerate is always regarded as the reference duty ratio, irrespective of the load. Therefore, the reference duty ratio, which is a duty ratio acquired at timing deviating from the correct timing due to the influence of the load, has an negative impact on the accuracy for detecting whether the washings are biased.

[0009] In addition, in the case of a structure for detecting whether the washings are biased, a problem to be solved for long is to shorten the time for the dewatering operation.

SUMMARY

[0010] The present invention is a dewatering machine completed in the background described above, and aims at providing a dewatering machine capable of improving detection accuracy of bias of washings.

[0011] In addition, the present invention also aims at providing a dewatering machine capable of shortening duration of dewatering operation.

Solution for solving the problems

[0012] The present invention provides a dewatering machine, including: a dewatering drum for accommodating washings and rotating to dewater the washings; an electric motor for rotating the dewatering drum; a load measuring unit for measuring a load of the washings in the dewatering drum when the dewatering drum begins to rotate; a drive control unit for, after the load measuring measures the load, rotating the motor constantly at a first rotating speed by controlling a duty ratio of a voltage applied to the motor and then rotating the motor constantly at a second rotating speed higher than the first rotating speed so as to dewater the washings formally; an acquisition unit for acquiring the duty ratio of the voltage applied to the motor as a reference duty ratio in an acceleration state in which the motor accelerates to the first rotating speed; a timing determination unit for determining timing for the acquisition unit to acquire the reference duty ratio; a determination unit for determining whether the washings in the dewatering drum are biased or not according to an index indicating a change between a duty ratio of the voltage applied to the motor to maintain the first rotating speed and the reference duty ratio within a specified period after the acquisition unit acquires the reference duty ratio; and a stopping control unit for stopping the rotation of the dewatering drum in a case where the determination unit determines that the washings are biased, wherein the timing determination unit determines the timing for the acquisition unit to acquire the reference duty ratio according to the load measured by the load measuring unit.

[0013] In addition, in the present invention, the dewatering machine includes an execution unit for, in a case where the stopping control unit enables the dewatering drum to stop rotating, executing one of the following executions: a rotation of the dewatering drum for restart the dewatering of the washings and a processing for correcting the bias of the washings in the dewatering drum.

[0014] In addition, in the present invention, before the motor rotates constantly at the first rotating speed, the drive control unit rotates the motor constantly at a specified speed lower than the first rotating speed, and the execution unit shortens the duration in which the motor rotates constantly at the specified speed in a case where the execution unit executes the rotation of the dewatering drum for restart the dewatering of the washings.

[0015] In addition, the present invention provides a dewatering machine, including: a dewatering drum for accommodating washings and rotating to dewater the washings; an electric motor for rotating the dewatering drum; a drive control unit for rotating the motor constantly at a first rotating speed by controlling a duty ratio of a voltage applied to the motor and then rotating the motor constantly at a second rotating speed higher than the first rotating speed so as to dewater the washings formally; an acquisition unit for acquiring a duty ratio every a specified time within a specified period after the motor begins to accelerate to the first rotating speed; a counting unit for adding 1 to a count value with an initial value of zero when the duty ratio acquired by the acquisition unit is greater than or equal to the duty ratio acquired last time and resetting the count value to the initial value when the duty ratio acquired by the acquisition unit is smaller than the duty ratio acquired last time; a determination unit for determining that the washings in the dewatering drum are biased when the count value is greater than or equal to a specified threshold; and a stopping control unit for stopping the rotation of the dewatering drum in a case where the determination unit determines that the washings are biased.

[0016] In addition, the present invention provides a dewatering machine, including: a dewatering drum for accommodating washings and rotating to dewater the washings; an electric motor for rotating the dewatering drum; a drive control unit for rotating the motor constantly at a first rotating speed by controlling a duty ratio of a voltage applied to the motor and then rotating the motor constantly at a second rotating speed higher than the first rotating speed so as to dewater the washings formally; an acquisition unit for acquiring a duty ratio every a specified time within a period when the rotating speed of the motor accelerates from the first rotating speed to a second rotating speed; a determination unit for determining that the washings in the dewatering drum are biased when the duty ratio acquired by the acquisition unit is greater than or equal to a specified threshold; a stopping control unit for stopping the rotation of the dewatering drum in a case where the determination unit determines that the washings are biased; a receiving unit for receiving a selection related to a dewatering condition of the washings; and a threshold changing unit for changing the threshold according to the selection related to the dewatering condition received by the receiving unit.

[0017] In addition, the present invention provides a dewatering machine, including: a dewatering drum for accommodating washings and rotating to dewater the washings; an electric motor for rotating the dewatering drum; a drive control unit for rotating the motor constantly at a first rotating speed by controlling a duty ratio of a voltage applied to the motor and then rotating the motor constantly at a second rotating speed higher than the first rotating speed so as to dewater the washings formally; an acquisition unit for acquiring a maximum value of a duty ratio in an acceleration state in which the motor accelerates to the first rotating speed to serve as a maximum duty ratio; a calculation unit for calculating an accumulated value of a difference between the duty ratio in every specified time and the maximum duty ratio after the acquisition unit acquires the maximum duty ratio; a determination unit for determining that the washings in the dewatering drum are biased when the accumulated value is smaller than the specified threshold; and a stopping control unit for stopping the rotation of the dewatering drum in a case where the determination unit determines that the washings are biased.

[0018] In addition, in the present invention, the threshold value is calculated using an equation adopting a count value and the maximum duty ratio as variables, wherein the count value is added by 1 once every the specified time.

[0019] In addition, in the present invention, the drive control unit controls the duty ratio in the following way: in the acceleration state in which the motor accelerates to the first rotating speed, the drive control unit generates the maximum duty ratio when the rotating speed is slightly lower than a rotating speed at which the dewatering drum resonates.

Effects of the invention

[0020] Through the present invention, as the dewatering machine performing the dewatering operation controls the duty ratio of the voltage applied to the electric motor which rotates the dewatering drum, the motor rotates constantly at the first rotating speed, and then the motor rotates constantly at the second rotating speed higher than the first rotating speed. Thus, the washings in the dewatering drum are dewatered formally.

[0021] In association with the detection of the bias of the washings in the dewatering drum, the reference duty ratio is acquired by the acquisition unit in an acceleration state in which the motor accelerates to the first rotating speed. Then, after the acquisition unit acquires the reference duty ratio, within a specified period, whether the washings in the dewatering drum are biased or not is determined according to an index indicating the change between the duty ratio of the voltage applied to the motor to maintain the first rotating speed and the reference duty ratio. In the case where the washings are determined to be biased, the rotation of the dewatering drum is stopped.

[0022] As a detection step of the bias, when the dewatering drum begins to rotate, a load of the washings in the dewatering drum is measured, and a timing determination unit determines timing for the acquisition unit to acquire the reference duty ratio according to the measured load. Thus, since the reference duty ratio is acquired at the correct timing in consideration of the load, the detection of the bias of the washings can be accurately executed on the basis of the reference duty ratio. The result is that the accuracy for detecting whether the washings are biased is improved.

[0023] In addition, through the present invention, in a case where the rotation of the dewatering drum is stopped according to the determination that the washings are biased, either of the rotation of the dewatering drum for restart the dewatering of the washings and the processing for correcting the bias of the washings in the dewatering drum can be selectively executed according to the index indicating the change between the duty ratio between the reference duty ratio.

[0024] That is, when the washings are determined to be biased, the processing for correcting the bias of the washings is not necessarily executed. Therefore, when the index is an index indicating that the washings are slightly biased, the dewatering drum is immediately rotated so as to restart the dewatering, thereby shortening the dewatering operation time.

[0025] In addition, through the present invention, in the dewatering operation including a step of rotating the motor constantly at the specified speed lower than the first rotating speed, in a case where the rotation of the dewatering drum for restart the dewatering of the washings is executed, since the duration of the step is shortened, the dewatering time is further shortened.

[0026] In addition, through the present invention, as the dewatering machine performing the dewatering operation controls the duty ratio of the voltage applied to the electric motor which rotates the dewatering drum, the motor rotates constantly at the first rotating speed, and then the motor rotates constantly at the second rotating speed higher than the first rotating speed. Thus, the washings in the dewatering drum are dewatered formally.

[0027] In association with the detection of the bias of the washings in the dewatering drum, after the motor begins to accelerate to the first rotating speed, a duty ratio is acquired every a specified time within a specified period, and each duty ratio is compared with the duty ratio acquired last time. Specifically, when the acquired duty ratio is greater than or equal to the duty ratio acquired last time, the count value with an initial value of zero is added by 1, and when the acquired duty ratio is smaller than the duty ratio acquired last time, the count value is reset to the initial value.

[0028] Moreover, when the count value is greater than or equal to the specified threshold, the washings in the dewatering drum are determined to be biased, and the rotation of the dewatering drum is stopped.

[0029] As long as the change between duty ratios obtained at adjacent timings is always monitored as described above, even if the change between the duty ratio and the initial duty ratio acquired at the beginning of the detection is small, the accurate detection for acquiring the change of the duty ratio during the detection in real time can also be performed, so that the accuracy for detecting whether the washings are biased can be improved.

[0030] In addition, through the present invention, as the dewatering machine performing the dewatering operation controls the duty ratio of the voltage applied to the electric motor which rotates the dewatering drum, the motor rotates constantly at the first rotating speed, and then the motor rotates constantly at the second rotating speed higher than the first rotating speed. Thus the washings in the dewatering drum are dewatered formally.

[0031] In association with the detection of the bias of the washings in the dewatering drum, within the period where the rotating speed of the motor accelerates from the first rotating speed to the second rotating speed, a duty ratio is acquired every the specified timing. When the duty ratio is greater than or equal to the specified threshold, the washings in the dewatering drum are determined to be biased, and the rotation of the dewatering drum is stopped.

[0032] The dewatering machine may receive a selection related to a dewatering condition of the washings via the receiving unit and may change the threshold according to the received dewatering condition. Thus, since the bias of the washings can be detected through the threshold adaptive to the dewatering condition in the dewatering operation under various dewatering conditions, the accuracy for detecting whether the washings are biased can be improved.

[0033] In addition, through the present invention, as the dewatering machine operates the dewatering operation controls the duty ratio of the voltage applied to the electric motor which rotates the dewatering drum, the motor rotates constantly at the first rotating speed, and then the motor rotates constantly at the second rotating speed higher than the first rotating speed. Thus, the washings in the dewatering drum are dewatered formally.

[0034] In association with the detection of the bias of the washings in the dewatering drum, a maximum value of the duty ratio is acquired to serve as the maximum duty ratio in the acceleration state where the motor accelerates to the first rotating speed, and then an accumulated value of the difference between the maximum duty ratio and the duty ratio of every specified timing is calculated.

[0035] In a case where the washings in the dewatering drum are not biased and after the maximum duty ratio is generated, since the motor can also accelerate to the first rotating speed even if the duty ratio is relatively small, the duty ratio is gradually reduced. Thus, since the difference between the duty ratio and the maximum duty ratio is gradually increased, the accumulated value is increased. However, in a case where the washings in the dewatering drum are biased, since the motor must increase the duty ratio after generating the maximum duty ratio in order to accelerate to the first rotating speed, the duty ratio after the maximum duty ratio is generated can hardly decrease. Thus, since the difference between the duty ratio and the maximum duty ratio can hardly increase, the accumulated value can hardly increase.

[0036] Therefore, when the accumulated value is smaller than the specified threshold, the washings in the dewatering drum are determined to be biased, and the rotation of the dewatering drum is stopped.

[0037] As long as a novel structure for monitoring the relative change between the duty ratio generated after the maximum duty ratio and the maximum duty ratio is adopted, the accuracy for detecting whether the washings are biased can be improved.

[0038] In addition, through the present invention, the threshold value is calculated using an equation adopting the count value added by 1 once every the specified timing and the maximum duty ratio as variables. The maximum duty ratio varies according to the load of the washings in the dewatering drum. Therefore, the threshold value is set differently according to the load. Thus, since whether the washings are biased is detected according to the optimum threshold corresponding to the load of the washings in the dewatering drum, false detection can be prevented. Therefore, the accuracy for detecting whether the washings are biased is further improved.

[0039] In addition, through the present invention, the duty ratio is set in such a manner that the maximum duty ratio is generated when the rotating speed is slightly lower than the rotating speed at which the dewatering drum resonates. At this moment, the resonance occurs early after the maximum duty ratio is generated. Therefore, a phenomenon that the accumulated value is difficult to increase appears soon. Hence, the bias of the washings in the dewatering drum can be early and correctly detected.

BRIEF DESCRIPTION OF DRAWINGS

[0040]

Fig. 1 is a schematic longitudinal sectional right view illustrating a dewatering machine 1 of an embodiment of the present invention;

Fig. 2 is a block diagram illustrating an electric structure of a dewatering machine 1.

Fig. 3 is a time chart illustrating a state of a rotating speed of a motor 6 in a dewatering operation implemented by a dewatering machine 1.

Fig. 4 is a diagram illustrating a relationship between a weight of washings accommodated in a dewatering drum 4 of a dewatering machine 1 and a load detected by a dewatering machine 1 according to the weight of the washings;

Fig. 5A is a flow chart illustrating an outline of detections 1 to 4 for detecting whether washings in a dewatering drum 4 are biased in dewatering operation;

Fig. 5B is a flow chart illustrating an outline of detections 1 to 4 for detecting whether washings in a dewatering drum 4 are biased in dewatering operation;

Fig. 6A is a flow chart illustrating control actions related to detections 1 and 2;

Fig. 6B is a flow chart illustrating control actions related to detections 1 and 2;

Fig. 7 is a graph illustrating a relationship between a rotating speed of a motor 6 and a difference Sn of a rotating speed in association with detection 1;

Fig. 8 is a graph illustrating a relationship between a rotating speed of a motor 6 and an accumulated value U of an absolute value of a difference about a difference S in association with detection 2;

Fig. 9A is a flow chart illustrating control actions related to detections 3 and 4;

Fig. 9B is a flow chart illustrating control actions related to detections 3 and 4;

Fig. 10 is a graph illustrating a relationship between time and a first count value E in association with detection 3;

Fig. 11 is a graph illustrating a relationship between time and a corrected duty ratio dn_diff in association with detection 4;

Fig. 12 is a flow chart illustrating an outline of detections 5-1 and 5-2 for detecting whether washings in a dewatering drum 4 are biased in dewatering operation;

Fig. 13 is a flow chart illustrating control actions related to detection 5-1;

Fig. 14 is a graph illustrating a relationship between a rotating speed and a moving accumulated value Cn in association with detections 5-1 and 5-2;

Fig. 15 is a flow chart illustrating control actions related to detection 5-2;

Fig. 16 is a flow chart illustrating a control action of detecting foam in dewatering operation;

Fig. 17 is a time chart illustrating a state of a rotating speed of a motor 6 during dewatering operation implemented by a dewatering machine 1 in association with detection 6;

Fig. 18 is a flow chart illustrating control actions related to detection 6;

Fig. 19 is a graph illustrating a relationship between a count value G and an accumulated value H in association with detection 6; and

Fig. 20 is a graph illustrating a relationship between a count value G and a duty ratio in association with detection 6.

A list of reference numerals:

[0041] 1: dewatering machine; 4: dewatering drum; 6: motor: 30: control part; dg: duty ratio; dmax: maximum duty ratio; dn: duty ratio; d0: reference duty ratio; dn_diff: corrected duty ratio; E: first count value; G: count value; H: accumulated value; and Q: washings.

DETAILED DESCRIPTION

[0042] Embodiments of the present invention are described below in detail with reference to drawings.

[0043] Fig. 1 is a schematic longitudinal sectional right view illustrating a dewatering machine 1 of an embodiment of the present invention.

[0044] An up-down direction in Fig. 1 is called as an up-down direction X of a dewatering machine 1, and a left-right direction in Fig. 1 is called as a front-rear direction Y of the dewatering machine 1. Firstly, the dewatering machine 1 is schematically described. In the up-down direction X, an up direction is called as an upper side X1, and a down direction is called as a lower side X2. In the front-rear direction Y, a left direction in Fig. 1 is called as a front direction Y1, and a right direction in Fig. 1 is called as a rear direction Y2.

[0045] The dewatering machine 1 includes all apparatuses capable of carrying out dewatering operation of washings Q. Therefore, the dewatering machine 1 not only includes an apparatus having a dewatering function, but also includes a washing machine having a dewatering function and a washing and drying machine. The dewatering machine 1 is described below by taking the washing machine as an example.

[0046] The dewatering machine 1 includes a housing 2, an outer drum 3, a dewatering drum 4, a rotary wing 5, an electric motor 6, and a transmission mechanism 7.

[0047] The housing 2 is made of, e.g., metal, and formed in a box shape. An upper surface 2A of the housing 2 is formed obliquely relative to the front-rear direction Y in a manner of extending to the upper side X1 toward the rear direction Y2. An opening 8 connecting the inside and outside of the housing 2 is formed in the upper surface 2A. A door 9 for opening and closing the opening 8 is arranged on the upper surface 2A. An operation part 20 consisting of a liquid crystal operation panel and the like is arranged in a region toward the front direction Y1 than the opening 8 on the upper surface 2A. A user can operate the operation part 20 to select a dewatering condition freely, or instruct the dewatering machine 1 to start or to stop.

[0048] The outer drum 3 is made of, e.g., resin, and formed in a bottomed cylindrical shape. The outer drum 3 has a substantially cylindrical circumferential wall 3A arranged along the up-down direction X; a bottom wall 3B, configured to block a hollow part of the circumferential wall 3A from the lower side X2; and an annular wall 3C, which is annular and protrudes towards a circle center side of the circumferential wall 3A while covering an edge at a side of the upper side X1 of the circumferential wall 3A. An outlet-inlet 10 communicated with the hollow part of the circumferential wall 3A from the upper side X1 is formed inside the annular wall 3C. The outlet-inlet 10 is arranged in opposite and communicated state relative to the opening 8 of the housing 2 from the lower side X2. A door 11 for opening and closing the outlet-inlet 10 is arranged on the annual wall 3C. The bottom wall 3B is formed in a circular plate shape in a manner of substantially extending horizontally. A through hole 3D penetrating through the bottom wall 3B is formed in a position of the circle center of the bottom wall 3B.

[0049] Water can be stored in the outer drum 3. A water supply pipeline 12 connected with a faucet of tap water is connected with the outer drum 3 from the upper side X1, and the tap water is supplied into the outer drum 3 from the water supply pipeline 12. A water supply valve 13 which can be opened and closed to start or stop water supply is arranged in a midway of the water supply pipeline 12. A drainage pipeline 14 is connected with the outer drum 3 from the lower side X2, and the water in the outer drum 3 is discharged outside the washing machine from the drainage pipeline 14. A drainage valve 15 which can be opened and closed to start or stop drainage is arranged in a midway of the drainage pipeline 14.

[0050] The dewatering drum 4 is made of, e.g., metal, and is formed in a bottomed cylindrical shape which is a circle smaller than the outer drum 3, and can accommodate washings Q. The dewatering drum 4 has a substantially cylindrical circumferential wall 4A arranged along the up-down direction X and a bottom wall 4B configured to block a hollow part of the circumferential wall 4A from the lower side X2.

[0051] An internal circumferential surface of the circumferential wall 4A is an internal circumferential surface of the dewatering drum 4. An upper end part of the internal circumferential surface of the circumferential wall 4A is an outlet-inlet 21 for enabling the hollow part of the circumferential wall 4A to expose to the upper side X1. The outlet-inlet 21 is arranged in opposite and communicated state relative to the outlet-inlet 10 of the outer drum 3 from the lower side X2. The outlet-inlet 10 and the outlet-inlet 21 are opened and closed through the door 11 together. A user of the dewatering machine 1 puts the washings Q in the dewatering drum 4 and takes the washings Q out of the dewatering drum 4 through the opened opening 8, the outlet-inlet 10 and the outlet-inlet 21.

[0052] The dewatering drum 4 is coaxially accommodated in the outer drum 3. The dewatering drum 4 accommodated in the outer drum 3 can rotate around an axis 16 which forms a central axis and extends in the up-down direction X. In addition, a plurality of through holes, which are not shown, are formed in the circumferential wall 4A and the bottom wall 4B of the dewatering drum 4, and the water in the outer drum 3 can flow between the outer drum 3 and the dewatering drum 4 through the through holes. Therefore, a water level in the outer drum 3 is consistent with a water level in the dewatering drum 4.

[0053] The bottom wall 4B of the dewatering drum 4 is spaced from the bottom wall 3B of the outer tank 3 toward the upper side X1 and is formed in a circular plate shape extending substantially parallel. A through hole 4C penetrating through the bottom wall 4B is formed in a position of a circle center of the bottom wall 4B consistent with the axis 16. A tubular supporting shaft 17 surrounding the through hole 4C and stretching out to the lower side X2 along the axis 16 is arranged on the bottom wall 4B. The supporting shaft 17 is inserted into the through hole 3D of the bottom wall 3B of the outer drum 3, and a lower end part of the supporting shaft 17 is located closer to the lower side X2 relative to the bottom wall 3B.

[0054] The rotary wing 5, i.e., an impeller, is formed in a discoid shape by taking the axis 16 as a circle center, and is arranged concentrically with the dewatering drum 4 along the bottom wall 4B in the dewatering drum 4. A plurality of blades 5A radially disposed are arranged on an upper surface of the rotary wing 5 toward the outlet-inlet 21 of the dewatering drum 4. A rotating shaft 18 extending toward the lower side X2 from a circle center of the rotary wing 5 along the axis 16 is arranged on the rotary wing 5. The rotating shaft 18 is inserted into a hollow part of the supporting shaft 17, and a lower end part of the rotating shaft 18 is located closer to the lower side X2 relative to the bottom wall 3B of the outer drum 3.

[0055] In the present embodiment, the motor 6 is implemented through a variable frequency motor. The motor 6 is arranged in the lower side X2 of the outer drum 3 in the housing 2, and is provided with an output shaft 19 rotating around the axis 16. A transmission mechanism 7 is located between the lower end parts of both the supporting shaft 17 and the rotating shaft 18, and an upper end part of the output shaft 19. The transmission mechanism 7 selectively transmits a driving force outputted by the motor 6 from the output shaft 19 to one or both of the supporting shaft 17 and the rotating shaft 18. A widely known transmission mechanism can be taken as the transmission mechanism 7.

[0056] The dewatering drum 4 and the rotary wing 5 rotate around the axis 16 when the driving force from the motor 6 is transmitted to the supporting shaft 17 and the rotating shaft 18. The washings Q in the dewatering drum 4 are stirred through the rotating dewatering drum 4 and the blades 5A of the rotary wing 5 during washing and rinsing. In addition, the washings Q in the dewatering drum 4 are dewatered through high-speed integrated rotation of the dewatering drum 4 and the rotary wing 5 during dewatering after the rinsing.

[0057] Fig. 2 is a block diagram illustrating an electric structure of a dewatering machine 1.

[0058] Referring to Fig. 2, the dewatering machine 1 includes: a load measuring unit, a drive control unit, an acquisition unit, a timing determination unit, a determination unit, a stopping control unit, an execution unit, a counting unit, a receiving unit, a threshold value changing unit and a control part 30 as a calculation unit. The control part 30 is disposed in the housing 2 (referring to Fig. 1) and includes, for example, a CPU 31; a memory 32 such as ROM or RAM; a timer 35; and a microcomputer as a counter 34.

[0059] The dewatering machine 1 further includes a water level sensor 33 and a rotating speed reading apparatus 34. The water level sensor 33, the rotating speed reading apparatus 34, the motor 6, the transmission mechanism 7, the water supply valve 13, the drainage valve 15 and the operation part 20 are electrically connected with the control part 30 respectively.

[0060] The water level sensor 33 is a sensor for detecting the water levels of the outer drum 3 and of the dewatering drum 4, and a detection result of the water level sensor 33 is inputted into the control part 30 in real time.

[0061] The rotating speed reading apparatus 34 is an apparatus for reading a rotating speed of the motor 6, and strictly speaking, for reading a rotating speed of the output shaft 19 of the motor 6, and consists of, e.g., a Hall integrated circuit (IC). The rotating speed read by the rotating speed reading apparatus 34 is inputted into the control part 30 in real time. The control part 30 controls a duty ratio of a voltage applied to the motor 6 according to the inputted rotating speed, and then, enables the motor 6 to rotate at a desired rotating speed.

[0062] The control part 30 switches a transmission target of the driving force of the motor 6 to one or both of the supporting shaft 17 and the rotating shaft 18 by controlling the transmission mechanism 7. The control part 30 controls the opening and closing of the water supply valve 13 and the drainage valve 15. As mentioned above, when the user selects the dewatering condition and the like of the washings Q by operating the operating part 20, the control part 30 receives the selection.

[0063] Next, the dewatering operation of the dewatering machine 1 is described.

[0064] Fig. 3 is a time chart illustrating a state of a rotating speed of a motor 6 in dewatering operation implemented by a dewatering machine 1. In the time chart of Fig. 3, a horizontal axis indicates elapsed time, and a vertical axis indicates a rotating speed of the motor 6 (unit: rpm).

[0065] Referring to Fig. 3, in the dewatering operation, the control part 30 measures the load of the washings Q in the dewatering drum 4 when the dewatering drum 4 begins to rotate. After the load is measured, the control part 30 enables the motor 6 to rotate at a constant speed of 120 rpm after the rotating speed of the motor 6 is increased to 120 rpm. Then the control part 30 enables the motor 6 to rotate at a constant speed of 240 rpm after the rotating speed of the motor 6 is increased from 120 rpm to 240 rpm. Then the control part 30 enables the motor 6 to rotate at a constant speed of 800 rpm after the rotating speed of the motor 6 is increased from 240 rpm to 800 rpm. Through the constant rotation of the motor 6 at 800 rpm, the washings Q in the dewatering drum 4 are formally dewatered. It shall be noted that during the dewatering operation, when the rotating speed of the motor 6 is, for example, comprised between 50 rpm and 60 rpm, the dewatering drum 4 resonates horizontally, and when the rotating speed of the motor 6 is, for example, comprised between 200 rpm and 220 rpm, the dewatering drum 4 resonates longitudinally.

[0066] When the washings Q in the dewatering drum 4 are in a state of being biased and arranged in the circumferential direction of the dewatering drum 4, the washings Q are biased in the dewatering drum 4. When the dewatering operation is carried out in such state, the dewatering drum 4 performs eccentric rotation. Thus, the dewatering drum 4 may swing widely, as such the dewatering machine 1 vibrate significantly and produce noise.

[0067] Therefore, the control part 30 detects whether the washings Q in the dewatering drum 4 are biased during the dewatering operation, and stops the motor 6 when the washings Q are detected to be biased. In such detection, the control part 30 performs five types of electric detections, i.e., detection 1, detection 2, detection 3, detection 4 and detection 5.

[0068] The detections 1 to 4 are executed in a low-speed eccentricity detection section, and the low-speed eccentricity detection section includes an acceleration period where the rotating speed of the motor 6 is increased from 120 rpm to 240 rpm and a specified period after the motor 6 begins to accelerate to 240 rpm. The detection 5 is executed in a period where the rotating speed of the motor 6 reaches 800 rpm from 240 rpm, i.e., a high-speed eccentricity detection section.

[0069] Fig. 4 is a graph illustrating a relationship between the weight and the load of the washings Q accommodated in the dewatering drum 4, and the load is detected by the dewatering machine 1 according to the weight of the washings Q. In the graph of Fig. 4, the horizontal axis indicates the weight (unit: kg) of the washings Q, and the longitudinal axis indicates a detection value of the load.

[0070] Referring to Fig. 4, as described above, the control part 30 measures the load of the washings Q in the dewatering drum 4 when the dewatering drum 4 begins to rotate. The control part 30 enables the dewatering drum 4 to rotate at the specified rotating speed when the dewatering drum 4 begins to rotate, and detects a value obtained after accumulating the duty ratio of the voltage applied to the motor 6 at this moment for a given times as the load. When the weight of the washings Q is increased, since a high voltage must be applied to the motor 6 to rotate the dewatering drum 4, the load is increased along with the increase of the voltage. Thus, the control part 30 electrically measures the load of the washings Q.

[0071] Fig. 5A and Fig. 5B are flow charts illustrating outlines of the detections 1 to 4.

[0072] Referring to Fig. 5A and Fig. 5B, when the dewatering rotation of the dewatering drum 4 is started by starting the dewatering operation (step S1), as described above, the control part 30 measures the load of the washings Q in the dewatering drum 4 (step S2), and then the motor 6 rotates at a constant speed of 120 rpm (step S3).

[0073] Then, the control part 30 begins to accelerate the motor 6 to 240 rpm (step S4), and the detection 1 described above is implemented during the acceleration of the motor 6 (step S5). In a case where a result of the detection 1 is not "OK" (step S5: No), that is, in a case where the control part 30 determines that the washings Q are biased, the control part 30 stops the motor 6, stops the rotation of the dewatering drum 4 (step SS6), and then determines whether the dewatering operation can be restarted or not (step S7).

[0074] Restart of the dewatering operation refers to rotating the dewatering drum 4 to restart the dewatering operation immediately after the control part 30 stops rotation of the dewatering drum 4 to suspend the dewatering operation. Detailed conditions will be described below. Sometimes, the restart may also be conducted according to the biased degree of the washings Q.

[0075] Before the restart, i.e., in a case where the restart has not been implemented (step S7: Yes), the control part 30 executes the restart (step S8). During the restarted dewatering operation, the control part 30 shortens the duration of constant rotation at 120 rpm to be less than the duration of constant rotation at 120 rpm during the dewatering operation just stopped. In the case of restart, since the washings Q are in a state of being attached to an inner circumferential surface of the dewatering drum 4 to a certain extent and removing most of the water, it is acceptable to shorten the duration of constant rotation at 120 rpm. Thus, the duration of the dewatering operation can be shortened. It shall be noted that such reduction of duration can also be executed in subsequent restarts.

[0076] When the restart cannot be performed (step S7: No), the control part 30 executes an imbalance correction (step S9). During the imbalance correction, after the drainage valve 15 is closed, the control part 30 opens the water supply valve 13 and supplies water into the dewatering drum 4 to reach a specified water level, and the washings Q in the dewatering drum 4 are immersed in the water so as to be easily scattered. In this state, the control part 30 rotates the dewatering drum 4 and the rotary wing 5, so that the washings Q attached to the inner circumferential surface of the dewatering drum 4 are dropped and stirred, thereby correcting the bias of the washings Q in the dewatering drum 4.

[0077] On the other hand, in a case where the result of the detection 1 is "OK" (step S5: Yes), that is, the control part 30 determines that the washings Q are not biased through the detection 1, the control part 30 continues to execute the above detection 2 (step S10) in the acceleration of the motor 6.

[0078] In a case where the result of the detection 2 is not "OK" (step S10: No), that is, the control part 30 determines that the washings Q are biased, the control part 30 stops the motor 6 and the dewatering drum 4 so as to suspend the dewatering operation (step S11). Then, the control part 30 confirms whether the dewatering condition of the currently suspended dewatering operation is a "wool fabric mode" or "independent dewatering operation" (step S12).

[0079] The wool fabric mode is a dewatering condition for dewatering the washings Q that are easy to absorb the water such as wool fabrics. When the dewatering condition is the wool fabric mode (step S12: Yes), and in a case where the currently suspended dewatering operation is the condition that the restart has not been implemented, i.e., before the restart (step S13: Yes), the control part 30 executes the restart for shortening the duration of constant rotation at 120 rpm (step S14).

[0080] In the case of the wool fabric mode, a great amount of water oozed from the wool fabric and accumulated in the outer drum 3 may obstruct the rotation of the dewatering drum 4. Thus, the control part 30 may mistakenly determine that the result of the detection 2 is not "OK". Moreover, when the imbalance correction is performed regardless of the mistaken determination and the wool fabric absorbs a great amount of water again, the mistaken determination may occur again in a subsequent detection 2. Therefore, in a case where the result of the detection 2 is determines as not "OK" under the wool fabric mode, the restart rather than the imbalance correction is performed (step S14) as long as the restart is not implemented (step S13: Yes). On the other hand, in the case of being not before the restart, that is, as long as the currently suspended dewatering operation is already restarted (step S13: No), the control part 30 executes the imbalance correction (step S15).

[0081] The independent dewatering operation refers to the dewatering condition under which the rinsed washings Q are put into the dewatering drum 4 and dewatered rather than the dewatering operation executed subsequently to the washing operation and the rinsing operation. In a case where the dewatering condition is the independent dewatering operation (step S12: Yes) and before the restart (step S13: Yes), the control part 30 executes the restart (step S14).

[0082] In the case of the independent dewatering operation, when the rinsed washings Q are immersed through the imbalance correction, it is meaningless to prepare the rinsed washings Q in advance. Therefore, in a case where the result of the detection 2 is determined not to be "OK" in the independent dewatering operation, the restart rather than the imbalance correction is performed as long as the restart has not been implemented. It shall be noted that the control part 30 can also prompt a user to redispose the washings Q in the dewatering drum 4 through the display of the operation part 20 and the error report performed by a buzzer. On the other hand, in the case of being not before the restart (step S13: No), the control part 30 executes the imbalance correction (step S15).

[0083] In another aspect, in a case where the dewatering condition is neither the wool fabric mode nor the independent dewatering operation (step S12: No), the control part 30 determines that the currently suspended dewatering operation is before the restart, and determiens whether the dewatering operation can be restarted subsequently or not (step S16). When the dewatering operation is before the restart and can be restarted (step S16: Yes), the control part 30 executes the restart for shortening the duration of constant rotation at 120 rpm (step S 17). When the condition of being before the restart and capable of being restarted is not satisfied (step S16: No), the control part 30 executes the imbalance correction (step S18).

[0084] Moreover, in a case where the result of the detection 2 is "OK" (step S10: Yes), that is, in a case where the control part 30 determines that the washings Q are not biased in the detection 2, the control part 30 confirms if the value of the timer 35 is greater than a set value per load (step 19). That is, in the step S19, the control part 30 confirms whether the duration counted by the timer 35 already reaches a set value corresponding to the load of the washings Q in the dewatering drum 4. The set value is described in detail below.

[0085] When the value of the timer 35 is greater than the set value per load (step S19: Yes), and the motor 6 is in the state of rotating at a constant speed of 240 rpm, the control part 30 executes the above detections 3 and 4 (step S20). In a case where results of the detections 3 and 4 are not "OK" (step S20: No), that is, the control part 30 determines that the washings Q are biased, the control part 30 stops the motor 6 and the dewatering drum 4 so as to suspend the dewatering operation (step S11), and executes the corresponding processing in steps S12 to S18.

[0086] In another aspect, in a case where the results of the detection 3 and detection 4 are "OK" (step S20: Yes), that is, in a case where the control part 30 determines that the washings Q are not biased in the detection 3 and detection 4, the control part 30 continues to rotate the motor 6 at a constant speed of 240 rpm so as to continue the dewatering at 240 rpm (step S21).

[0087] Next, detections 1 to 4 are respectively described in detail.

[0088] Fig. 6A and Fig. 6B are flow charts illustrating control actions related to the detections 1 detection 2. Firstly, referring to Fig. 6A and Fig. 6B, the detections 1 and 2 are described. The detections 1 and 2 are detections of the bias of the washings Q by utilizing the rotating speed of the motor 6.

[0089] In the above step S4, the control part 30 begins to accelerate the motor 6 to 240 rpm and begins the detections 1 and 2. Firstly, the control part 30 trigger the timer 35 to time, and measures a rotating speed V0 of the motor 6 at the beginning of the acceleration through the rotating speed reading apparatus 34 (step S31). The rotating speed V0 is about 120 rpm.

[0090] With respect to the value of the timer 35, i.e., the timing, the detection time of the detections 1 and 2, i.e. the acceleration time for the motor 6 to accelerate to 240 rpm varies depending on the load. The reason is that the heavier the washings Q are, the more time the motor 6 needs to reach the rotating speed of 240 rpm. Therefore, the set value per load related to the acceleration time of the motor 6 is obtained in advance through experiments and the like, and stored in the memory 32.

[0091] Then, the control part 30 begins to count through the counter 36 (step S32), and performs the counting once every 0.3 second by initializing the counter 36 once every 0.3 second (step S33 and step S34).

[0092] The control part 30 measures the rotating speed Vn (n: count value) of the motor 6 in each counting (step S35). In step S35, the control part 30 calculates the difference Sn between the measured rotating speed Vn and the rotating speed Vn-1 measured before the Vn. Then, the control part 30 calculates the accumulated value U based on an absolute value of the difference between a difference Sn and a previous difference Sn-1 in the step S35.

[0093] Next, the control part 30 confirms whether the value of the timer 35 is already greater than the set value per load, that is, whether the measuring time of the timer 35 reaches the set value corresponding to the load of the washings Q in the dewatering drum 4 (step S36). The step S36 is equivalent to the step S19 described above (referring to Fig. 5A).

[0094] In a case where the value of the timer 35 is less than the set value per load, that is, in a case where the timing of the timer 35 does not reach the corresponding set value (step S36: No), and when the load of the washings Q in the dewatering drum 4 is less than a given amount (step S37: Yes), the control part 30 determines that whether the difference Sn just calculated falls within the scope of the detection 1 (step S38). The given amount is obtained in advance through the experiment and the like and stored in the memory 32.

[0095] Specifically, the threshold value is preset for the difference Sn and stored in the memory 32. Fig. 7 is a graph illustrating the relationship between the rotating speed of the motor 6 and the difference Sn in association with the detection 1. In the graph of Fig. 7, the horizontal axis indicates the rotating speed (unit: rpm), and the longitudinal axis indicates the difference Sn (unit: rpm).

[0096] By referring to the range of the rotating speed indicated by the dotted arrow in Fig. 7, in a case where the washings Q are regarded not to be biased due to small eccentricity, because of the stable acceleration of the dewatering drum 4, the deviation of the difference Sn is small as shown by the solid line. However, in a case where the washings Q are regarded to be biased due to large eccentricity, because of the instable acceleration of the dewatering drum 4, as shown by the dotted line, the deviation of the difference Sn is large, and a minimum value of the difference Sn is smaller than the threshold value. Therefore, returning to Fig. 6A, when the difference Sn is smaller than or equal to the threshold value, the control part 30 determines that the difference Sn falls within the scope of the detection 1 (step S38: Yes). In this way, in the detection 1, the instability degree of the acceleration of the dewatering drum 4 indicating whether the washings Q are biased is detected according to the difference Sn.

[0097] When the control part 30 determines that the difference Sn falls within the scope of the detection 1 (step S38: Yes), the rotation of the motor 6 is stopped (step S6), and the corresponding processing in the above steps S7 to S9 is executed (referring to Fig. 5A). The processing of the step S31 to step 38 is included in the above step S5 (referring to Fig. 5A).

[0098] When the control part 30 determines that the difference Sn does not fall within the range of the detection 1 since the difference Sn is greater than the threshold value (step S38: No), the control part 30 determines whether the accumulated value U just calculated falls within the scope of the detection 2 or not (step S39).

[0099] In addition, when the load of the washings Q in the dewatering drum 4 is greater than a given amount (step S37: No), the control part 30 executes the determination performed by the detection 2 in the step S39 rather than the determination performed by the detection 1 in the step S38. The reason is that in a case where the amount of the washings Q is greater than the given amount, since a great amount of water is oozed out from the washings Q or the bias of the washings Q is sharply changed due to the sudden attachment of the washings Q to the inner circumferential surface of the dewatering drum 4, it is possible that the detection 1 cannot be performed stably. Therefore, in a case where the amount of the washings Q is greater than the given amount, the detection 1 is omitted.

[0100] In association with the determination about whether the accumulated value U falls within the scope of the detection 2, the threshold value is preset for the accumulated value U and stored in the memory 32. Fig. 8 is a diagram illustrating the relationship between the rotating speed of the motor 6 and the accumulated value U in association with the detection 2. In the graph of Fig. 8, the horizontal axis indicates the time (unit: sec), and the longitudinal axis indicates the accumulated value U (unit: rpm). By referring to Fig. 8, the threshold value is set as two threshold values, i.e. the upper threshold value represented by cardinal points and the upper threshold value represented by triangular points. The upper threshold value is a value greater than the lower threshold value.

[0101] In a case where the washings Q are not biased due to small eccentricity, since the acceleration of the dewatering drum 4 is stable, as shown by the solid line, the accumulated value U is always lower than the lower threshold value at any time. However, in a case where the washings Q are biased due to large eccentricity, since the acceleration of the dewatering drum 4 is instable, as shown by the dotted line, the accumulated value U is greater than the lower threshold value at any time. When the the washings Q are biased greatly, the accumulated value U is greater than the upper threshold value. Therefore, returning to Fig. 6A, when the accumulated value U is greater than or equal to the lower threshold value, the control part 30 determines that the accumulated value U falls within the scope of the detection 2 (step S39: Yes). In this way, in the detection 2, the instability degree of the acceleration of the dewatering drum 4 indicating whether the washings Q are biased is detected according to the accumulated value U.

[0102] When the control part 30 determines that the accumulated value U falls within the scope of the detection 2 (step S39: Yes), the rotation of the motor 6 is stopped (step S11), and the corresponding processing in the above steps S12 to S18 is executed. The treatment of the steps S31 to S37 and the step S39 is included in the step S10 described above (referring to Fig. 5A).

[0103] In a case where the dewatering condition is neither the wool fabric mode nor the independent dewatering operation (step S12: No), in the step S16, the control part 30 determines whether the bias of the washings Q is large enough to enable the accumulated value U to be greater than the upper threshold value or whether the currently suspended dewatering operation is already restarted or not.

[0104] In a case where the accumulated value U is greater than the upper threshold value or the dewatering operation is already restarted (step S16: Yes), the control part 30 executes the imbalance correction (Step S18). In a case where the accumulated value U is lower than the upper threshold value and the dewatering operation is not restarted (step S16: No), the control part 30 executes the restart (step S17). The determination about whether the accumulated value U is greater than the upper threshold value is equivalent to the determination about whether the restart can be carried out in the step S16 of Fig. 5B, and the determination about whether the restart is already carried out is equivalent to the determination about whether it is before the restart in the step S16 of Fig. 5B.

[0105] Thus, in the steps S16 to S18, the control part 30 determines whether the bias within the range of the detection 2 is small enough to perform the restart subsequently or large enough to perform the imbalance correct according to the determination abpit whether the accumulated value U is greater than the upper threshold value, and chooses to execute the restart and the imbalance correction according to the bias.

[0106] Moreover, in a state in which both the detections 1 and 2 determin that the washings Q are not biased, when the value of the timer 35 reaches the set value per load (step S36: Yes), the control part 30 terminates the detections 1 and 2 (step S40). In addition, in the step S40, the control part 30 acquires the duty ratio of the voltage applied to the motor 6 at the time point when the value of the timer 35 reaches the set value as the reference duty ratio d0. At the time point when the value of the timer 35 reaches the set value and the processing in the step S40 is executed, the motor 6 is in the acceleration state of accelerating to 240 rpm.

[0107] As described above, the set value in the step S36 varies depending on the load of the washings Q in the dewatering drum 4. Therefore, the control part 30 determines the timing for acquiring the reference duty ratio d0 in the step S40 according to the load measured during the dewatering operation of the dewatering drum 4. In other words, the control part 30 changes the timing for terminating the detections 1 and 2 and starts the subsequent detections 3 and 4 according to the load. Therefore, the detections 3 and 4 can be executed at the optimum timing corresponding to the amount of the washings Q.

[0108] Fig. 9A and Fig. 9B are flow charts illustrating control actions related to the detections 3 and 4. Referring to Fig. 9A and Fig. 9B, the detections 3 and 4 are described. The detections 3 and 4 are detections of the bias of the washings Q by utilizing the duty ratio of the voltage applied to the motor 6.

[0109] In the above step S40, the control part 30 acquires the reference duty ratio d0 and starts the detections 3 and 4. When the detections 3 and 4 start, the rotating speed of the motor 6 is in the state of reaching 240 rpm, and the motor 6 rotates at a constant speed of 240 rpm.

[0110] In association with the detections 3 and 4, a first count value E and a second count value T exist and are stored in the memory 32. When the detections 3 and 4 start, the control part 30 respectively resets the first count value E and the second count value T to the initial value 0 (step S41).

[0111] Then, the control part 30 initiates the timer 35 to begin the timing (step S42) and monitors whether the value of the timer 35 is greater than 8.1 seconds. The detections 3 and 4 are executed within this specified period of 8.1 seconds after the reference duty ratio d0 is acquired.

[0112] In addition, the control part 30 starts the counting through the counter 36 in the step S42, and performs the counting once every 0.3 second by initializing the timer 36 once every 0.3 second (step S43 and step S44). In step S44, the control part 30 adds 1 (+1) to the second count value T at the timing when the counter 36 is initialized, i.e. the timing when the counting is performed at every time.

[0113] The control part 30 acquires a duty ratio dn (n: count value) of the voltage applied to the motor 6 during counting at every time of timing (step S45). That is, within this specified period of 8.1 seconds, the control part 30 acquires a duty ratio dn once at the specified timing of every 0.3 second.

[0114] In addition, in the step S45, the control part 30 performs the operation for the corrected duty ratio dn_diff at the timing of every 0.3 second on the basis of the following formula (1) and formula (2). The corrected duty ratio dn_diff is a value obtained by correcting the duty ratio dn acquired at the same timing, so that the detection in the detection 4 can be accurately executed. In addition, A and B in the formula (1) and formula (2) are constants obtained through the experiment and the like.

$$dn\_diff = A \times dn - dn\_x \qquad \ldots\text{Formula (1)}$$

$$dn\_x = (A \times d0) - (B \times T) \qquad \ldots\text{Formula (2)}$$

[0115] Next, when the acquired duty ratio dn is greater than or equal to the duty ratio dn-1 acquired last time (step S46: Yes), the control pat 30 adds 1 (+1) to the first count value E (step S47). Furthermore, in the detection 3, the duty ratio dn originally acquired by the control part 30 is the above reference duty ratio d0. In another aspect, when the acquired duty ratio dn is less than the duty ratio dn-1 acquired at the last timing (step S46: No), the control part 30 resets the first count value E to the initial value 0 (zero) (step S48).

[0116] Then, the control part 30 confirms whether the value of the timer 35 is less than 8.1 seconds, i.e., whether the measuring time of the timer 35 is greater than 8.1 seconds (step S49).

[0117] In a case where the value of the timer 35 is less than 8.1 seconds (step S49: Yes), when the load of the washings Q in the dewatering drum 4 is greater than a given amount (step S50: Yes), the control part 30 determines whether the latest first count value E falls within the scope of the detection 3 (step S51). The given amount is obtained in advance through the experiment and the like and stored in the memory 32.

[0118] Specifically, the threshold is preset for the first count value E and stored in the memory 32. Fig. 10 is a graph illustrating the relationship between the time and the first count value E in association with the detection 3. In the graph of Fig. 10, the horizontal axis indicates the time (unit: sec), and the longitudinal axis indicates the first count value E. Referring to Fig. 10, the threshold is provided with two values, i.e. a lower threshold value represented by a single-point line and an upper threshold value represented by a double-point line. Both the upper value and the lower value are unrelated to the elapsed time and are fixed values. The upper value is greater than the lower value.

[0119] In a case where the washings Q are not biased due to small eccentricity, even if the voltage is low, the motor 6 can also rotate at a constant speed of 240 rpm, so that the duty ratio dn is gradually decreased. Thus, as shown by the solid line, the first count value E is stabilized in proximity to the initial value 0.

[0120] However, in a case where the washings Q are biased due to large eccentricity, since the high voltage is needed to maintain the rotating speed of the motor 6 at 240 rpm, the duty ratio dn is not decreased. Thus, the first count value E is increased rather than returned to the initial value, and as shown by the dotted line, the first count value E is greater than the lower threshold value at any timing. When the washings Q are biased greatly, the first count value E may also be greater than the upper threshold value.

[0121] Therefore, returning to Fig. 9A, when the latest first count value E is greater than or equal to the lower threshold value, the control part 30 determines that the first count value E falls within the scope of the detection 3 (step S51: Yes). That is, when the first count value E within the above specified period of 8.1 seconds is greater than or equal to the specified threshold, the control part 30 determines that the washings Q in the dewatering drum 4 are biased.

[0122] As long as the change between adjacent duty ratios dn obtained at timing is always monitored like in the detection 3, even if the reference duty ratio d0, i.e., the change between the duty ratio dn and the initial duty ratio dn, acquired at the beginning of the detection is small, the accurate detection for controlling the change of the duty ratio dn during the detection in real time can also be performed. Thus, the accuracy for detecting whether the washings Q are biased can be improved.

[0123] Then, when the control part 30 determines that the first count value E does not fall within the range of the detection 3 since the first count value E is less than the lower threshold value (step S51: No), the control part 30 determines whether the corrected duty ratio dn_diff just obtained falls within the scope of the detection 4 (step S52).

[0124] In addition, when the load of the washings Q in the dewatering drum 4 is less than a given amount (step S50: No), the control part 30 executes the determination performed by the detection 4 in the step S52 rather than the determination performed by the detection 3 in the step S51. The reason is that when the detection 3 is executed in a case where the amount of the washings Q is less than the given amount, the first count value E is instable since the duty ratio dn is converged at an early stage, so it is possible that the detection 3 cannot be executed stably. Therefore, in a case where the amount of the washings Q is less than the given amount, the detection 3 is omitted.

[0125] Determination about whether the corrected duty ratio dn_diff falls within the scope of the detection 4 is that the threshold is preset for the corrected duty ratio dn_diff and is stored in the memory 32. Fig. 11 is a graph illustrating a relationship between the time and the corrected duty ratio dn_diff in association with the detection 4. In the graph of Fig. 11, the horizontal axis represents time (unit: second) and the vertical axis represents the corrected duty ratio dn_diff. By referring to Fig. 11, two threshold values including a lower threshold value represented by a single-dot dash line and an upper threshold value represented by a double-dot dash line are set for the threshold. The upper threshold value and the lower threshold value gradually increase with elapsed time, respectively. The upper threshold value is greater than the lower threshold value.

[0126] In a case where the washings Q are not biased due to small eccentricity, since the motor 6 can also rotate at the constant speed of 240 rpm even if the voltage is low, the corrected duty ratio dn_diff is smaller than the lower threshold value and gradually decreases as shown by a solid line.

[0127] However, in a case where the washings Q are biased due to large eccentricity, a high voltage is required to maintain the rotating speed of the motor 6 at 240 rpm. Therefore, the corrected duty ratio dn_diff does not decrease, but exceeds the lower threshold value as shown by a dotted line. When the washings Q are biased greatly, the corrected duty ratio dn_diff may exceed the upper threshold value. Therefore, returning to Fig. 9A, when the corrected duty ratio dn_diff is greater than the lower threshold value, the control part 30 determines that the corrected duty ratio dn_diff falls within the scope of the detection 4 (step S52: Yes).

[0128] It shall be noted that the corrected duty ratio dn_diff obtained by the above formulas (1) and (2) is a value set when the duty ratio dn is equal to or greater than the reference duty ratio d0 and is increased over time. Therefore, the corrected duty ratio dn_diff does not fall within the threshold values only when the duty ratio dn decreases normally relative to the reference duty ratio d0.

[0129] As mentioned above, the first count value E for the detection 3 and the corrected duty ratio dn_diff for the detection 4 refer to indexes of change between the duty ratio dn of the voltage applied to the motor 6 and the reference duty ratio d0 within the specified period of 8.1 seconds for maintaining the rotating speed of 240 rpm. The control part 30 determines whether the washings Q in the dewatering drum 4 are biased based on such indexes in the detections 3 and 4.

[0130] In addition, since the first count value E for the detection 3 and the corrected duty ratio dn_diff for the detection 4 are obtained based on the reference duty ratio d0, the reference duty ratio d0 is an important factor which affects accuracy for detecting whether the washings Q are biased. In the dewatering machine 1, as described above, the control part 30 measures the load of the washings Q in the dewatering drum 4 (step S2 in Fig. 5A) when the dewatering drum 4 starts to rotate, and determines the timing for acquiring the reference duty ratio d0 according to the measured load (step S36 in Fig. 6A). Thus, since the reference duty ratio d0 is acquired at appropriate timing in consideration of the influence of the load, whether the washings Q are biased can be accurately detected in the detections 3 and 4 according to the reference duty ratio d0. As a result, the accuracy for detecting whether the washings Q are biased can be improved.

[0131] Moreover, when the control part 30 determines that the first count value E falls within the scope of the detection 3 (step S51: Yes) or determines that the corrected duty ratio dn_diff falls within the scope of the detection 4 (step S52: Yes), the rotation of the motor 6 is stopped (the step S11) and the corresponding processing in steps S12-S18 is performed. The processing in steps S40-S52 is included in the step S20 (referring to Fig. 5A).

[0132] Steps S16A and S16B in Fig. 9B are included in the above step S16 (referring to Fig. 5B). Specifically, the determination in the step S16A is equivalent to the determination of whether it is before the restart in the step S16 in Fig. 5B; and the determination in the step S16B is equivalent to the determination of whether the restart is performed in the step S16 in Fig. 5B.

[0133] When the dewatering condition is neither a woolen fabric mode nor a single-dewatering operation (step S12: No), the control part 30 determines whether the currently suspended dewatering operation is before a restart in the step S16A. When the currently suspended dewatering operation is determined to be before the restart (step S16A: Yes), the control part 30 determines whether the bias of the washings Q is as low as an extent that both the first count value E and the corrected duty ratio dn_diff are smaller than respective upper threshold values.

[0134] When the currently suspended dewatering operation is before the restart (step S16A: Yes) and the first count value E and the corrected duty ratio dn_diff are smaller than the respective upper threshold values (step S16B: Yes), the control part 30 executes the restart (step S17).

[0135] When the currently suspended dewatering operation is not before the restart, i.e., the restart is completed (step S16A: No), the control part 30 executes imbalance correction (step S18). In addition, even if the currently suspended dewatering operation is before the restart (step S16A: Yes), in a case where at least one of the first count value E and the corrected duty ratio dn_diff is greater than the respective upper threshold value (step S16B: No), the control part 30 executes imbalance correction (step S18).

[0136] In this way, in a case where the rotation of the dewatering drum 4 is stopped in the step S11, the controller 30 determines the bias falling within the scopes of the detection 3 and the detection 4 is small enough to continue to restart or is large enough to require imbalance correction according to the first count value E and the corrected duty ratio dn_diff in steps S16B to S18.

[0137] In other words, the control part 30 executes the restart or the imbalance correction according to the first count value E and the corrected duty ratio dn_diff, i.e., according to whether the values are greater than or equal to the respective upper threshold values. Therefore, when the washings Q are determined to be biased, the imbalance correction is not necessarily executed. Thus, when the first count value E and the corrected duty ratio dn_diff are values representing small bias of the washings Q, the time for the dewatering operation can be shortened by executing the restart immediately.

[0138] Moreover, when the washings Q are determined to be not biased in both the detections 3 and 4, and the value of the timer 35 passes 8.1 seconds (step S49: No), the control part 30 terminates the detections 3 and 4 (step S53).

[0139] Next, the detection 5 is described in detail. Specifically, the detection 5 is divided into detection 5-1 and detection 5-2. Fig. 12 is a flow chart illustrating outlines of the detection 5-1 and the detection 5-2. In detection 5-1 and the detection 5-2, whether the washings Q are biased is detected by utilizing the duty ratio.

[0140] Referring to Fig. 12, after the detections 3 and 4 are completed, the motor 6 continues to rotate at the constant speed of 240 rpm for a specified duration. With expiration of the specified time, the control part 30 accelerates the motor 6 from 240 rpm to the target rotating speed of 800 rpm (step S60).

[0141] When the rotating speed of the motor 6 reaches 300 rpm in a state where the motor 6 is accelerated, the control part 30 takes the duty ratio of the voltage applied to the motor 6 at the time point as an α value (step S61). 300 rpm is the rotating speed at which the dewatering drum 4 does not store water and is least affected by the eccentricity of the dewatering drum 4. Therefore, the α value at 300 rpm is the duty ratio in a state of being least affected by the eccentricity of the dewatering drum 4 and only affected by the load of the washings Q.

[0142] Then, the control part 30 performs the above detection 5-1 when the motor 6 continues to accelerate and the rotating speed is increased from 600 rpm to 729 rpm (step S62). When the result of the detection 6-1 is not "OK" (step S62: No), i.e., the control part 30 determines that the washings Q are biased, the control part 30 stops the motor 6 and stops the rotation of the dewatering drum 4 (step S63). In this way, after the dewatering operation is suspended, the control part 30 determines whether the dewatering operation is before the restart, i.e., determines whether the currently suspended dewatering operation has already been restarted (step S64).

[0143] When the dewatering operation is before the restart (step S64: Yes), the control part 30 executes the restart (step S65). When the dewatering operation is not before the restart (step S64: No), the control part 30 executes the imbalance correction (step S66).

[0144] On the other hand, in a case where the result of the detection 5-1 is "OK" (step S62: Yes), i.e., the control part 30 determines that the washings Q are not biased in the detection 5-1, the control part 30 continues to perform the detection 5-2 in a state that the motor 6 continues accelerating from 730 rpm (step S67).

[0145] In a case where the result of the detection 5-2 is "OK" (step S67: Yes), i.e., the control part 30 determines that the washings Q are not biased in the detection 5-2, the control part 30 continues dewatering the washings Q by rotating the motor 6 at the constant target rotating speed after accelerating the motor 6 to the target rotating speed (800 rpm) (step S68).

[0146] On the other hand, when the result of the detection 5-2 is not "OK" (step S67: No), i.e., in a case where the control part 30 determines that the washings Q are biased, the control part 30 continues to dewater the washings Q by rotating the motor 6 at a constant rotating speed below the target rotating speed (step S69).

[0147] Next, the detection 5-1 and the detection 5-2 are respectively described in detail.

[0148] Fig. 13 is a flow chart illustrating control actions related to the detection 5-1.

[0149] Referring to Fig. 13, the control part 30 starts the detection 5-1 as the rotating speed of the motor 6 reaches 600 rpm in a state of continuing accelerating the motor 6 after the step S61 (referring to Fig. 12) (step S70).

[0150] Then, the control part 30 starts to count through the counter 36 (step S71). The counter 36 is initialized once every 0.3 second so as to count once every 0.3 second (steps S72 and S73).

[0151] The control part 30 acquires a rotating speed of the motor 6 during each counting and a duty ratio dn (n: a count value) of voltage applied to the motor 6 during the counting (step S74). Namely, the control part 30 acquires the rotating speed and the duty ratio dn of the motor 6 at each specified moment within a period where the rotating speed of the motor 6 reaches 800 rpm from 240 rpm.

[0152] In addition, the control part 30 calculates a correction value Bn obtained by correcting the duty ratio dn with the α value according to a following formula (3) in step S74. It shall be noted that X and Y in the formula (3) are constants derived from experiments and the like. Different from simple ratio calculation, a weight in the formula (3) is changed, so that the correction value Bn obtained by correcting the duty ratio dn can execute the detection 5-1 with good accuracy.

$$Bn=dn-(\alpha\times X+Y)\ldots\text{Formula (3)}$$

[0153] In addition, the control part 30 calculates a moving accumulated value Cn (n: count value) of the correction value Bn in step S74. The moving accumulated value Cn (n: count value) is a sum of 5 consecutive correction values Bn in a counting sequence. Moreover, for a certain moving accumulated value Cn and a previous moving accumulated value Cn-1, the 4 correction values Bn on the rear side of the 5 correction values Bn forming the moving accumulated value Cn-1 are same with the 4 correction values Bn on the front side of the 5 correction values Bn forming the moving accumulated value Cn. It shall be noted that the quantity of the correction values Bn summed for forming the moving accumulated value Cn is not limited to 5.

[0154] Furthermore, the control part 30 calculates a threshold of the moving accumulated value Cn (step S75) according to a following formula (4).

$$\text{The threshold} = (\text{rotating speed})\times a+b\ldots\text{Formula (4)}$$

[0155] The a and b in the formula (4) are constants derived from experiments and the like and stored in the memory 32. In addition, constants a and b vary depending on the current rotating speed of the motor 6 and a selected dewatering condition. Thus, the threshold herein has multiple values at the same rotating speed. It shall be noted that, it can be known from the formula (4) that the threshold is not influenced by the α value.

[0156] Then, the control part 30 confirms whether the current rotating speed of the motor 6 is less than 730rpm or not (step S76).

[0157] In a case where the current rotating speed of the motor 6 is less than 730 rpm (step S76: "Yes"), the control part 30 determines whether a last moving accumulated value Cn falls within the scope of the detection 5-1 or not (step S77).

[0158] Fig. 14 is a graph illustrating a relationship between the rotating speed and the moving accumulated value Cn in association with the detections 5-1 and 5-2. In the graph of Fig. 14, a horizontal axis represents the rotating speed (unit: rpm), and a longitudinal axis represents the moving accumulated value Cn. Referring to Fig. 14, for the threshold calculated in step S75, two threshold values including a first threshold value represented by a single-dot dash line and a second threshold value represented by a double-dot dashed line are set according to, for example, different dewatering conditions. The first threshold value is higher than the second threshold value.

[0159] Following dewatering conditions exist: a dewatering condition in which dewatering operation is carried out after water is stored in the dewatering drum 4 and washings are rinsed in "ordinary rinsing" mode, a dewatering condition of "water-splashing and dewatering" in which dewatering is performed and water is splashed to the washings Q when water is drained, a dewatering condition of "restart", etc. The use operates the operation part 20 to make a selection from these dewatering conditions, and selection is received by the control part 30. In the dewatering after washing and ordinary rinsing, the acceleration of the motor 6 needs a force since the washings Q contain a great quantity of water; while under the condition of "water-splashing and dewatering" and "restart", the acceleration of the motor 6 may need a very tiny force since the washings are in a state of removing water to some extent.

[0160] In the dewatering operation after washing and ordinary rinsing, the control part 30 uses the first threshold value higher than the second threshold value since the detection can hardly be implemented using the second threshold value. On the other hand, in the dewatering after water splashing, dewatering and the restart, the control part 30 uses the second threshold value lower than the first threshold value since the detection is not accurate if the control part 30 uses the first threshold value. Thus, under either the condition that the washings Q contain a great quantity of water or the condition that the water of the washings Q is removed to some extent, the detection 5-1 is executed by using the threshold value adapted with respective conditions.

[0161] In addition, based on the objective same as the differentiation of such dewatering conditions, under the condition of large load of the washings Q in the dewatering drum 4, the control part 30 uses the first threshold value higher than the second threshold value since the detection can hardly be implemented using the second threshold value in the detection 5-1. In addition, under the condition of small load of the washings Q in the dewatering drum 4, the control part 30 uses the second threshold value lower than the first threshold value since the detection is not accurate if the control part 30 uses the first threshold value in the detection 5-1. Thus, the detection 5-1 is executed by using the threshold value adapted with different loads of the washings Q respectively.

[0162] It shall be noted that, although the two threshold values including the first threshold value and the second threshold value are illustrated in Fig. 14, more than 3 threshold values may also be set according to various dewatering conditions and loads.

[0163] Moreover, compared with the condition that the washings Q are not biased due to smaller eccentricity (referring to a solid line), the moving accumulated value Cn at each rotating speed is increased under the condition that the washings Q are biased due to large eccentricity (referring to the dotted lines in Fig. 14). If the washings Q are greatly biased, the moving accumulated value Cn is larger than the set threshold values, i.e., a corresponding one of the first threshold value and the second threshold value.

[0164] Thus, returning to Fig. 13, when the newest moving accumulated value Cn is above the set threshold value, the control part 30 determines that the moving accumulated value Cn falls within the scope of the detection 5-1 (step S77: "Yes").

[0165] When the control part 30 determines that the moving accumulated value Cn falls within the scope of the detection 5-1 (step S77: "Yes"), the rotation of the motor 6 is stopped (the above step S63) and the corresponding processing in step S64-step S66 is executed. The processing in step S71-step S77 is included in the step S62 (referring to Fig. 12).

[0166] Then, in a state that washings Q are determined to be not biased in the detection 5-1, when the rotating speed of the motor 6 reaches 730 rpm (step S76: "No"), the control part 30 ends the detection 5-1, and then starts the detection 5-2 (step S78).

[0167] Fig. 15 is a flow chart illustrating control actions related to detection 5-2.

[0168] Referring to Fig. 15, in a state that the motor 6 continues accelerating, the control part 30 starts to carry out the detection 5-2 (step S78 above) as the rotating speed of the motor 6 reaches 730 rpm.

[0169] Then, the control part 30 starts to count through the counter 36 (step S79) and initializes the counter 36 per 0.3s so as to carry out counting per 0.3s (step S80 and step S81).

[0170] Like step S74 in the detection 5-1, the control part 30 may acquire the rotating speed of the motor 6 during each counting and the duty ratio dn of the voltage applied to the motor 6 during the counting, and calculate the correction value Bn and the moving accumulated value Cn (step S82).

[0171] Then, the control part 30 calculates the threshold for the moving accumulated value Cn according to the formula (4) (step S83). The constants a and b forming the formula (4) are same as those in detection 5-1, and may have different values due to the current rotating speed of the motor 6 and the selected dewatering condition. Thus, the threshold herein includes multiple values at the same rotating speed, e.g., the first threshold value and the second threshold value.

[0172] Then, the control part 30 confirms whether the current rotating speed of the motor 6 reaches the target rotating speed (800 rpm) (step S84).

[0173] Under the condition that the current rotating speed of the motor 6 is less than the target rotating speed (step S84: "Yes"), like in the detection 5-1 (step S77), the control part 30 determines whether the newest moving accumulated value Cn falls within the scope of the detection 5-2 (step S85).

[0174] Specifically, referring to Fig. 14, in a case where the washings Q are biased due to large eccentricity (referring to the dotted lines in Fig. 14), compared with the condition that the washings Q are not biased due to small eccentricity (referring to the solid line), the moving accumulated value Cn at each rotating speed is increased. When the washings Q are greatly biased, the moving accumulated value Cn is larger than the set threshold value, i.e., a corresponding one of the first threshold values and the second threshold values.

[0175] Thus, returning to Fig. 15, when the newest moving accumulated value Cn is above the set second threshold value, the control part 30 determines that the moving accumulated value Cn falls within the scope of the detection 5-2 (step S85: "Yes").

[0176] When the control part 30 determines that the moving accumulated value Cn falls within the scope of the detection 5-2 (step S85: "Yes"), the rotating speed L of the motor 6 is acquired at a determined time point, i.e., in the detection 5-2 (step S86).

[0177] Then, the control part 30 rotates the motor 6 constantly at the acquired rotating speed L, strictly speaking, a rotating speed obtained by rounding away the single digit of the rotating speed L from zero, so that the washings Q are continuously dewatered (step S69 above). At this moment, the control part 30 prolongs dewatering time at the rotating speed L so as to obtain a same dewatering effect as that of dewatering at an original target rotating speed.

[0178] Then, in a state that the washings Q are determined to be not biased in the detection 5-2, when the rotating speed of the motor 6 reaches the target rotating speed (step S84: "No"), the control part 30 terminates the detection 5-2 and rotates the motor 6 constantly at the target rotating speed so as to continue dewatering the washings Q (step S68 above).

[0179] As described above, in the detections 5-1 and 5-2, the control part 30 changes the threshold according to the dewatering conditions received by the operation part 20 (steps S75 and S83). Moreover, when the acquired duty ratio dn, strictly, the moving accumulated value Cn calculated based on the acquired duty ratio dn is greater than a changed specified threshold value, the control part 30 determines whether the washings Q are biased in the dewatering drum 4. In other words, since whether the washings Q are biased can be detected using the threshold suitable for each dewatering condition during the dewatering operation in each dewatering condition, the accuracy for detecting whether the washings Q are biased can be improved.

[0180] The present invention is not limited to the above-described embodiments; and various changes can be made within the scope of claims.

[0181] For example, during the dewatering operation, particularly when the rotating speed of the motor 6 is lower than 600 rpm, the water may not be drained smoothly as the foam blocks the drainage pipeline 14. Therefore, the control part 30 can control the detection of the foam in the drainage pipeline 14 in parallel with the related control in the detections 1 to 5.

[0182] Fig. 16 is a flow chart illustrating a control action of detecting the foam in the dewatering operation.

[0183] Referring to Fig. 16, the control part 30 starts the dewatering of the dewatering drum 4 by starting the dewatering operation (the step S1). Thus, the rotating speed of the motor 6 is increased as described above (referring to Fig. 3).

[0184] The control part 30 acquires the rotating speed of the motor 6 once at every specified timing in the dewatering operation and the duty ratio of the voltage applied to the motor 6, i.e., the duty ratio of applied voltage (step S91).

[0185] When the rotating speed of the motor 6 is lower than 600 rpm (step S92: Yes), the control part 30 calculates a voltage limit value V_limit (step S93). The voltage limit value V_limit is the duty ratio of the maximum voltage applied to the motor 6 at each rotating speed and is calculated by substituting the rotating speed into the specified formula.

[0186] Moreover, the control part 30 detects the foam in the drainage pipeline 14 by determining whether the duty ratio of the applied voltage acquired in the step S91 is greater than the voltage limit value V_limit at every timing (step S94).

[0187] Specifically, since the water is accumulates at the bottom of the dewatering drum 4 and prevents the dewatering drum 4 from rotating when the foam blocks the drainage pipeline 14 and the water cannot be drained, in order to rotate the dewatering drum 4, a voltage equivalent to the duty ratio of the applied voltage above the voltage limit value V_limit must be applied to the motor 6. Therefore, when the duty ratio of the applied voltage is greater than the voltage limit value V_limit, the control part 30 determines that it is in such a state that the foam blocks the drainage pipeline 14 (step S94: Yes). On the other hand, when the duty ratio of the applied voltage is smaller than the voltage limit value V_limit, the control part 30 determines that it is in such a state that the foam does not block the drainage pipeline 14 (step S94: No).

[0188] When the control part 30 determines that the foam blocks the drainage pipeline 14 (step S94: Yes), whether it is before the restart is determined, i.e., whether the currently suspended dewatering operation is restarted (step S95).

[0189] When it is before the restart (step S95: Yes), the control part 30 executes the restart (step S96). When it is not before the restart (step S95: No), the control part 30 executes the imbalance correction (step S97). Regardless of executing the restart or the imbalance correction, the dewatering operation may be restarted after a temporary suspension. Therefore, during the restart of the dewatering operation, the foam in the drainage pipeline 14 may disappear naturally.

[0190] On the other hand, when the rotating speed of the motor 6 is greater than 600 rpm (step S92: No), the control part 30 terminates the processing of detecting the foam (step S98).

[0191] In addition, the control of Fig. 16 not only is used for detecting the foam, but also can be used for detecting a phenomenon of "stagnant water" that the water in the outer drum 3 cannot reach the drainage pipeline 14 due to vibration and the like.

[0192] In addition, in a low-speed eccentricity detection section (referring to Fig. 3) of the dewatering operation, the detections 1 to 4 are executed in order to electrically detect whether the washings Q in the dewatering drum 4 are biased. However, the detection 6 described below can also be executed instead of the detections 1 to 4, or the detection 6 can also be executed in parallel with the detections 1 to 4.

[0193] Fig. 17 is a time chart illustrating a state of the rotating speed of the motor 6 during the dewatering operation in association with the detection 6, and specifically, a chart from which a portion equivalent to the low-speed eccentricity detection section in Fig. 3 is deleted. Therefore, in the time chart of Fig. 17, the horizontal axis represents the elapsed time and the vertical axis represents the rotating speed (unit: rpm) of the motor 6, as in Fig. 3. It shall be noted that, in Fig. 17, the state of the duty ratio of the voltage applied to the motor 6 by the control part 30 is represented by the dotted line, besides the state of the rotating speed of the motor 6 is represented by the solid line.

[0194] Referring to Fig. 17, the control part 30 controls the duty ratio in such a manner that the maximum value of the duty ratio is generated during an acceleration state of accelerating the motor 6 from 120 rpm to 240 rpm in the low-speed eccentricity detection section. At this time, an accelerated speed of the motor 6 is controlled to be always fixed. The maximum value of the duty ratio generated during the acceleration state of the motor 6 is called the maximum duty ratio dmax below. Specifically, the control part 30 controls the duty ratio in such a manner that the maximum duty ratio dmax is generated at a rotating speed (for example, 180 rpm) slightly lower than the rotating speed (200 rpm to 220 rpm) at which the dewatering drum 4 resonates, and specifically, longitudinally resonates.

[0195] Such control of the duty ratio can be executed commonly regardless of the magnitude of the load of the washings Q in the dewatering drum 4. In addition, in order to realize the control, a gain and the like representing the difference between the target rotating speed of the motor 6 and a current actual rotating speed and representing responsiveness of the change of the rotating speed relative to the duty ratio are preset in the control part 30. It shall be noted that the rotating speed at which the longitudinal resonance occurs is called longitudinal resonance rotating speed below.

[0196] When the control part 30 starts to accelerate the motor 6 from 120 rpm, the duty ratio gradually increases as shown by the dotted line in Fig. 17. Then, the maximum duty ratio dmax is generated when the rotating speed of the motor 6 reaches 180 rpm. When the washings Q are not biased in the dewatering drum 4, since the motor 6 can be accelerated to 240 rpm even if the duty ratio is relatively small after the maximum duty ratio dmax is generated, the duty ratio gradually decreases as shown by the dotted line.

[0197] However, when the washings Q are biased in the dewatering drum 4, the vibration is increased as the rotating speed of the motor 6 approaches the longitudinal resonance rotating speed. Therefore, since the duty ratio must be increased to 240 rpm, the duty ratio dmax needs to be increased even after the maximum duty ratio dmax is generated, and the duty ratio after the maximum duty ratio dmax is generated can hardly decrease. Therefore, after the maximum duty ratio dmax is generated, the duty ratio may be maintained at a value slightly lower than the maximum duty ratio dmax without decrease as shown by a one-dot lock line in Fig. 17, or may be increased after temporarily falling below the maximum duty ratio dmax as shown by the double-dot dash line in Fig. 17. In the detection 6, whether the washings Q in the dewatering drum 4 are biased is electrically detected by monitoring a relative change between the duty ratio after the maximum duty ratio dmax is generated and the maximum duty ratio dmax.

[0198] Fig. 18 is a flow chart illustrating control actions related to the detection 6. Referring to Fig. 8, the detection 6 is described.

[0199] In the step S4, the control part 30 starts to accelerate the motor 6 from 120 rpm to 240 rpm. Then, since the duty ratio has the maximum value when the rotating speed of the motor 6 reaches, for example, 180 rpm in the acceleration state of accelerating the motor 6 to 240 rpm, the control part 30 takes the maximum value as the maximum duty ratio dmax (step S101).

[0200] In association with the detection 6, a count value G and an accumulated value H exist and are stored in the memory 32. When acquiring the maximum duty ratio dmax, the control part 30 resets the count value G and the accumulated value H to an initial value 0 (step S101).

[0201] Then, after the maximum duty ratio dmax is acquired, when the rotating speed of the motor 6 reaches the rotating speed (for example, 200 rpm) immediately before the longitudinal resonance (step S102: Yes), the control part 30 starts the timer 35 to start the timing and starts to count by the counter 36 (step S103). As a result, the detection 6 is started. The control part 30 initializes the counter 36 once every specified time (for example, 0.1 second) to count once every 0.1 second (steps S104 and S105) by referring to the value of the timer 35. The control part 30 adds one (+1) to the count value G once at timing of initializing the counter 36 every time in step S105, i.e., at timing of counting every time.

[0202] The control part 30 acquires the duty ratio dg (g: count value G) of the voltage applied to the motor 6 once during counting when counting every time (step S106). In other words, the control part 30 acquires the duty ratio dg once every specified time of 0.1 second.

[0203] In addition, in step S106, the control part 30 acquires the duty ratio dg once every specified time and calculates an accumulated value H of a difference between the duty ratio dg and the previous maximum duty ratio dmax. The difference is a value obtained by subtracting the duty ratio dg from the maximum duty ratio dmax. The accumulated value H is a value obtained by adding the latest difference to the last accumulated value H, and is updated every time when adding 1 to the count value G.

[0204] Fig. 19 is a graph illustrating the relationship between the count value G and the accumulated value H in association with the detection 6. In the graph of Fig. 19, the horizontal axis represents the count value G, and the vertical axis represents the accumulated value H. Referring to Fig. 19, when the washings Q are not biased in the dewatering drum 4 due to relatively small eccentricity, the duty ratio gradually decreases after the maximum duty ratio dmax is generated, as described above. Thus, since the difference between the duty ratio dg and the maximum duty ratio dmax is gradually increased, the accumulated value H is increased as shown by the solid line. On the other hand, when the washings Q are biased in the dewatering drum 4 due to relatively large eccentricity, the duty ratio after the maximum duty ratio dmax is generated can hardly decrease, as described above. Therefore, since the difference between the duty ratio dg and the maximum duty ratio dmax can hardly increase, the accumulated value H can hardly increase as shown by the dotted line.

[0205] A specified threshold is set for the accumulated value H. The threshold is obtained from the following formula (5) using the count value G added with 1 every specified time and the maximum duty ratio dmax as variables.

$$\text{Threshold} = (K \times G\text{-}L) - M \times (N\text{-}dmax) \ldots \text{Formula (5)}$$

[0206] K, L, M and N in the formula (5) are constants previously obtained from experiments and the like, and are stored in the memory 32. As shown by dot dash lines in Fig. 19, the threshold is changed in a manner of increasing as the count value G increases. The threshold can be pre-stored in the memory 32, and can also be calculated by the control part 30 based on the formula (5) every time when the count value G is changed.

[0207] Referring to Fig. 18, when the count value G reaches the timing of, for example, 20, and specifically, reaches the timing of start of longitudinal resonance (step S107: Yes), the control part 30 confirms whether the latest accumulated value H is smaller than the specified threshold value obtained from the formula (5) (step S108). When the accumulated value H is smaller than the threshold (step S108: Yes), the control part 30 determines whether the washings Q are biased in the dewatering drum 4 and stops the motor 6 (step S109). Therefore, the rotation of the dewatering drum 4 is stopped. After the motor 6 is stopped, similar to the detections 1 to 4, the processing of steps S11 to S18 can also be executed (referring to Fig. 5B).

[0208] When the accumulated value H is no less than the specified threshold (step S108: No) and the count value G reaches the specified value (for example, 81) (step S110: Yes), the rotating speed of the motor 6 reaches 240 rpm and the motor 6 is in a state of rotating at the constant speed of 240 rpm. In this case, the control part 30 terminates the detection 6 (step S111).

[0209] In this way, the accuracy for detecting whether the washings Q are biased can be improved by monitoring the detection 6 for the index representing the relative change between the duty ratio dg after the maximum duty ratio dmax is generated and the maximum duty ratio dmax, i.e., the accumulated value H.

[0210] Particularly, in the detection 6, the duty ratio is set in such a manner that the maximum duty ratio dmax is generated at a rotating speed slightly lower than the longitudinal resonance rotating speed. At this time, the longitudinal resonance occurs at an earlier timing after the maximum duty ratio dmax is generated. As a result, the phenomenon that the accumulated value H can hardly increase occurs earlier. Therefore, that the washings Q are biased in the dewatering drum 4 can be detected early and correctly. In addition, when the maximum duty ratio dmax is generated at the longitudinal resonance rotating speed, a bad condition that the subsequent change of the rotating speed becomes unstable may appear. However, in the present embodiment, such a bad condition can be suppressed by generating the maximum duty ratio dmax at the rotating speed slightly lower than the longitudinal resonance rotating speed.

[0211] Fig. 20 is a graph illustrating the relationship between the count value G and the duty ratio in association with the detection 6. In the graph of Fig. 20, the horizontal axis represents the count value G and the vertical axis represents the duty ratio. Referring to Fig. 20, when the load is relatively large, as shown by the solid line, a relatively large duty ratio is required to increase the rotating speed of the motor 6 at a constant acceleration, and the maximum duty ratio dmax is increased accordingly. On the other hand, when the load is relatively small, as shown by the dotted line, a relatively small duty ratio is required to increase the rotating speed of the motor 6 at the constant accelerated speed, and the maximum duty ratio dmax s decreased accordingly. Therefore, for the difference between the duty ratio dg after the specified time from generation of the maximum duty ratio dmax and the maximum duty ratio dmax, a difference R when the load is relatively small is apparently smaller than a difference S when the load is relatively large. So, compared with the case of a large load, it is conceivable that it is more difficult for the accumulated value H in the case of a small to increase, and the accumulated value H is also smaller than the threshold even if the washings Q are not biased. In this way, when the load is relatively small, the dewatering operation may be stopped due to false detection of presence of the bias of the washings Q.

[0212] Therefore, the threshold is obtained from the formula (5) using the count value G and the maximum duty ratio dmax as the variables, as described above. Since the maximum duty ratio dmax varies depending on the magnitude of the load of the washings Q in the dewatering drum 4, the threshold is determined differently based on the load. Therefore, since whether the washings Q are biased is detected based on an optimal threshold corresponding to the magnitude of the load of the washings Q in the dewatering drum 4 in the detection 6, the false detection can be prevented even if the load is relatively small. Thus, the accuracy for detecting whether the washings Q are biased can be further improved.

[0213] In above embodiments, the motor 6 is controlled through the duty ratio on a premise that the motor 6 is a variable frequency motor. However, when the motor 6 is a brush motor, the motor 6 is controlled through the voltage applied to the motor 6 instead of the duty ratio.

[0214] In addition, although the rotating speed in the above description has specific values, such as 120 rpm, 240 rpm or 800 rpm, these specific values are values that vary according to performance of the dewatering machine 1. In addition, sometimes the duty ratio may be obtained for making various determinations in the above description. However, the duty ratio can be original data of the obtained duty ratio, can also be a corrected value that is corrected as needed, and can further be a value calculated based on the duty ratio like the moving accumulated value Cn.

[0215] In addition, the dewatering drum 4 of above embodiments can be configured vertically in a manner of rotating by using an axis 16 extending in the up-down direction X as a center. However, the dewatering drum 4 can also be configured obliquely in a manner of obliquely extending the axis 16 relative to the up-down direction X.

Claims

1. A dewatering machine, comprising:

a dewatering drum configured to accommodate washings and rotate to dewater the washings;

an electric motor configured to rotate the dewatering drum;
a load measuring unit configured to measure a load of the washings in the dewatering drum when the dewatering drum begins to rotate;
a drive control unit configured to, after the load measuring unit measures the load, rotate the motor constantly at a first rotating speed by controlling a duty ratio of a voltage applied to the motor and then rotate the motor constantly at a second rotating speed higher than the first rotating speed so as to dewater the washings formally;
an acquisition unit configure to acquire the duty ratio of the voltage applied to the motor as a reference duty ratio in an acceleration state in which the motor accelerates to the first rotating speed;
a timing determination unit configured to determine timing for the acquisition unit to acquire the reference duty ratio;
a determination unit configured to, in a specified period after the acquisition unit acquires the reference duty ratio, determine whether the washings in the dewatering drum are biased or not according to an index indicating a change between a duty ratio of the voltage applied to the motor to maintain the first rotating speed and the reference duty ratio; and
a stopping control unit configured to stop the rotation of the dewatering drum when the determination unit determines that the washings are biased,
wherein the timing determination unit determines the timing for the acquisition unit to acquire the reference duty ratio according to the load measured by the load measuring unit.

2. The dewatering machine according to claim 1, wherein the dewatering machine comprises an execution unit configured to, after the stopping control unit stops the rotation of the dewatering drum, execute one of the following executions: a rotation of the dewatering drum for restart the dewatering of the washings and a processing for correcting the bias of the washings in the dewatering drum.

3. The dewatering machine according to claim 2, wherein
before the motor rotates constantly at the first rotating speed, the drive control unit rotates the motor constantly at a specified speed lower than the first rotating speed; and
the execution unit shortens the duration in which the motor rotates constantly at the specified speed when the execution unit executes the rotation of the dewatering drum for restart the dewatering of the washings.

4. A dewatering machine, comprising:

a dewatering drum configured to accommodate washings and rotate to dewater the washings;
an electric motor configured to rotate the dewatering drum;
a drive control unit configured to rotate the motor constantly at a first rotating speed by controlling a duty ratio of a voltage applied to the motor and then rotate the motor constantly at a second rotating speed higher than the first rotating speed so as to dewater the washings formally;
an acquisition unit configured to acquire a duty ratio every a specified time within a specified period after the motor begins to accelerate to the first rotating speed;
a counting unit configured to add 1 to a count value with an initial value of zero when the duty ratio acquired by the acquisition unit is greater than or equal to the duty ratio acquired last time and reset the count value to the initial value when the duty ratio acquired by the acquisition unit is smaller than the duty ratio acquired last time;
a determination unit configured to determine that the washings in the dewatering drum are biased when the count value is greater than or equal to a specified threshold; and
a stopping control unit configured to stop the rotation of the dewatering drum when the determination unit determines that the washings are biased.

5. A dewatering machine, comprising:

a dewatering drum configured to accommodate washings and rotate to dewater the washings;
an electric motor configured to rotate the dewatering drum;
a drive control unit configured to rotate the motor constantly at a first rotating speed by controlling a duty ratio of a voltage applied to the motor and then rotate the motor constantly at a second rotating speed higher than the first rotating speed so as to dewater the washings formally;
an acquisition unit configured to acquire a duty ratio every a specified time within a period when the rotating speed of the motor accelerates from the first rotating speed to a second rotating speed;
a determination unit configured to determine that the washings in the dewatering drum are biased when the duty ratio acquired by the acquisition unit is greater than or equal to a specified threshold;

a stopping control unit configured to stop the rotation of the dewatering drum when the determination unit determines that the washings are biased;
a receiving unit configured to receive a selection related to a dewatering condition of the washings; and
a threshold changing unit configured to change the threshold according to the selection related to the dewatering condition received by the receiving unit.

6. A dewatering machine, comprising:

a dewatering drum configured to accommodate washings and rotate to dewater the washings;
an electric motor configured to rotate the dewatering drum;
a drive control unit configured to rotate the motor constantly at a first rotating speed by controlling a duty ratio of a voltage applied to the motor and then rotate the motor constantly at a second rotating speed higher than the first rotating speed so as to dewater the washings formally;
an acquisition unit configured to acquire a maximum value of a duty ratio in an acceleration state in which the motor accelerates to the first rotating speed to serve as a maximum duty ratio;
a calculation unit configured to calculate an accumulated value of a difference between the duty ratio in every specified time and the maximum duty ratio after the acquisition unit acquires the maximum duty ratio;
a determination unit configured to determine that the washings in the dewatering drum are biased when the accumulated value is smaller than the specified threshold; and
a stopping control unit configured to stop the rotation of the dewatering drum when the determination unit determines that the washings are biased.

7. The dewatering machine according to claim 6, wherein the threshold is calculated using an equation adopting a count value and the maximum duty ratio as variables, wherein the count value is added by 1 once every the specified time.

8. The dewatering machine according to claim 6 or 7, wherein the drive control unit controls the duty ratio in the following way: in the acceleration state in which the motor accelerates to the first rotating speed, the drive control unit generates the maximum duty ratio when the rotating speed is slightly lower than a rotating speed at which the dewatering drum resonates.

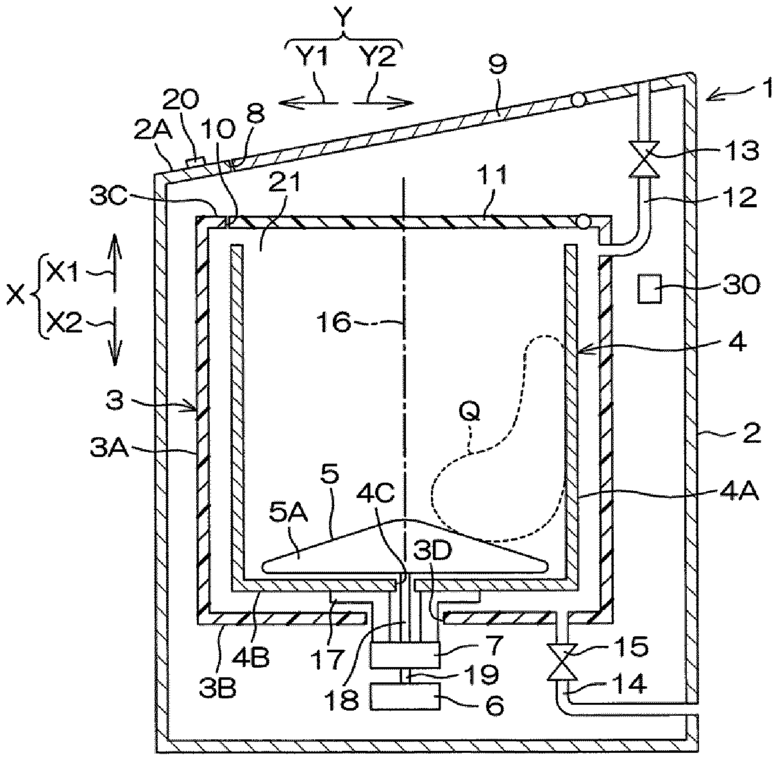
Y
Y1
Y2
9
1
20
2A
10
8
13
3C
21
11
12
X1
X
X2
30
16
4
3
Q
2
3A
5
4C
5A
4A
3D
4B
17
7
15
3B
18
19
14
6

Fig. 1

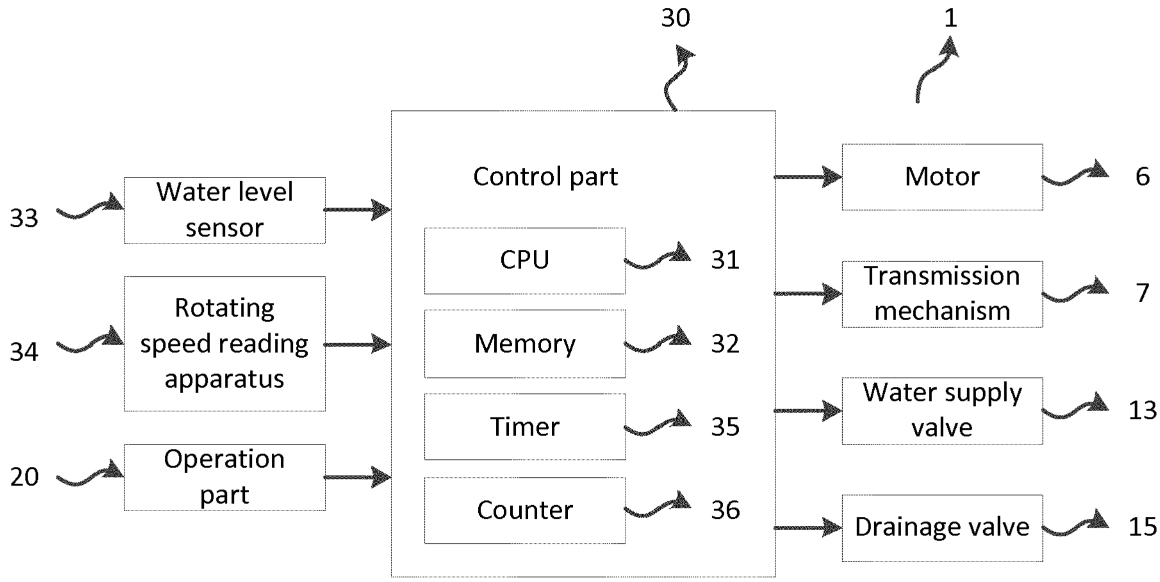
30
1
Control part
33
Water level sensor
CPU
31
Memory
32
34
Rotating speed reading apparatus
Timer
35
20
Operation part
Counter
36
Motor
6
Transmission mechanism
7
Water supply valve
13
Drainage valve
15

Fig. 2

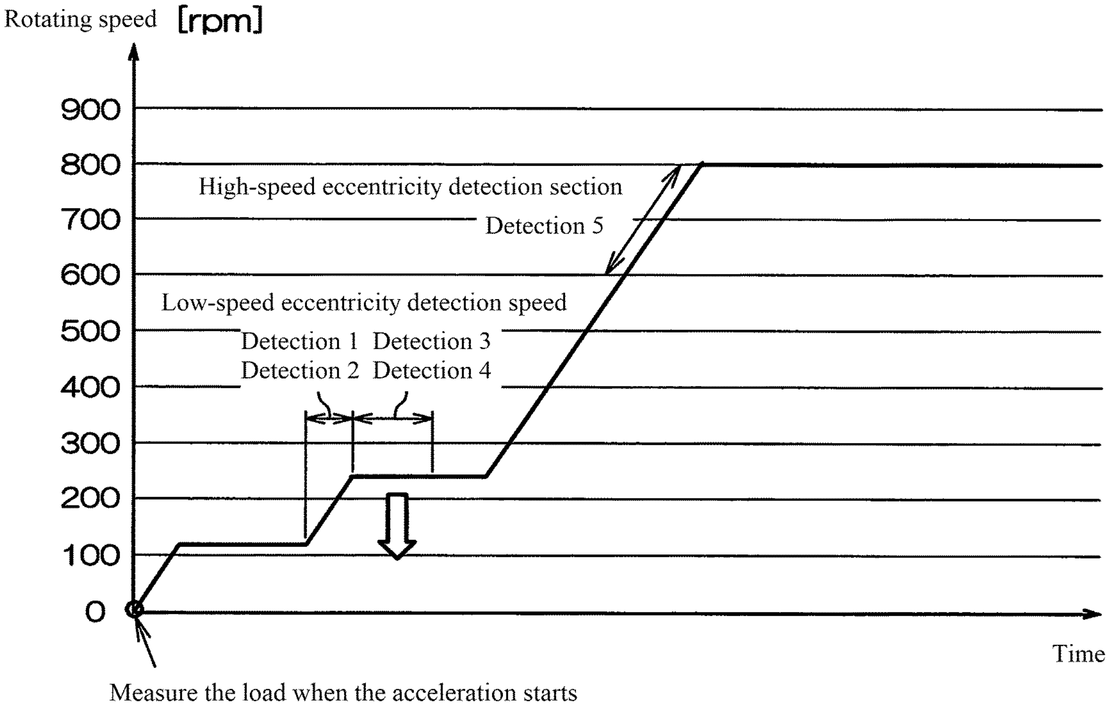
Rotating speed [rpm]
900
800
700
600
500
400
300
200
100
0
High-speed eccentricity detection section
Detection 5
Low-speed eccentricity detection speed
Detection 1 Detection 3
Detection 2 Detection 4
Time
Measure the load when the acceleration starts

Fig. 3

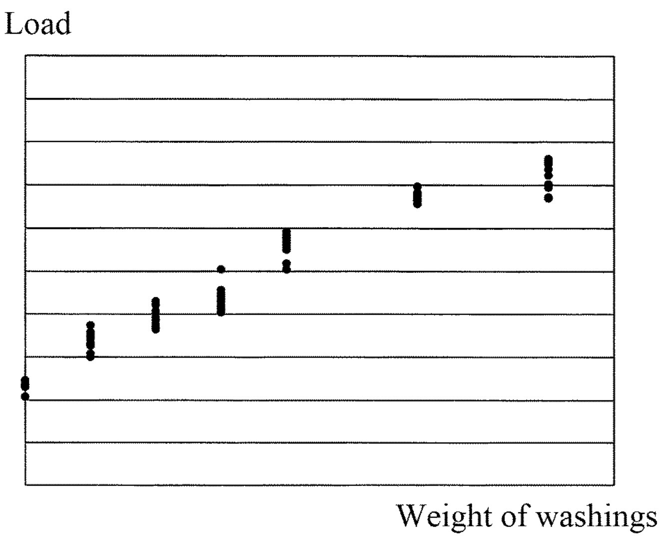
Load
Weight of washings

Fig. 4

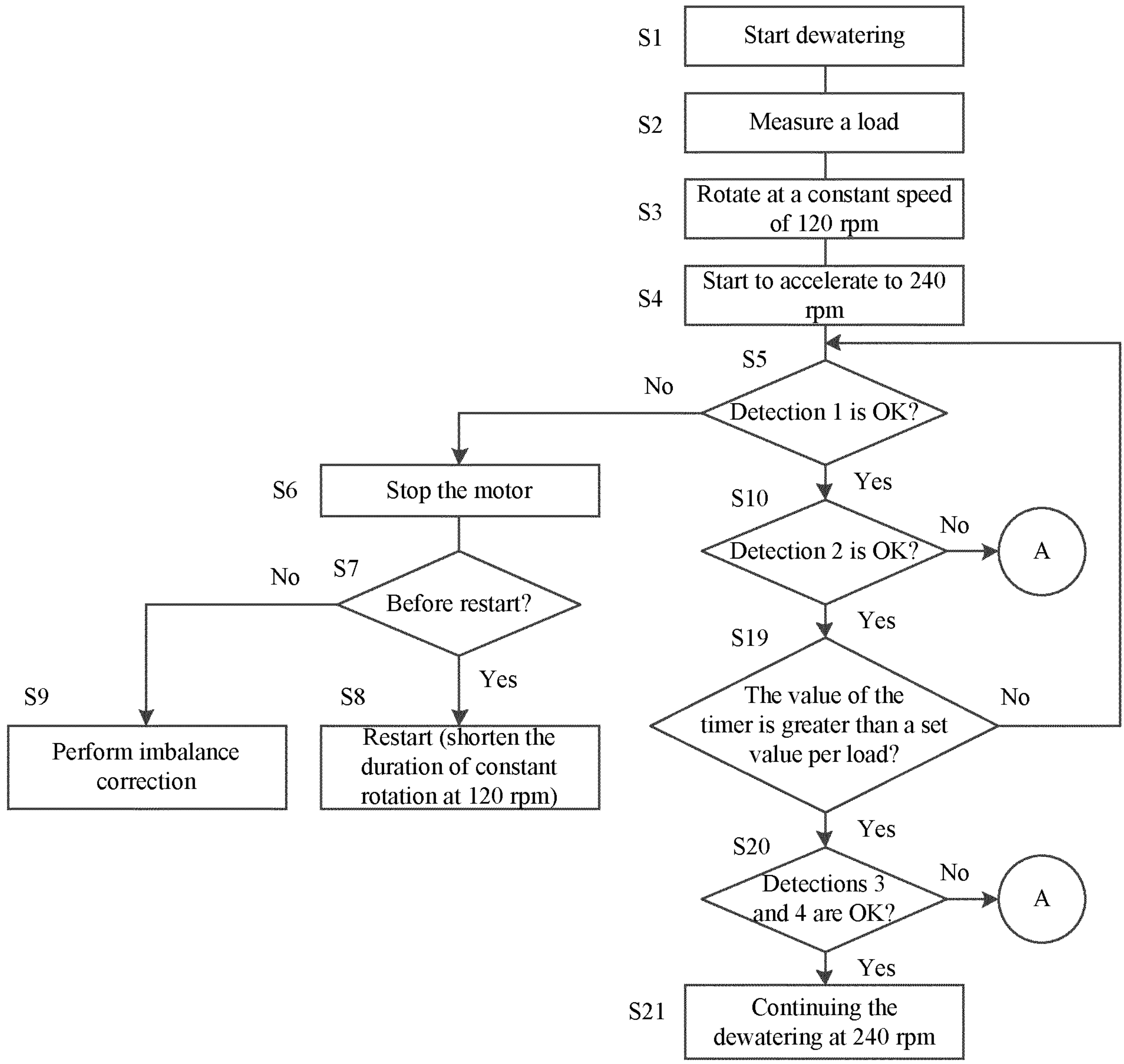
S1
Start dewatering
S2
Measure a load
S3
Rotate at a constant speed of 120 rpm
S4
Start to accelerate to 240 rpm
S5
Detection 1 is OK?
No
Yes
S6
Stop the motor
S7
Before restart?
No
Yes
S9
Perform imbalance correction
S8
Restart (shorten the duration of constant rotation at 120 rpm)
S10
Detection 2 is OK?
No
A
Yes
S19
The value of the timer is greater than a set value per load?
No
Yes
S20
Detections 3 and 4 are OK?
No
A
Yes
S21
Continuing the dewatering at 240 rpm

Fig. 5A

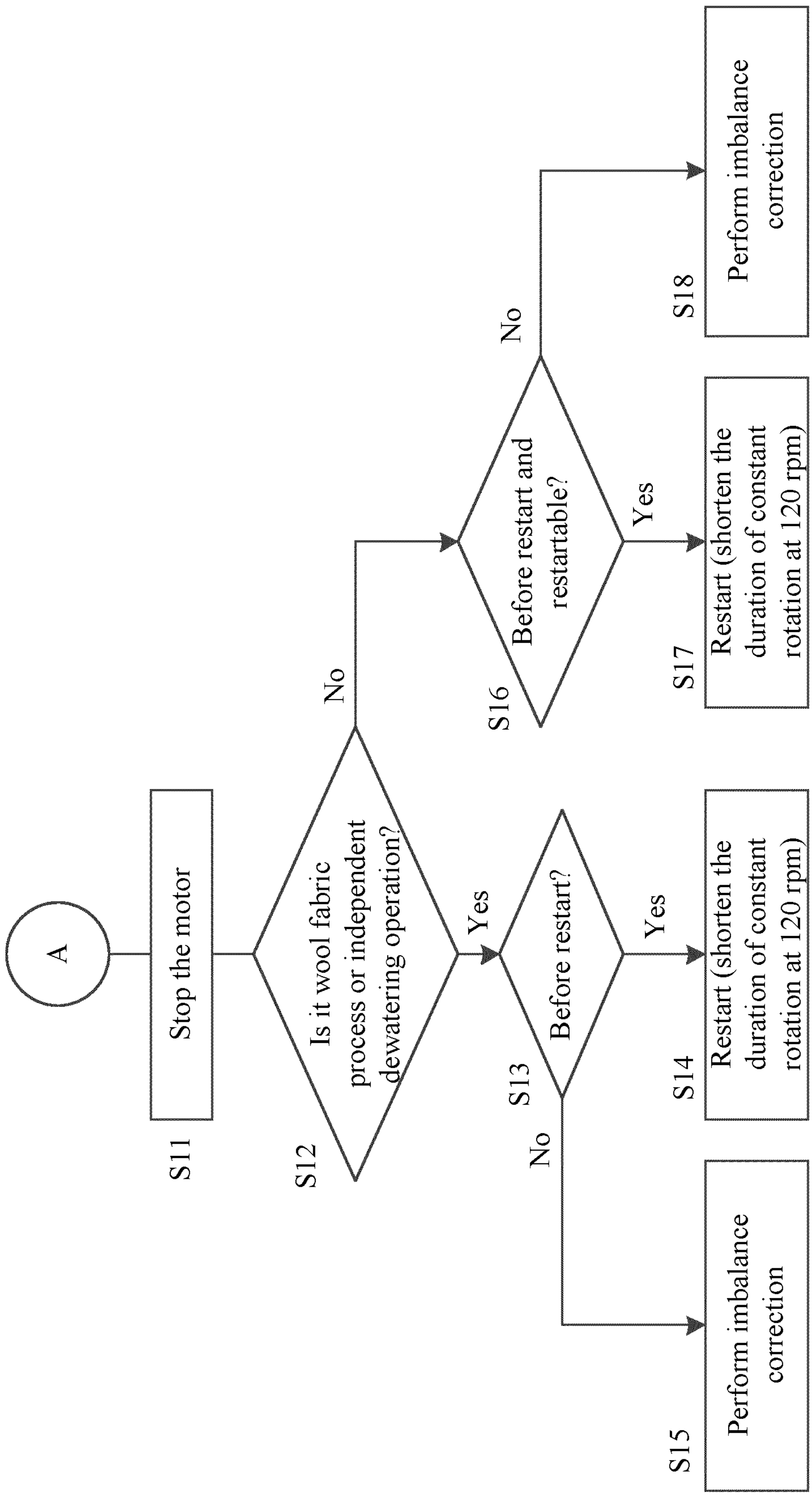
A
S11
Stop the motor
S12
Is it wool fabric process or independent dewatering operation?
Yes
No
S13
Before restart?
Yes
No
S14
Restart (shorten the duration of constant rotation at 120 rpm)
S15
Perform imbalance correction
S16
Before restart and restartable?
Yes
No
S17
Restart (shorten the duration of constant rotation at 120 rpm)
S18
Perform imbalance correction

Fig. 5B

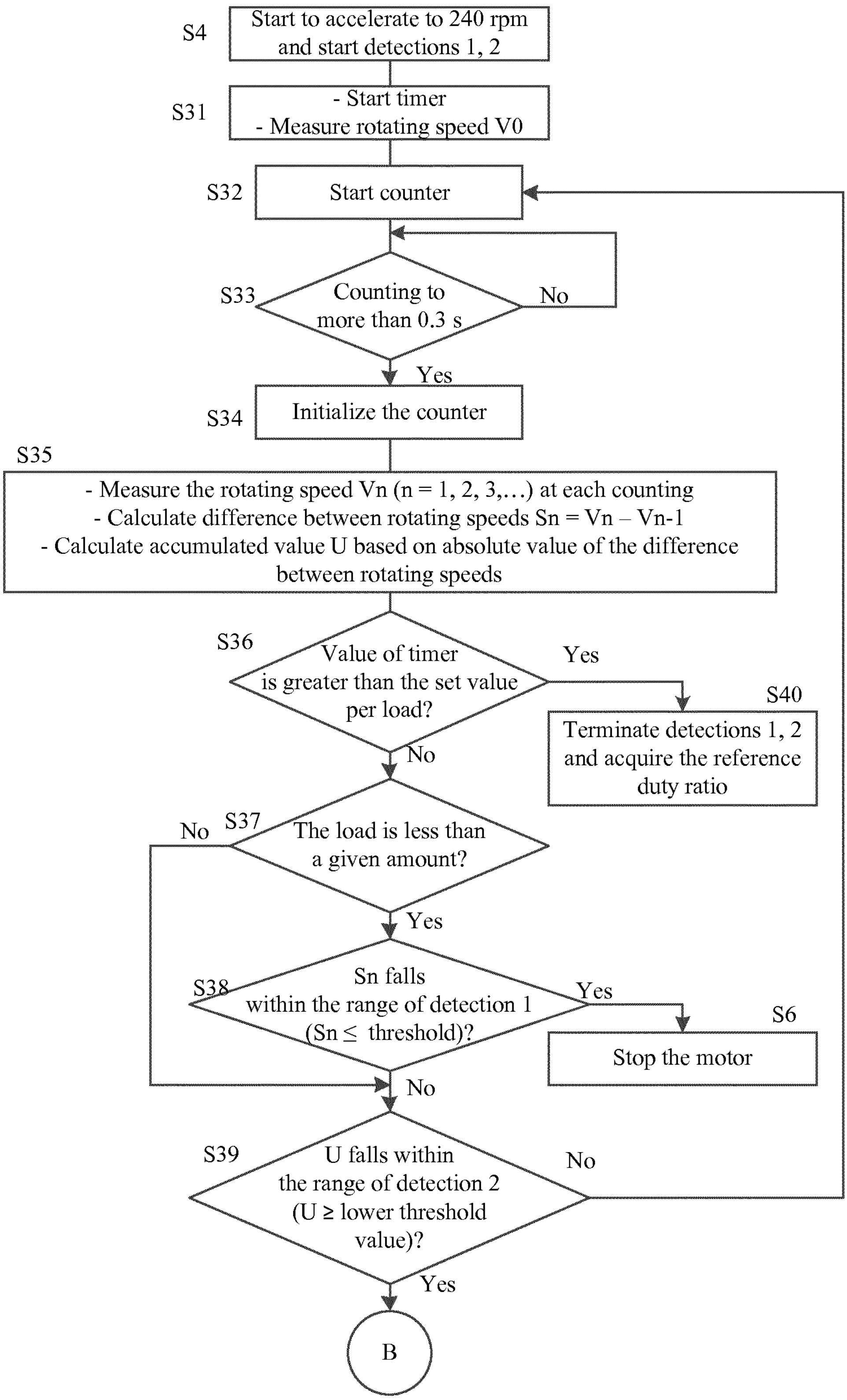
S4
Start to accelerate to 240 rpm and start detections 1, 2
S31
- Start timer
- Measure rotating speed V0
S32
Start counter
S33
Counting to more than 0.3 s
No
Yes
S34
Initialize the counter
S35
- Measure the rotating speed Vn (n = 1, 2, 3,…) at each counting
- Calculate difference between rotating speeds Sn = Vn – Vn-1
- Calculate accumulated value U based on absolute value of the difference between rotating speeds
S36
Value of timer is greater than the set value per load?
Yes
No
S40
Terminate detections 1, 2 and acquire the reference duty ratio
S37
The load is less than a given amount?
No
Yes
S38
Sn falls within the range of detection 1 (Sn ≤ threshold)?
Yes
No
S6
Stop the motor
S39
U falls within the range of detection 2 (U ≥ lower threshold value)?
No
Yes
B

Fig. 6A

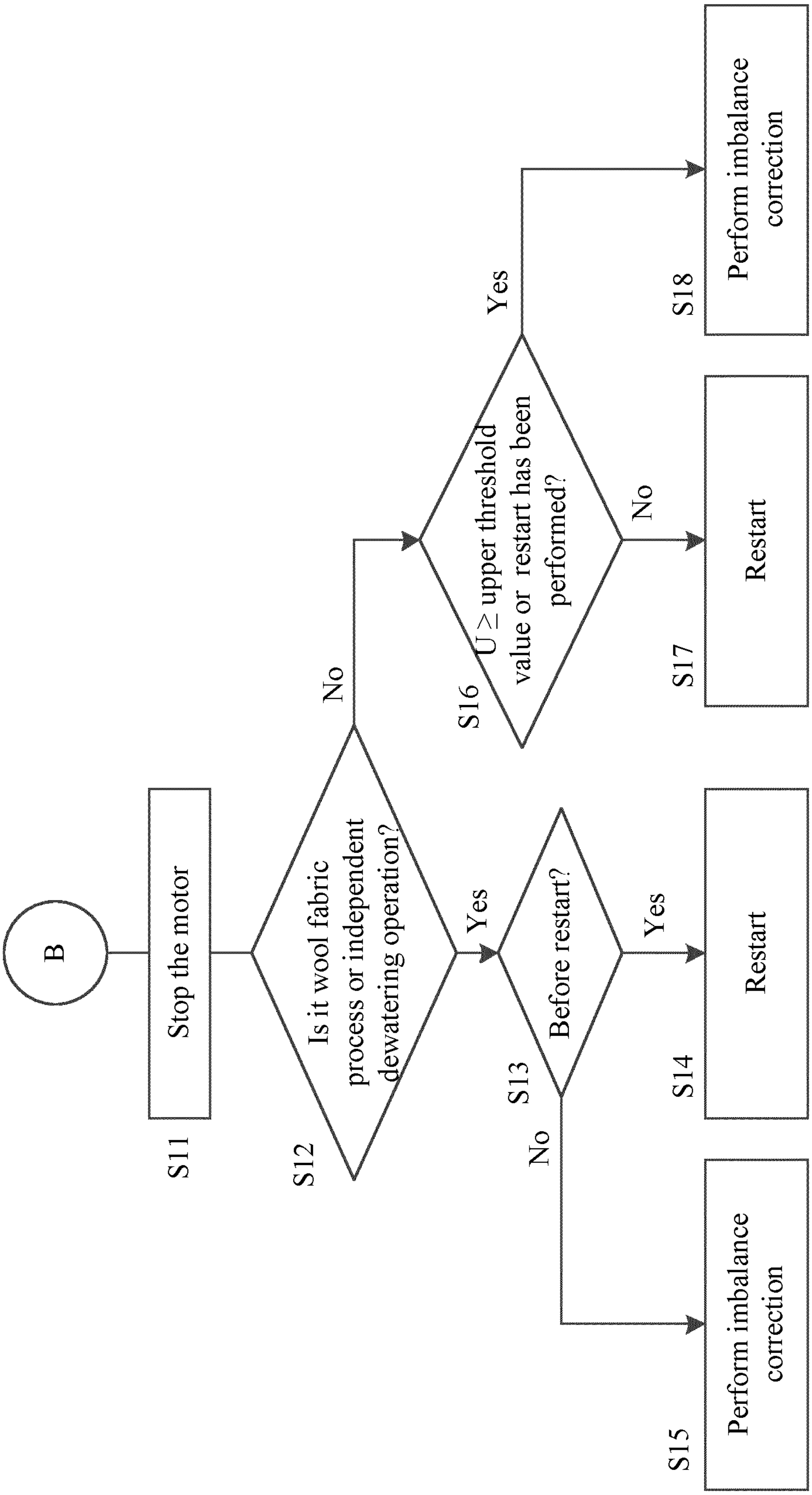
B
S11
Stop the motor
S12
Is it wool fabric process or independent dewatering operation?
Yes
No
S13
Before restart?
Yes
No
S14
Restart
S15
Perform imbalance correction
S16
U ≥ upper threshold value or restart has been performed?
No
Yes
S17
Restart
S18
Perform imbalance correction

Fig. 6B

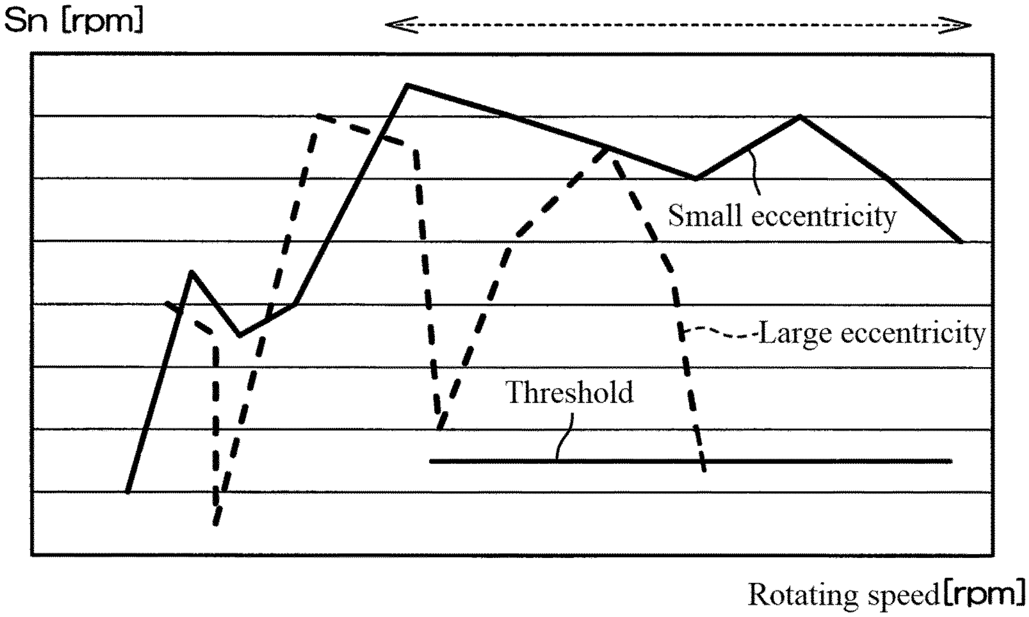
Sn [rpm]
Small eccentricity
Large eccentricity
Threshold
Rotating speed[rpm]

Fig. 7

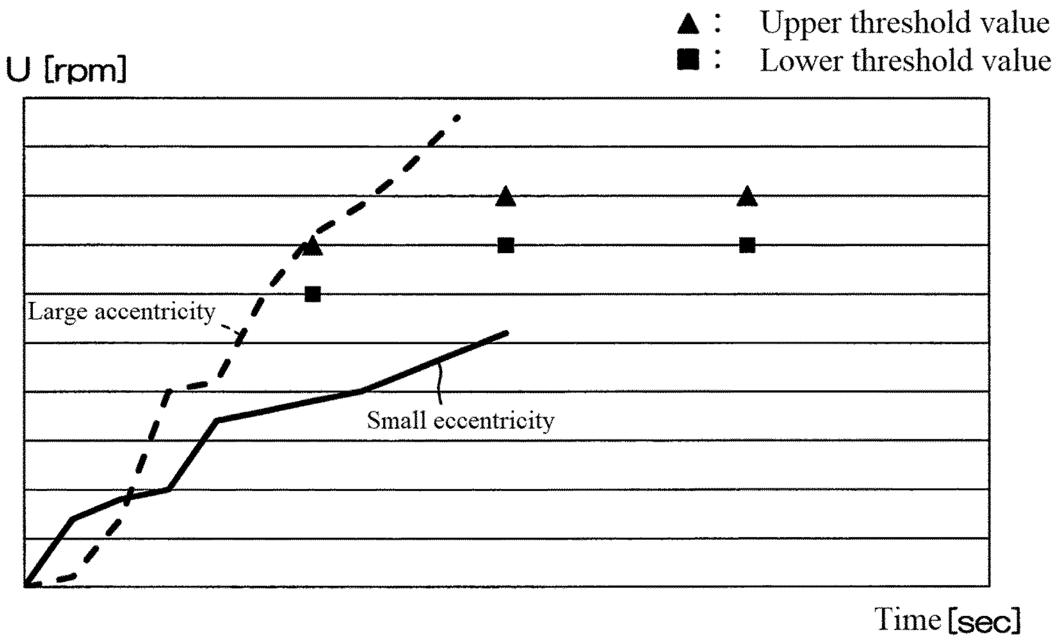
▲ : Upper threshold value
■ : Lower threshold value
U [rpm]
Large accentricity
Small eccentricity
Time [sec]

Fig. 8

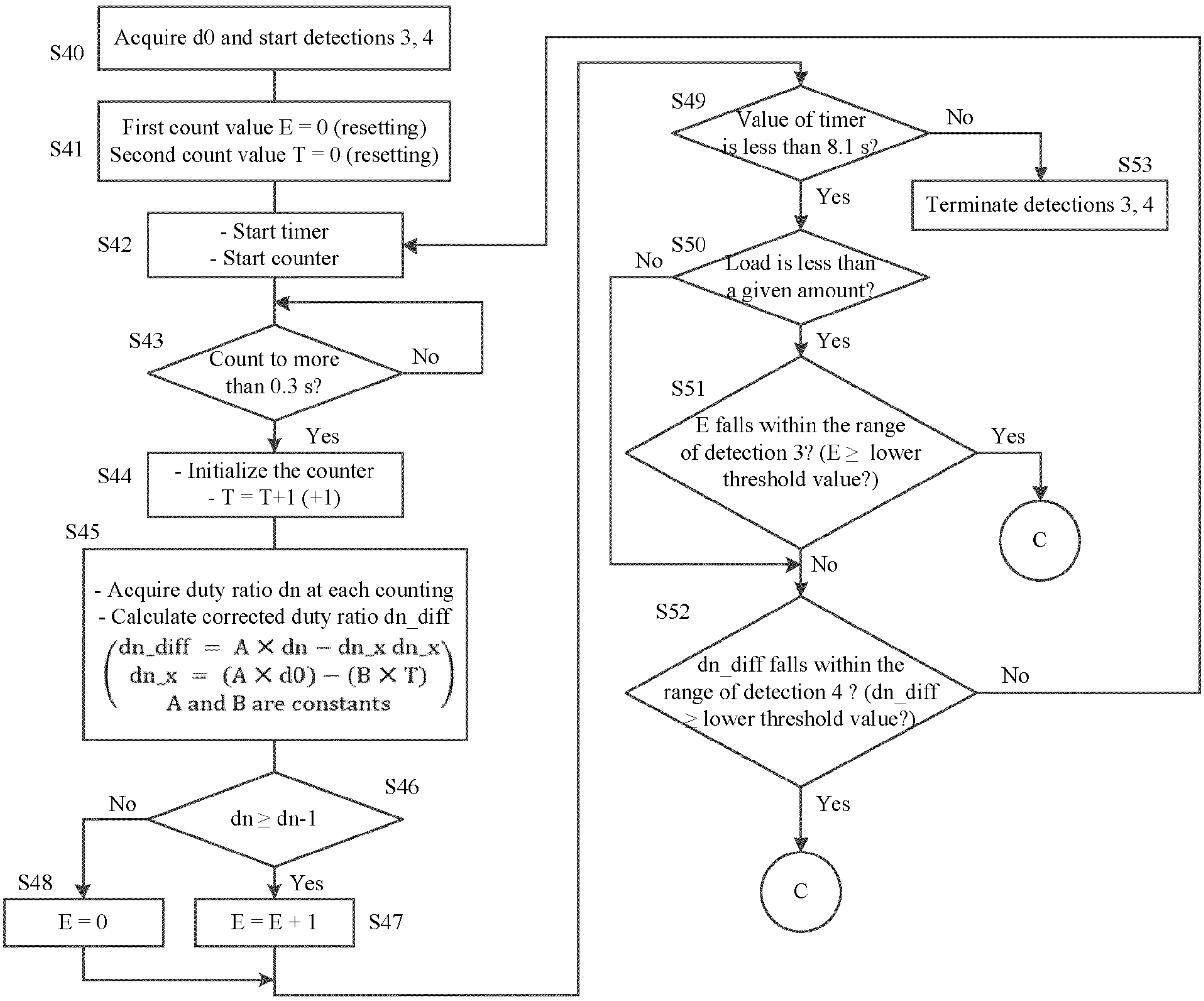
S40
Acquire d0 and start detections 3, 4
S41
First count value E = 0 (resetting)
Second count value T = 0 (resetting)
S42
- Start timer
- Start counter
S43
Count to more than 0.3 s?
No
Yes
S44
- Initialize the counter
- T = T+1 (+1)
S45
- Acquire duty ratio dn at each counting
- Calculate corrected duty ratio dn_diff
dn_diff = A × dn − dn_x dn_x
dn_x = (A × d0) − (B × T)
A and B are constants
S46
dn ≥ dn-1
No
Yes
S48
E = 0
E = E + 1
S47
S49
Value of timer is less than 8.1 s?
No
Yes
S53
Terminate detections 3, 4
S50
Load is less than a given amount?
No
Yes
S51
E falls within the range of detection 3? (E ≥ lower threshold value?)
Yes
No
C
S52
dn_diff falls within the range of detection 4 ? (dn_diff ≥ lower threshold value?)
No
Yes
C

Fig. 9A

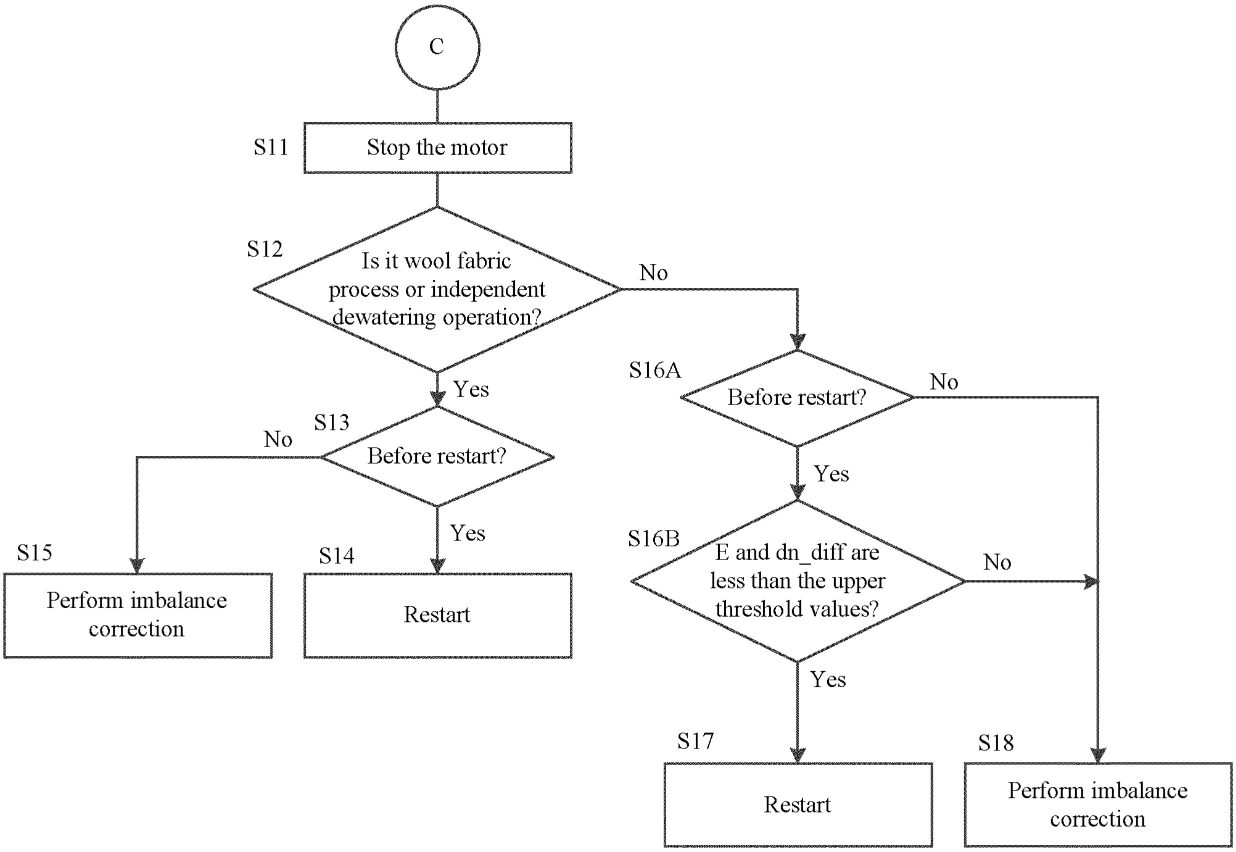
C
S11
Stop the motor
S12
Is it wool fabric process or independent dewatering operation?
No
Yes
S13
Before restart?
No
Yes
S15
Perform imbalance correction
S14
Restart
S16A
Before restart?
No
Yes
S16B
E and dn_diff are less than the upper threshold values?
No
Yes
S17
Restart
S18
Perform imbalance correction

Fig. 9B

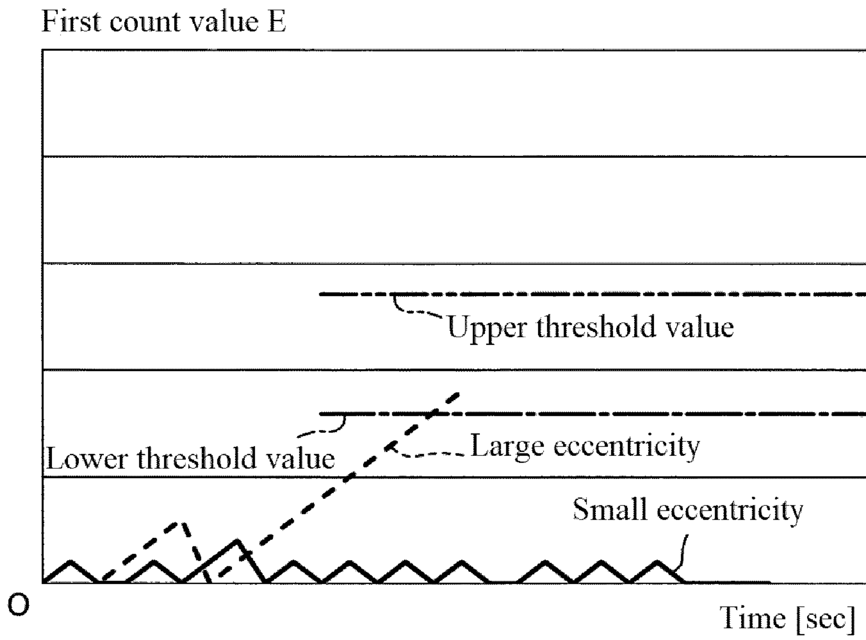
First count value E
Upper threshold value
Large eccentricity
Lower threshold value
Small eccentricity
O
Time [sec]

Fig. 10

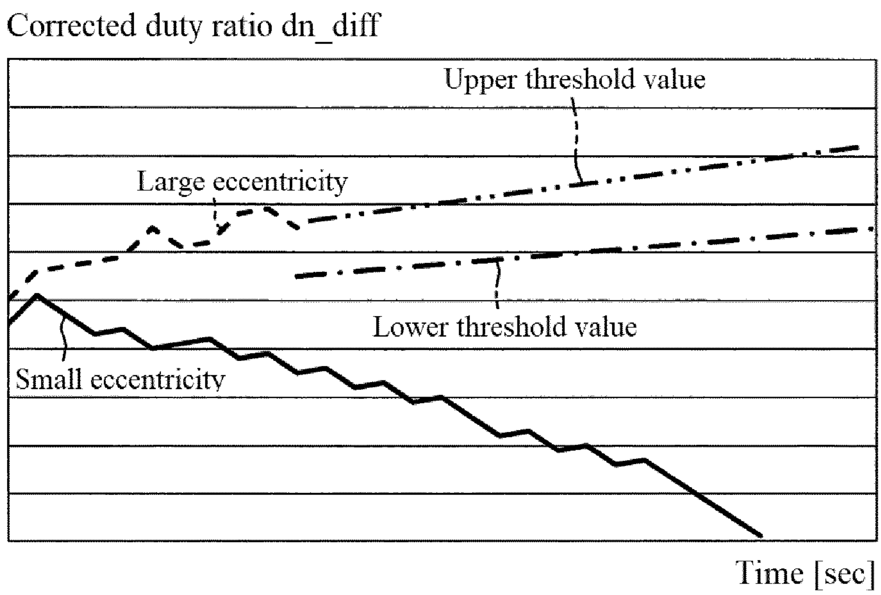
Corrected duty ratio dn_diff
Upper threshold value
Large eccentricity
Lower threshold value
Small eccentricity
Time [sec]

Fig. 11

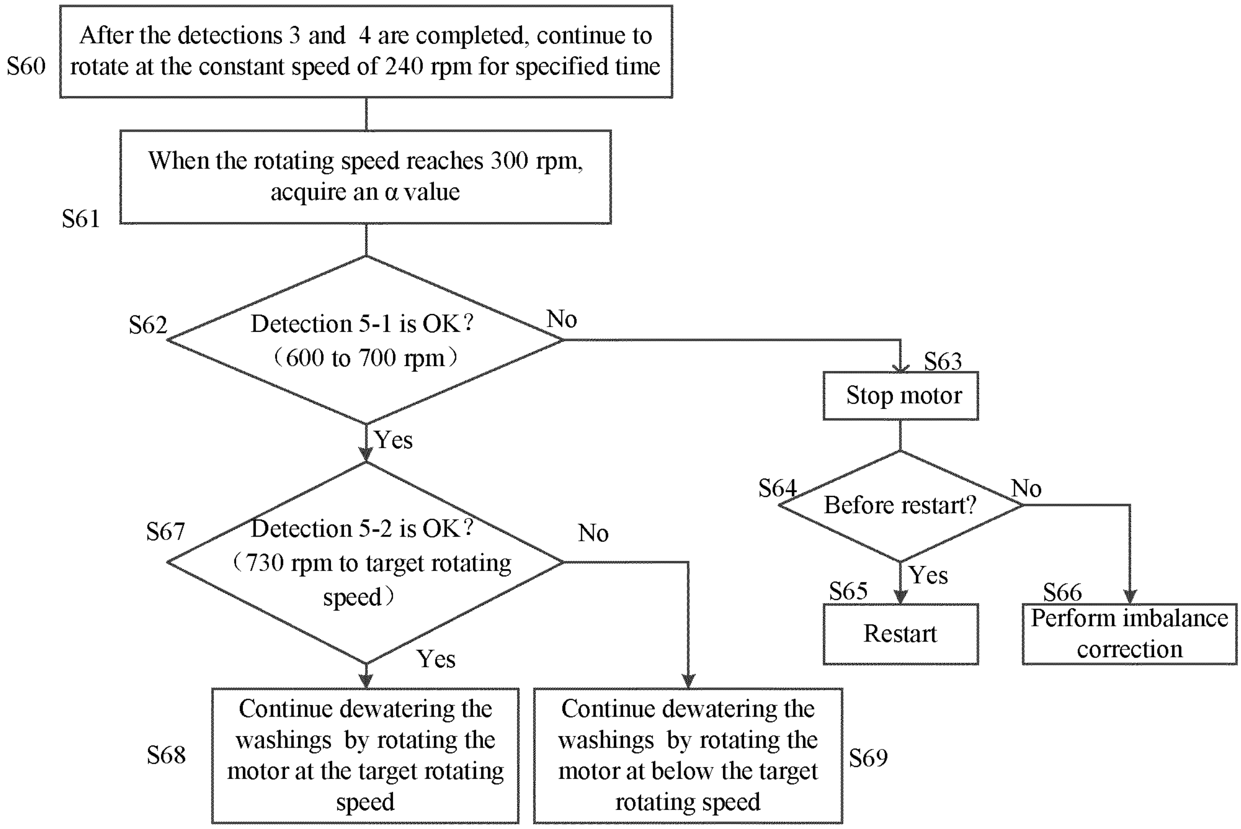
S60
After the detections 3 and 4 are completed, continue to rotate at the constant speed of 240 rpm for specified time
When the rotating speed reaches 300 rpm, acquire an α value
S61
S62
Detection 5-1 is OK?
(600 to 700 rpm)
No
S63
Stop motor
Yes
S64
Before restart?
No
S67
Detection 5-2 is OK?
(730 rpm to target rotating speed)
No
Yes
S65
Restart
S66
Perform imbalance correction
Yes
S68
Continue dewatering the washings by rotating the motor at the target rotating speed
Continue dewatering the washings by rotating the motor at below the target rotating speed
S69

Fig. 12

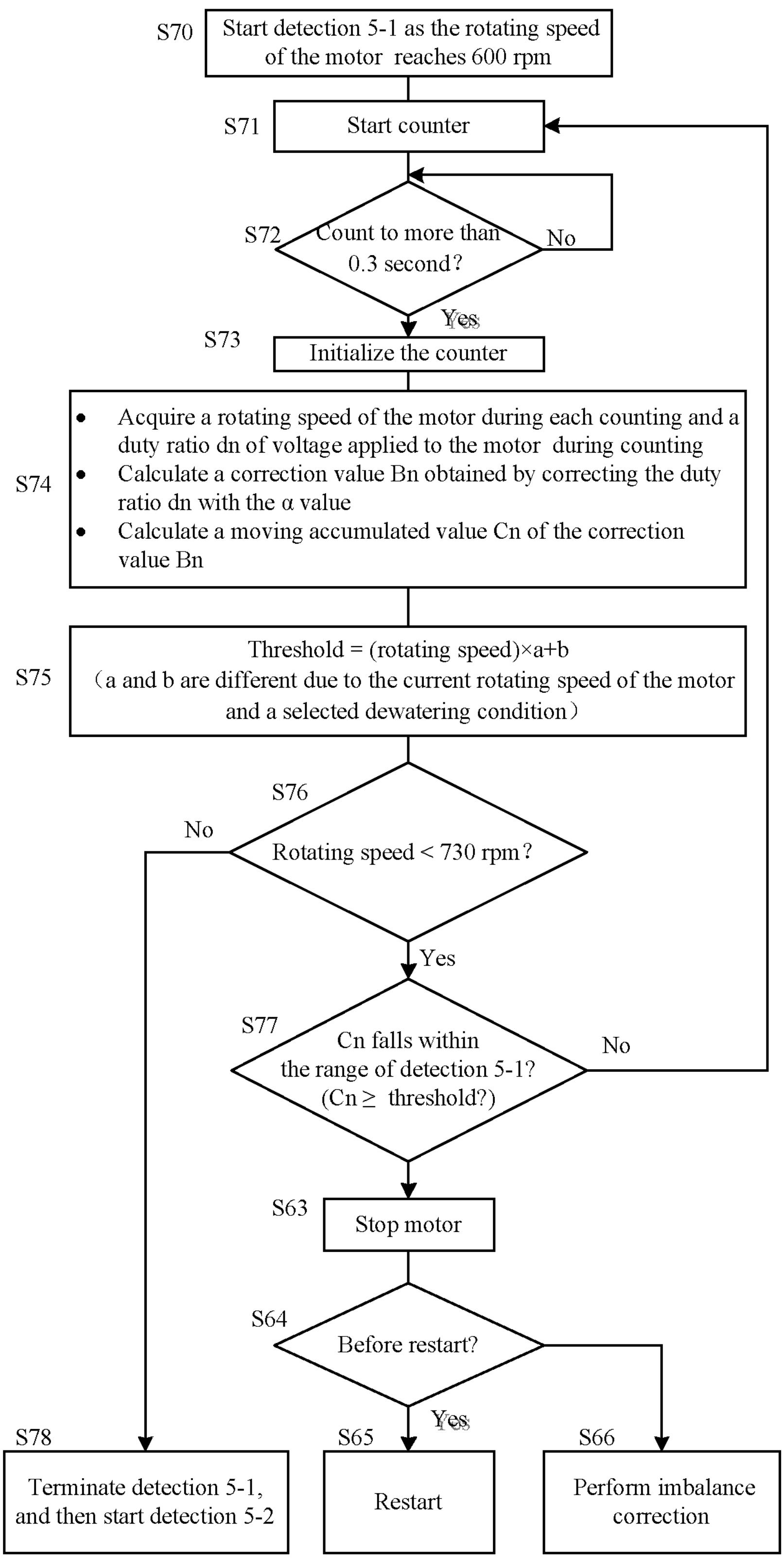
S70
Start detection 5-1 as the rotating speed of the motor reaches 600 rpm
S71
Start counter
S72
Count to more than 0.3 second?
No
Yes
S73
Initialize the counter
S74
Acquire a rotating speed of the motor during each counting and a duty ratio dn of voltage applied to the motor during counting
Calculate a correction value Bn obtained by correcting the duty ratio dn with the α value
Calculate a moving accumulated value Cn of the correction value Bn
S75
Threshold = (rotating speed)×a+b
(a and b are different due to the current rotating speed of the motor and a selected dewatering condition)
S76
No
Rotating speed < 730 rpm?
Yes
S77
Cn falls within the range of detection 5-1? (Cn ≥ threshold?)
No
S63
Stop motor
S64
Before restart?
Yes
S78
Terminate detection 5-1, and then start detection 5-2
S65
Restart
S66
Perform imbalance correction

Fig. 13

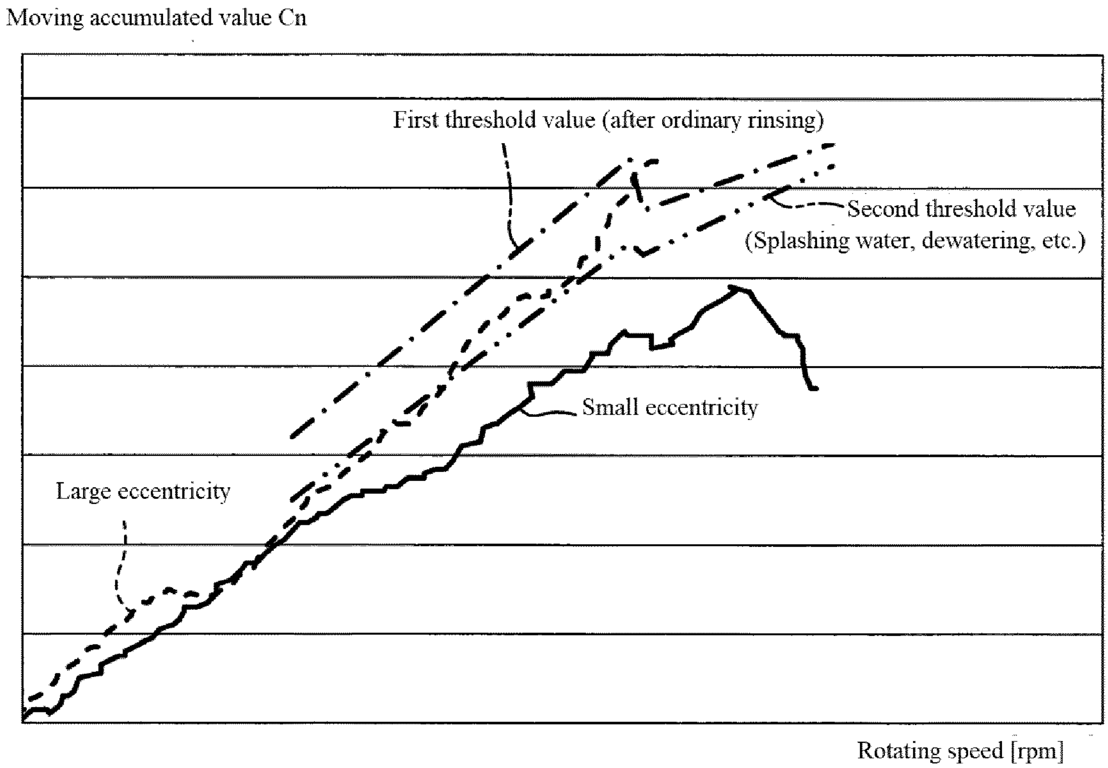
Moving accumulated value Cn
First threshold value (after ordinary rinsing)
Second threshold value
(Splashing water, dewatering, etc.)
Small eccentricity
Large eccentricity
Rotating speed [rpm]

Fig. 14

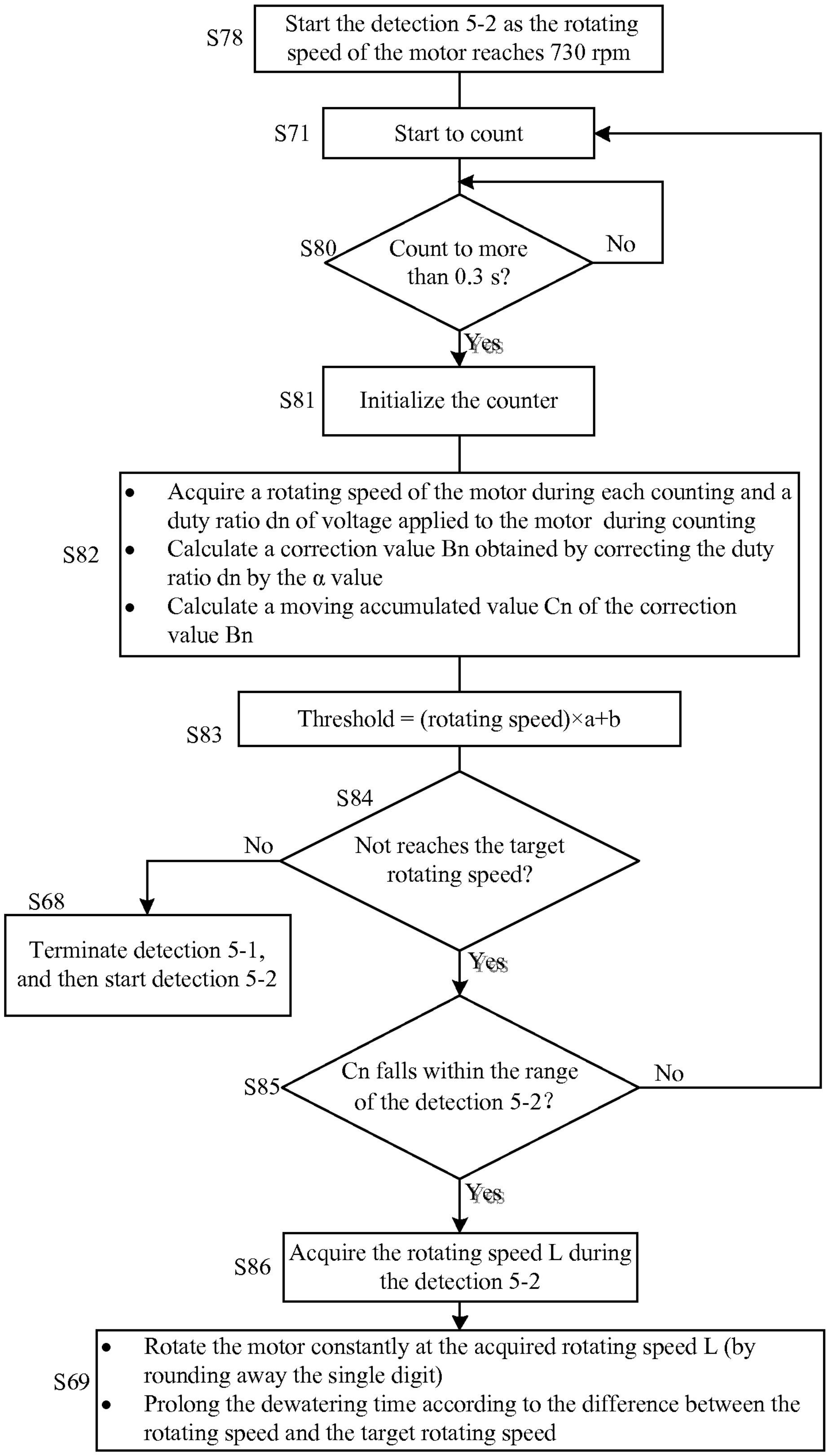
S78
Start the detection 5-2 as the rotating speed of the motor reaches 730 rpm
S71
Start to count
S80
Count to more than 0.3 s?
No
Yes
S81
Initialize the counter
S82
• Acquire a rotating speed of the motor during each counting and a duty ratio dn of voltage applied to the motor during counting
• Calculate a correction value Bn obtained by correcting the duty ratio dn by the α value
• Calculate a moving accumulated value Cn of the correction value Bn
S83
Threshold = (rotating speed)×a+b
S84
Not reaches the target rotating speed?
No
S68
Terminate detection 5-1, and then start detection 5-2
Yes
S85
Cn falls within the range of the detection 5-2?
No
Yes
S86
Acquire the rotating speed L during the detection 5-2
S69
• Rotate the motor constantly at the acquired rotating speed L (by rounding away the single digit)
• Prolong the dewatering time according to the difference between the rotating speed and the target rotating speed

Fig. 15

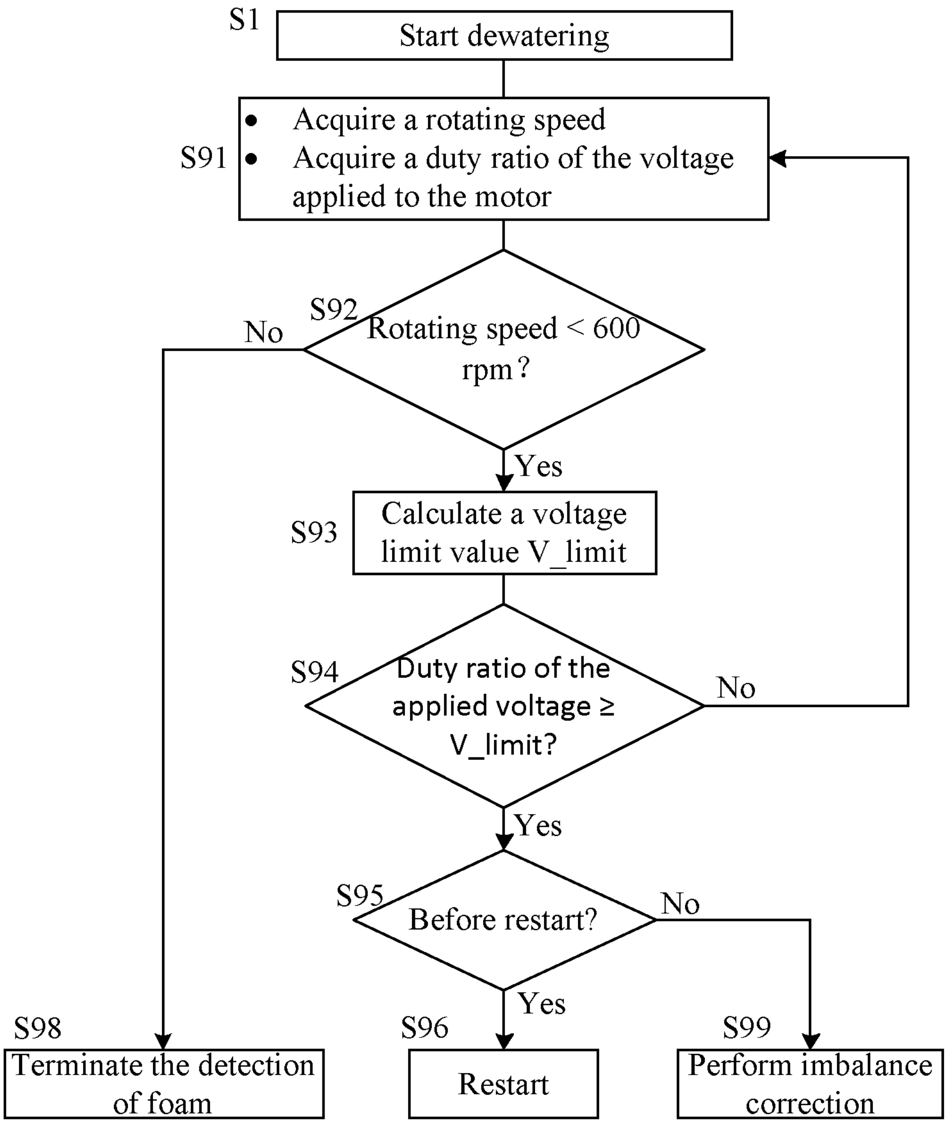
S1
Start dewatering
S91
Acquire a rotating speed
Acquire a duty ratio of the voltage applied to the motor
S92
Rotating speed < 600 rpm?
No
Yes
S93
Calculate a voltage limit value V_limit
S94
Duty ratio of the applied voltage ≥ V_limit?
No
Yes
S95
Before restart?
No
Yes
S98
Terminate the detection of foam
S96
Restart
S99
Perform imbalance correction

Fig. 16

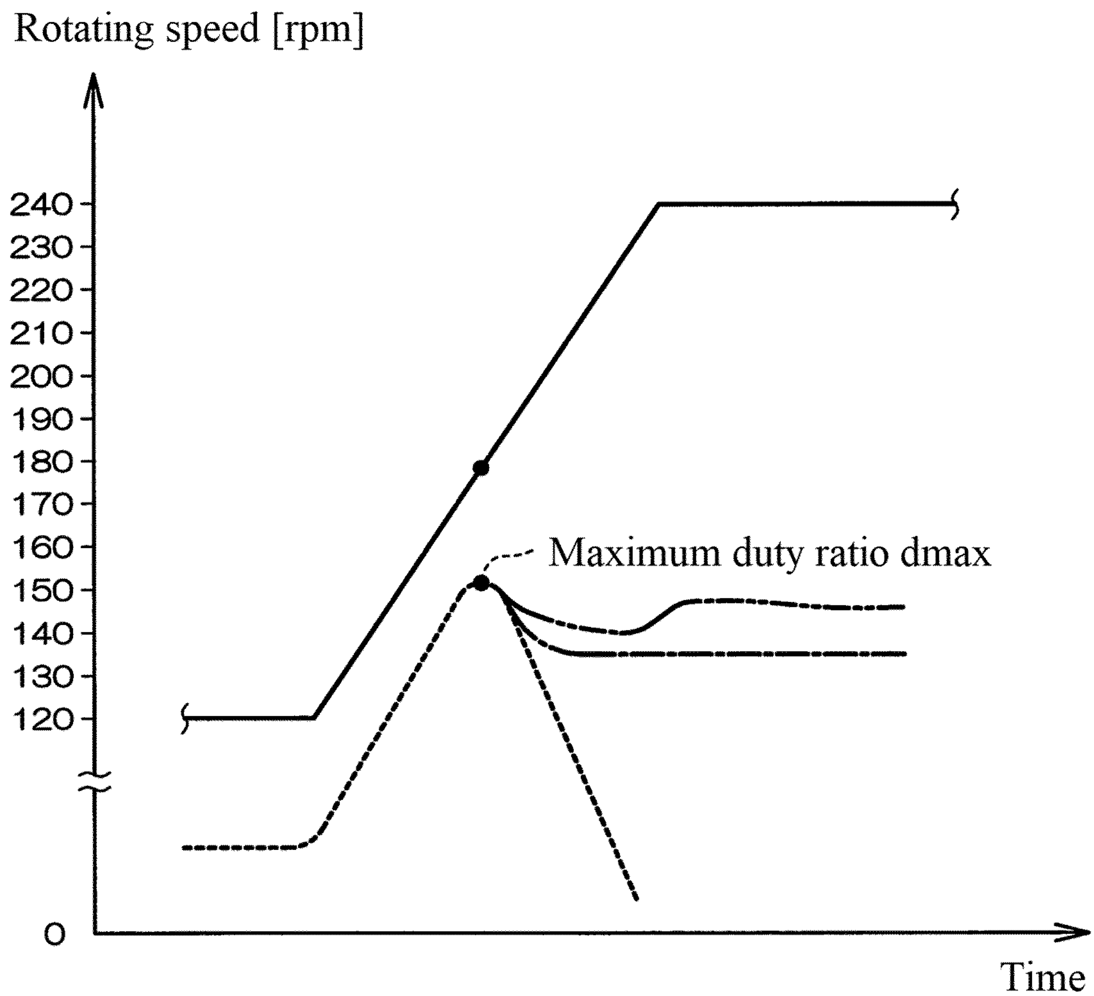
Rotating speed [rpm]
240
230
220
210
200
190
180
170
160
150
140
130
120
0
Maximum duty ratio dmax
Time

Fig. 17

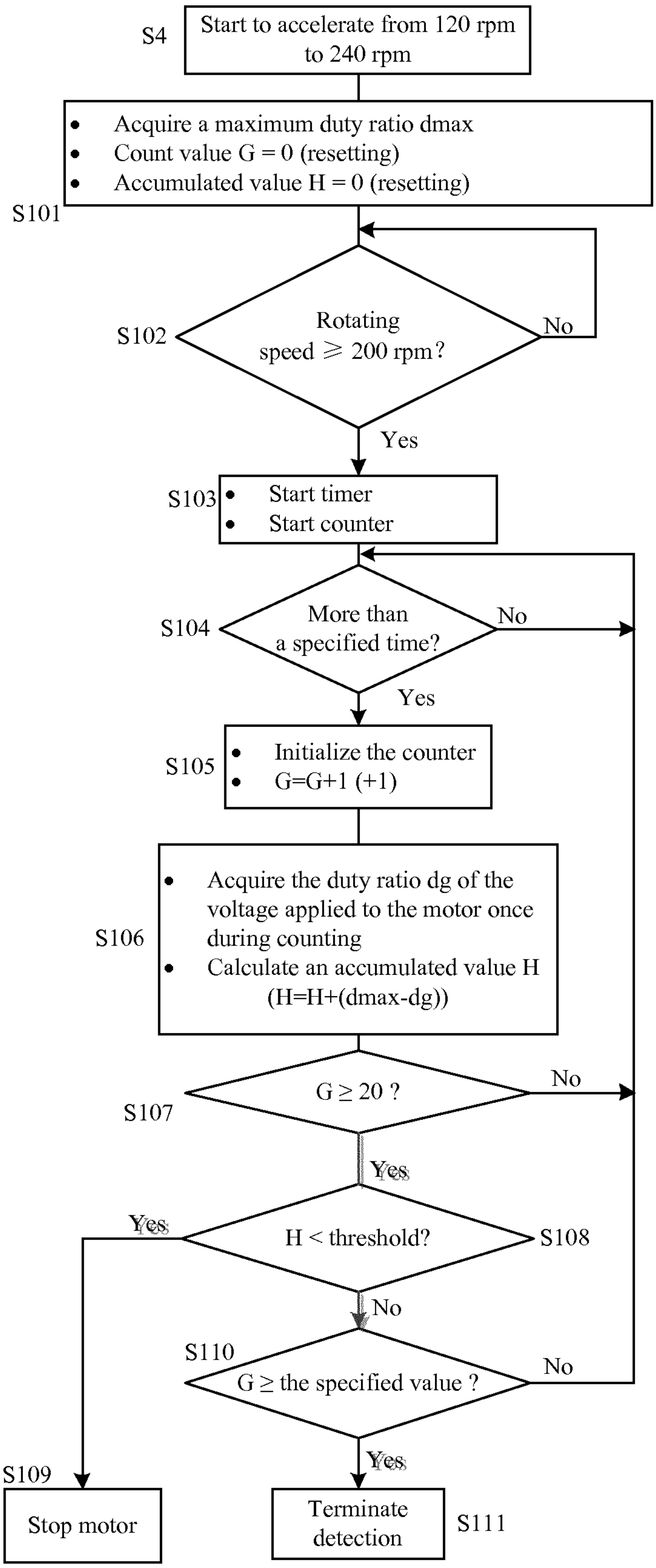
S4
Start to accelerate from 120 rpm to 240 rpm
S101
• Acquire a maximum duty ratio dmax
• Count value G = 0 (resetting)
• Accumulated value H = 0 (resetting)
S102
Rotating speed ⩾ 200 rpm?
No
Yes
S103
• Start timer
• Start counter
S104
More than a specified time?
No
Yes
S105
• Initialize the counter
• G=G+1 (+1)
S106
• Acquire the duty ratio dg of the voltage applied to the motor once during counting
• Calculate an accumulated value H (H=H+(dmax-dg))
S107
G ≥ 20 ?
No
Yes
S108
H < threshold?
Yes
No
S110
G ≥ the specified value ?
No
Yes
S109
Stop motor
Terminate detection
S111

Fig. 18

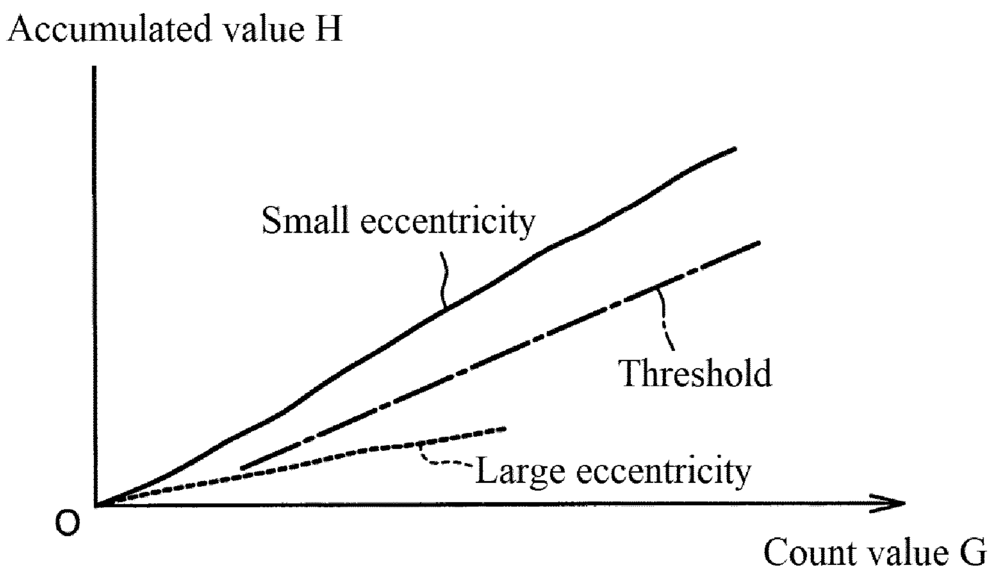
Accumulated value H
Small eccentricity
Threshold
Large eccentricity
O
Count value G

Fig. 19

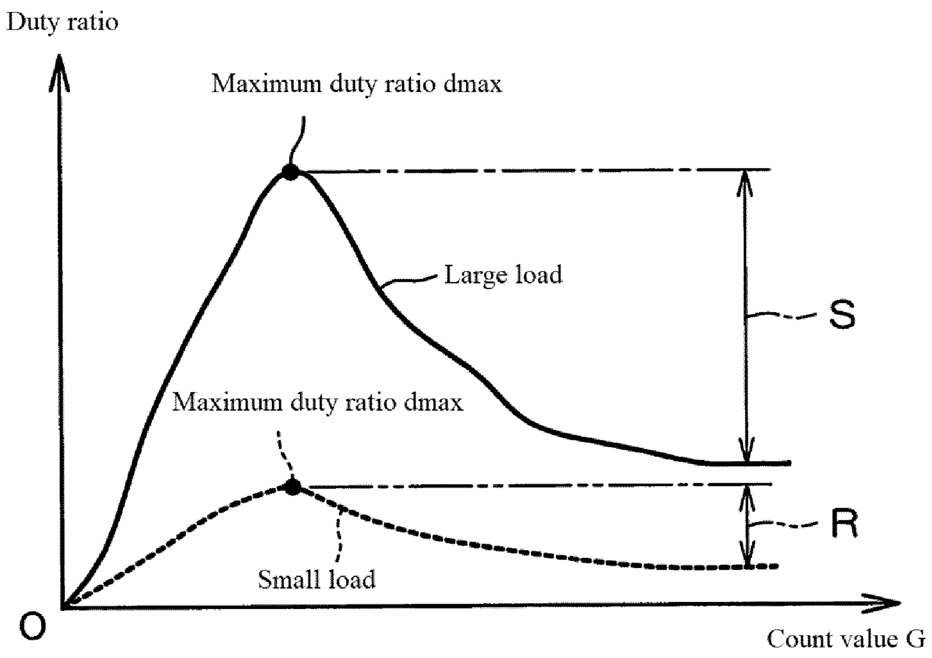
Duty ratio
Maximum duty ratio dmax
Large load
S
Maximum duty ratio dmax
R
Small load
O
Count value G

Fig. 20

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2016/083395

A. CLASSIFICATION OF SUBJECT MATTER

D06F 33/02 (2006.01) i; D06F 23/04 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

D06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS; CNTXT, DWPI; SIPOABS: unbalance loading, bias, offset, duty ratio, eccentricity, eccentric, eccentrical, eccentrically, unbalance, unbalanced, imbalance, non-balance, balance, disequilibrium, non-equilibrium, uneven, duty, cycle, ratio, load, pulse, rpm, speed, revolv+, velocity

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 102251369 A (SANYO ELECTRIC CO., LTD. et al.), 23 November 2011 (23.11.2011), description, paragraphs [0149], [0166-0167], [0179-0182], [0195-0197] and [0224-0225], and figures 1, 3, 5, 9 and 12	1-8
A	CN 102251367 A (SANYO ELECTRIC CO., LTD. et al.), 23 November 2011 (23.11.2011), the whole document	1-8
A	JP 2008035925 A (SANYO ELECTRIC CO.), 21 February 2008 (21.02.2008), the whole document	1-8
A	JP 2008307414 A (SANYO ELECTRIC CO.), 25 December 2008 (25.12.2008), the whole document	1-8
PX	JP 2016026536 A (HAIER ASIA CO., LTD.), 18 February 2016 (18.02.2016), claims 1-8	1-8

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 August 2016 (23.08.2016)	**01 September 2016 (01.09.2016)**

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Information on patent family members

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