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(54) DEHYDRATOR

(57) A dewatering machine capable of early inhibiting eccentric rotation of a dewatering tank obliquely configured is provided. The dewatering machine (1) includes: a dewatering tank (4), formed in a cylindrical shape with a central axis (17) extending in a direction (K) inclined relative to an up-down direction (Z); a balancing ring (19) coaxially arranged in the dewatering tank (4), and liquid for achieving rotational balance of the dewatering tank (4) is contained in the balancing ring and flows freely; and a control part (30). The control part (30) causes the dewatering tank (4) to rotate at a rotating speed lower than a lowest rotating speed at which the dewatering tank (4) resonates in a dewatering preparation stage of washings Q in the dewatering tank (4), so as to detect a biased position of the washings Q in the dewatering tank (4), and causes the dewatering tank (4) to stop rotating immediately before the washings Q biased in the dewatering tank (4) are positioned at an opposite side of liquid biased downward in the balancing rings (19) to a lower side Z2, relative to the central axis (17).

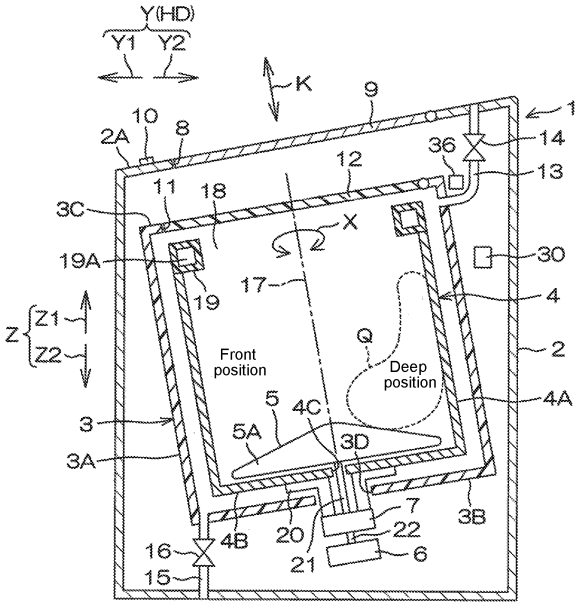


FIG.1

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Description

TECHNICAL FIELD

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

BACKGROUND

[0002] A washing machine with a dewatering function is disclosed in the following patent literature 1. In the washing machine, as for a cylindrical washing tank for containing washings, a central axis of the washing tank is obliquely arranged relative to a plumb line. Therefore, an upper part of the washing tank is obliquely configured in a manner of protruding towards a front side of the washing machine.

Existing technical literature

Patent literature

[0003] Patent literature 1: Japanese Patent Application Laid-open No. 2000-312795

Problems to be solved by the disclosure

[0004] In a dewatering machine in which a dewatering tank for containing washings is biased like the washing machine in patent literature 1, the washings are easy to bias in the dewatering tank. If dewatering operation is conducted in a state that the washings are biased, the dewatering tank will conduct eccentric rotation, thereby causing a vibration. Therefore, in the dewatering machine, it is aimed to inhibit the eccentric rotation of the dewatering tank early, so as to avoid vibration as much as possible.

SUMMARY

[0005] The present disclosure is made on the basis of the background and aims to provide a washing machine capable of inhibiting eccentric rotation of a biased dewatering tank early.

Solutions for the problems

[0006] The present disclosure provides a dewatering machine, including: a dewatering tank, formed in a cylindrical shape with a central axis extending in a direction inclined relative to an up-down direction, the dewatering tank is configured to contain washings, and rotate around the central axis so as to dewater the washings; a balancing ring, formed in a hollow annular shape, the balancing ring is coaxially arranged in the dewatering tank, and liquid for achieving rotational balance of the dewatering tank is contained in the balancing ring and flows freely; and a dewatering preparation unit, configured to cause the dewatering tank, in a dewatering preparation stage for the washings, to rotate at a rotating speed lower than a lowest rotating speed at which the dewatering tank resonates, so as to detect a biased position of the washings in the dewatering tank; and cause the dewatering tank to stop rotating immediately before the washings biased in the dewatering tank are positioned, relative to the central axis, at an opposite side of the liquid biased downward in the balancing ring.

[0007] In addition, the present disclosure provides a dewatering machine, including: a dewatering tank, formed in a cylindrical shape with a central axis extending in a direction inclined relative to an up-down direction, the dewatering tank is configured to contain washings, and rotate around the central axis so as to dewater the washings; an electric motor, configured to cause the dewatering tank to rotate; an information value acquisition unit, configured to, when the electric motor is in an acceleration state of accelerating to a target rotating speed used for formally dewatering the washings, sequentially acquire an information value that should be decreased as a rotating speed of the electric motor increases; a counting unit, configured to add a count value with an initial value of zero by 1 once the information value acquisition unit acquires the information value; a calculation unit, configured to calculate an accumulated value of a difference between the information value and a previous information value under a condition that the information value is larger than the previous information value; a determination unit, configured to determine that the washings are biased in the dewatering tank when the accumulated value with the count value of a specified value reaches a first threshold with the count value of the specified value; and a stopping unit, configured to cause the dewatering tank to stop rotating when it is determined by the determination unit that the washings are biased.

[0008] In addition, the dewatering machine according to the present disclosure further includes an information correction

unit, configured to correct the information value through moving average before the accumulated value is calculated by the calculation unit.

[0009] In addition, the dewatering machine according to the present disclosure further includes an execution unit, the execution unit is configured to alternatively execute any of a restarting process and a correction process under a condition that the dewatering tank is stopped rotating through the stopping unit, the restarting process is a process for restarting to dewater the washings by causing the dewatering tank to rotate again, and the correction process is a process for correcting the biasing of the washings in the dewatering tank; and the execution unit is configured to select to execute the correction process rather than selecting to execute the restarting process in the following situation: the restarting process has been executed for a specified number, and the dewatering tank is caused to stop rotating by the stopping unit

[0010] In addition, the dewatering machine according to the present disclosure further includes an acceleration unit, and the acceleration unit causes the electric motor to accelerate in three stages including a first acceleration stage, a second acceleration stage and a third acceleration stage. The first acceleration stage refers to an acceleration stage, in which the motor accelerates toward the target rotating speed from starting rotating until the rotating speed of the motor reaches a first rotating speed, the first rotating speed is higher than a rotating speed at which the dewatering tank resonates transversely and lower than a rotating speed at which the dewatering tank resonates longitudinally. The second acceleration stage is an acceleration stage, in which the rotating speed of the motor increases from the first rotating speed to a second rotating speed higher than the first rotating speed. The third acceleration stage is an acceleration stage, in which the rotating speed of the motor increases from the second rotating speed to the target rotating speed. The first threshold is independently set in the first acceleration stage, the second acceleration stage and the third acceleration stage respectively, and the information value acquisition unit is configured to acquire the information value in the first acceleration stage, the second acceleration stage and the third acceleration stage respectively, the counting unit causes the count value to be added by 1 and calculates the accumulated value, and the determination unit determines that the washings are biased in the dewatering tank when the accumulated value reaches the first threshold.

[0011] In addition, the dewatering machine according to the present disclosure further includes a duty ratio acquisition unit, configured to acquire a duty ratio of voltage applied to the motor at each specified time in the third acceleration stage; and a transformation unit, configured to transform the duty ratio acquired by the duty ratio acquisition unit into a specified index value. When the index value reaches a second threshold for a corresponding time, the determination unit determines that the washings are biased in the dewatering tank.

[0012] In addition, the dewatering machine according to the present disclosure further includes a threshold modification unit, configured to modify the second threshold according to the accumulated value in at least one acceleration stage of the first acceleration stage, the second acceleration stage and the third acceleration stage.

[0013] In addition, in the present disclosure, when a variation of the accumulated value reaches a third threshold, the determination unit determines that the washings are biased in the dewatering tank.

[0014] In addition, the present disclosure provides a dewatering machine, including: a dewatering tank, formed in a cylindrical shape with a central axis extending in a direction inclined relative to an up-down direction, the dewatering tank is configured to contain washings, and rotate around the central axis so as to dewater the washings; an outer tank, configured to contain the dewatering tank; an electric motor, configured to cause the dewatering tank to rotate; a determination unit, configured to determine that the washings are biased in the dewatering tank when an information value, relevant to a rotation state of the electric motor before a rotating speed of the electric motor reaches a target rotating speed used for formally dewatering the washings, reaches a threshold; a detection unit, configured to mechanically detect eccentric rotation of the dewatering tank by contacting the outer tank when the dewatering tank eccentrically rotates along with biasing of the washings in the dewatering tank and the outer tank is caused to vibrate; a stopping unit, configured to cause the dewatering tank to stop rotating in one of the following situations: it is determined by the determination unit that the washings are biased; the eccentric rotation of the dewatering tank is detected by the detection unit; and a threshold correction unit, configured to correct the threshold in one of the following situations: a difference between the information value and the threshold is above the specified value when the eccentric rotation of the dewatering tank is detected by the detection unit; it is determined by the determination unit that the washings are biased before the eccentric rotation is detected by the detection unit.

[0015] In addition, the present disclosure provides a dewatering machine, including: a dewatering tank, formed in a cylindrical shape with a central axis extending in a direction inclined relative to an up-down direction, the dewatering tank is configured to contain washings, and rotate around the central axis so as to dewater the washings; an outer tank, configured to contain the dewatering tank; an electric motor, configured to cause the dewatering tank to rotate; a determination unit, configured to determine that the washings are biased in the dewatering tank when an information value, relevant to a rotation state of the electric motor before a rotating speed of the electric motor reaches a target rotating speed used for formally dewatering the washings, reaches a threshold; a detection unit, configured to mechanically detect eccentric rotation of the dewatering tank by contacting the outer tank when the dewatering tank eccentrically rotates along with biasing of the washings in the dewatering tank and the outer tank is caused to vibrate; a stopping unit, configured to cause the dewatering tank to stop rotating in one of the following situations: it is determined by the

determination unit that the washings are biased; the eccentric rotation of the dewatering tank is detected by the detection unit; and a suspending unit, configured to suspend an operation performed by the stopping unit for stopping the rotation of the dewatering tank, until a detection number of the detection unit reaches a specified number before it is determined by the determination unit that the washings are biased.

Effects of disclosure

[0016] According to the present disclosure, since the dewatering tank of the dewatering machine has a cylindrical shape with a central axis extending along a direction inclined relative to an up-down direction, the dewatering tank is arranged obliquely. A hollow annular balancing ring is coaxially arranged on the dewatering tank. Thus, in a static state of the dewatering tank, liquid contained in the balancing ring is biased downwards in the balancing ring.

[0017] In the dewatering tank, washings are assumed to be biased in a rotating direction of the dewatering tank in a same position as the liquid biased downwards in the balancing ring. In the state, when rotation of the dewatering tank is started to dewater the washings, the dewatering tank eccentrically rotates from the beginning of the rotation.

[0018] Therefore, in the dewatering machine, in a dewatering preparation stage, a dewatering preparation unit causes the dewatering tank to rotate at a very low speed lower than a maximum rotating speed at which the dewatering tank resonates, so as to detect a biased position of the washings in the dewatering tank in a rotating direction. The dewatering preparation unit causes the dewatering tank to stop rotating according to the detected biased position immediately before the washings biased in the dewatering tank will be positioned at an opposite side of the liquid biased downwards in the balancing ring, relative to the central axis.

[0019] In addition, since the dewatering tank stops rotating when the washings biased in the dewatering tank are positioned at the opposite side of the liquid in the balancing ring relative to the central axis, the washings finally may come to a same side of the liquid in the balancing ring due to no time to stop and inertial rotation of the dewatering tank after stopping.

[0020] Therefore, if the dewatering tank stops rotating immediately before the washings biased in the dewatering tank will be positioned at the opposite side of the liquid in the balancing ring relative to the central axis, the washings biased in the dewatering tank and the liquid biased downwards in the balancing ring can be maintained in a state of being positioned on approximately opposite sides relative the central axis. After such preparation stage, when the dewatering tank rotates to dewater, the dewatering tank rotates in a state that the liquid in the balancing ring and the washings are approximately balanced. Thus, eccentric rotation of the dewatering tank obliquely arranged can be early inhibited.

[0021] According to the present disclosure, the dewatering tank of the dewatering machine has a cylindrical shape having the central axis which extends along the direction inclined relative to the up-down direction, and is arranged obliquely. In the dewatering machine which uses a motor to rotate the dewatering tank, in a state that the motor is accelerated to a target rotating speed for formally dewatering the washings, information values which are decreased with the increase of the rotating speed of the motor are acquired successively. When the information values are obtained each time, a count value with an initial value of zero is added by 1.

[0022] If the washings in the dewatering tank are biased, an information value at a certain time becomes larger than a previous information value sometimes since an information value which shall be decreased is changed. In this case, an accumulated value of a difference between the information value and the previous information value is larger than zero. If the dewatering tank continues to rotate in a state that the washings in the dewatering tank are biased, the accumulated value becomes larger.

[0023] Moreover, when the accumulated value when the count value is the specified value reaches a first threshold when the count value is the specified value, it is determined that the washings are biased in the dewatering tank, and the dewatering tank stops rotating. Thus, under a condition that the washings are biased in the obliquely arranged dewatering tank, eccentric rotation of the dewatering tank may be inhibited early in an acceleration state of the motor.

[0024] According to the present disclosure, since an information value used in calculation of the accumulated value is corrected through moving average before calculation of the accumulated value, the information value is a high accuracy value of eliminating an error. Thus, the accumulated value with high accuracy is calculated according to the corrected information value, and whether the washings are biased is detected through the accumulated value with high accuracy, so that eccentric rotation of the dewatering tank may be inhibited early.

[0025] According to the present disclosure, under a condition that the washings are biased in the dewatering tank and the dewatering tank stops rotating, the restarting process or the correction process is executed. The restarting process is a process for restarting to dewater the washing by enabling the dewatering tank to rotate again, and the correction process is a process for correcting washing biasing in the dewatering tank.

[0026] Dewatering is started again through the restarting process under a condition that washing biasing is small to an extent without generating eccentric rotation of the dewatering tank, so that time used by the whole dewatering process may be shortened as much as possible. Under a condition that washing biasing is large to an extent that eccentric rotation of the dewatering tank is still generated, washing biasing may be reliably corrected through the correction process.

[0027] Under a condition that the restarting process is executed for the specified number and the dewatering tank stops rotating, washing biasing is large to an extent needing to be corrected. In this case, the correction process is quickly executed without spending time on carrying out the restarting process repeatedly and stopping rotation of the dewatering tank, so that biasing may be reliably corrected. Thus, eccentric rotation of the dewatering tank may be inhibited early.

[0028] According to the present disclosure, in the first acceleration stage, the second acceleration stage and the third acceleration stage of the motor from starting rotation to reaching the target rotating speed, the accumulated values are respectively calculated, and when the accumulated values reach the corresponding first thresholds in the first acceleration stage, the second acceleration stage and the third acceleration stage respectively, washing biasing in the dewatering tank may be determined, so that the dewatering tank stops rotating. Namely, since the biasing of the washings is detected in the first acceleration stage after the motor starts to rotate, eccentric rotation of the dewatering tank may be inhibited early. Furthermore, since the biasing of the washings is detected in three stages according to a sequence of the first acceleration stage, the second acceleration stage and the third acceleration stage, the condition of washing biasing may be reliably detected, and eccentric rotation of the dewatering tank is inhibited as early as possible.

[0029] According to the present disclosure, in the third acceleration stage, when the duty ratio acquired at each specified moment is transformed into a specified index value, and the index value reaches a second threshold at a corresponding moment, it is determined that the washings are biased in the dewatering tank. That is, in the third acceleration stage, since the condition whether the washing is biased in the dewatering tank is double detected by adopting a mode of the information values and the first thresholds and adopting a mode of the duty ratio and the second thresholds, eccentric rotation of the dewatering tank may be reliably inhibited early.

[0030] According to the present disclosure, since the second threshold is properly changed according to the accumulated value in at least one acceleration stage of the first acceleration stage, the second acceleration stage and the third acceleration stage, whether the washings are biased may be detected with high accuracy through the second threshold changed with combination of a situation of the dewatering tank, and eccentric rotation of the dewatering tank is inhibited early.

[0031] According to the present disclosure, whether the washings are biased may be double detected through a mode whether the accumulated value reaches the first threshold and whether a variation of the accumulated value reaches the third threshold. In this case, whether the dewatering tank is in a state of large amplitude vibration, eccentric rotation of the dewatering tank may be reliably inhibited early according to the variation of the accumulated value though the accumulated value may be small without reaching the first threshold.

[0032] According to the present disclosure, the dewatering tank of the dewatering machine is in a cylindrical shape with a central axis extending in the direction inclined relative to the up-down direction and is obliquely arranged. Whether the washings are biased in the dewatering tank is double detected through an electric mode based on a relationship between the information value relative to the rotation state of the motor and the threshold and a mechanical mode based on contact between the detection unit and the outer tank.

[0033] In the dewatering machine in the shipment stage, due to an inclined difference of the dewatering tanks among individual dewatering machines, some dewatering machines may have a condition that the threshold is not correct. Thus, the threshold is corrected under the following situation: a difference between the information value when the detection unit detects eccentric rotation of the dewatering tank and a threshold is above the specified value, or the determination unit determines that the washings are biased before eccentric rotation is detected by the detection unit. Thus, in the dewatering process after the threshold is corrected, in the electric mode, whether the washings are biased is detected with high accuracy through the corrected threshold, so that eccentric rotation of the dewatering tank is inhibited early.

[0034] According to the present disclosure, the dewatering tank of the dewatering machine is in the cylindrical shape with the central axis extending in the direction inclined relative to up-down direction and is obliquely arranged. Whether the washings are biased in the dewatering tank is double detected through the electric mode based on a relationship between the information value relative to the rotation state of the motor and the threshold and a mechanical mode based on contact between the detection unit and the outer tank.

[0035] It is assumed that vibration of the dewatering tank is not too large, but due to the moving mode of the outer tank, the detection unit easily contacts the outer tank to generate error detection in the mechanical mode to cause the dewatering tank to stop rotating. Thus, until the detection number of the detection unit reach the specified number before the determination unit determines that the washings are biased, rotation stopping of the dewatering tank is suspended. Thus, not only the dewatering tank is prevented from stopping rotating due to error detection of the mechanical mode, but also eccentric rotation of the dewatering tank may be inhibited early.

BRIEF DESCRIPTION OF DRAWINGS

[0036]

FIG. 1 is a schematic longitudinal sectional right side view illustrating a dewatering machine according to an embodiment of the present disclosure.

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

FIG. 3 is a sequence diagram illustrating a state of an output signal of a Hall IC forming a rotating speed reading apparatus for reading a rotating speed of a motor.

FIG. 4 is a sequence diagram illustrating a state of a rotating speed of a motor in a dewatering operation process implemented in a dewatering machine.

FIG. 5 is a schematic diagram illustrating an interior of a dewatering tank.

FIG. 6 is a sequence diagram illustrating a state of a rotating speed of a motor at a preparation stage of dewatering operation.

FIG. 7 is a flow chart illustrating a control action at the preparation stage of dewatering operation.

FIG. 8 is a flow chart illustrating a control action in a first acceleration stage of a motor in a dewatering operation process.

FIG. 9A is a flow chart illustrating a control action related to detection 1 to detection 3 for detecting washings biasing in the dewatering tank in a first acceleration stage to a third acceleration stage of a motor.

FIG. 9B is a flow chart illustrating a control action related to detection 1 to detection 3.

FIG. 10 is a diagram illustrating a relationship between a count value n and a moving average value Cn in combination with detection 1 to detection 3.

FIG. 11 is a diagram illustrating a relationship between a count value n and an accumulated value G in combination with detection 1 to detection 3.

FIG. 12 is a flow chart illustrating a control action when a detection result is no good (NG).

FIG. 13 is a flow chart illustrating a control action in the second acceleration stage of the motor.

FIG. 14 is a flow chart illustrating a control action in the third acceleration stage of a motor.

FIG. 15 is a flow chart illustrating schemas of the detection 4-1 and the detection 4-2 for detecting whether there is washings biasing in the dewatering tank in the third acceleration stage.

FIG. 16 is a flow chart illustrating a control action of the detection 4-1.

FIG. 17 is a diagram illustrating a relationship between the rotating speed and a moving accumulated value Cm in combination with detection 4-1 and detection 4-2.

FIG. 18 is a flow chart illustrating a control action of the detection 4-2.

FIG. 19 is a flow chart illustrating a first modification of a control action of the detection 3 in the third acceleration stage.

FIG. 20 is a schematic diagram illustrating an interior of the dewatering tank in the dewatering operation process.

FIG. 21 is a flow chart illustrating a second modification of a control action of detection 3 in the third acceleration stage.

FIG. 22 is a flow chart illustrating a control action of a third modification in the dewatering operation process.

FIG. 23 is a flow chart illustrating a control action of the third modification.

FIG. 24 is a flow chart illustrating a control action of a fourth modification.

FIG. 25 is a flow chart illustrating a control action of a fifth modification.

Reference numerals List

[0037]

1: dewatering machine; 3: outer tank; 4: dewatering tank; 6: motor; 17: central axis; 19: balancing ring; 30: control part; 34: counter; 36: safety switch; C_m: moving accumulated value; C_n: moving average value; d_m: duty ratio; D_n: difference; G: accumulated value; K: inclined direction; n: count value; Q: washings; Z: up-down direction; Z2: lower side.

DETAILED DESCRIPTION

[0038] Embodiments of the present disclosure are described in detail by referring to the drawings below.

[0039] FIG. 1 is a schematic longitudinal sectional right side view illustrating a dewatering machine 1 according to an embodiment of the present disclosure. An up-down direction in FIG. 1 is referred to as an up-down direction Z of the dewatering machine 1, and a left-right direction in FIG. 1 is referred to as a front-rear direction Y of the dewatering machine 1. Firstly, description is made to summary of the dewatering machine 1. In the up-down direction Z, an upper side is referred to as an upper side Z1, and a lower side is referred to as a lower side Z2. In the front-rear direction Y, a left side in FIG. 1 is referred to as a front side Y1, and a right side in FIG. 1 is referred to as a rear side Y2.

[0040] The dewatering machine 1 includes all apparatuses capable of carrying out a dewatering operation of washings Q. That is, the dewatering machine 1 not only includes an apparatus with a dewatering function, but also includes a washing machine with a dewatering function and a washing and drying machine. Description is made in regard to the dewatering machine 1 by taking the washing machine as an example below.

[0041] The dewatering machine 1 includes: a housing 2, an outer tank 3, a dewatering tank 4, a rotary wing 5, an electric motor 6, and a transmission mechanism 7.

[0042] The housing 2 is made of, such as, metal, and formed in a box shape. An upper surface 2A of the housing 2 is formed to be inclined relative to a horizontal direction (HD) in a manner of extending to the upper side Z1 toward the rear side Y2. An opening 8 to enable the inside and outside of the housing 2 to be communicated 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 10 consisting of a LCD operation panel and the like is arranged in an area closer the front side Y1 than the opening 8 on the upper surface 2A. A user could select a dewatering condition freely, or make indications, such as an indication of starting to run, an indication of stopping running, to the dewatering machine 1, by operating the operation part 10.

[0043] The outer tank 3 is made of, such as, resin, and formed in a cylindrical shape having a bottom. The outer tank 3 has: a circumferential wall 3A, which is roughly cylindrical and configured along an inclined direction K inclined toward the front side Y1 relative to the up-down direction Z; a bottom wall 3B, configured to block a hollow part of the circumferential wall 3A from the lower side Z2; 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 Z1 of the circumferential wall 3A. The inclined direction K presents inclination not only relative to the up-down direction Z, but also relative to the horizontal direction (HD). An entrance 11 communicated with the hollow part of the circumferential wall 3A from the upper side Z1 is formed inside the annular wall 3C. The entrance 11 is opposite to the opening 8 of the housing 2 from the lower side Z2, and the entrance 11 and the opening 8 are in a communicated state. A door 12 for opening and closing the entrance 11 is arranged on the annual wall 3C. The bottom wall 3B is formed in a circulate plate shape which is orthogonal to the inclined direction K and obliquely extends relative to the horizontal direction (HD). A through hole 3D penetrating through the bottom wall 3B is formed in a circle center of the bottom wall 3B.

[0044] Water can be stored in the outer tank 3. A water feeding pipeline 13 connected with a faucet of tap water is connected with the outer tank 3 from the upper side Z1, so that the tap water is fed to the outer tank 3 through the water feeding pipeline 13. A feeding valve 14 which can be opened and closed to start or stop water feeding is arranged in a midway of the water feeding pipeline 13. A drainage pipeline 15 is connected with the outer tank 3 from the lower side Z2, and the water in the outer tank 3 is discharged outside the machine from the drainage pipeline 15. A drainage valve 16 which can be opened and closed to start or stop drainage is arranged in a midway of the drainage pipeline 15.

[0045] The dewatering tank 4 is made of, such as, metal, and has a central axis 17 extending along the inclined direction K. The dewatering tank 4 is formed in a cylindrical shape having a bottom smaller than that of the outer tank 3, and can accommodate the washings Q internally. The dewatering tank 4 has a roughly cylindrical circumferential wall 4A arranged along the inclined direction K and a bottom wall 4B for blocking a hollow part of the circumferential wall 4A from the lower side Z2.

[0046] An internal circumferential surface of the circumferential wall 4A is an internal circumferential surface of the dewatering tank 4. An upper end of the internal circumferential surface of the circumferential wall 4A is an entrance 18 for enabling the hollow part of the circumferential wall 4A to expose to the upper side Z1. The entrance 18 is opposite to the entrance 11 of the outer tank 3 from the lower side Z2, and the entrance 18 and the entrance 11 are in a communicated state. The entrances 11 and 18 are opened and closed through the door 12 together. A user of the dewatering machine 1 takes the washings Q in and out of the dewatering tank 4 through the opened opening 8 and the entrances 11 and 18.

[0047] The dewatering tank 4 is coaxially accommodated in the outer tank 3, and is obliquely arranged relative to the up-down direction Z and the horizontal direction HD. The dewatering tank 4 accommodated in the outer tank 3 can rotate around the central axis 17. A plurality of through holes which are not shown are formed in the circumferential wall 4A and the bottom wall 4B of the dewatering tank 4, and the water in the outer tank 3 can flow between the outer tank 3 and the dewatering tank 4 through the through holes. Therefore, a water level in the outer tank 3 is consistent with a water level in the dewatering tank 4.

[0048] A balancing ring 19 formed in a hollow annular shape is coaxially arranged at the upper end of the circumferential wall 4A, and is used for reducing vibration of the dewatering tank 4 when the dewatering tank 4 rotates so as to obtain rotational balance of the dewatering tank 4. Liquids for obtaining the rotational balance of the dewatering tank 4, such as saline water, are accommodated in an annular cavity 19A in the balancing ring 19 in a free flow manner.

[0049] The bottom wall 4B of the dewatering tank 4 is formed in a circulate plate shape extending with the bottom wall 3B of the outer tank 3 in parallel roughly across the gap in the upper side Z1, and a through hole 4C penetrating through the bottom wall 4B is formed at a circle center of the bottom wall 4B consistent with the central axis 17. A tubular supporting shaft 20 surrounding the through hole 4C and protruding to the lower side Z2 along the central axis 17 is arranged on the bottom wall 4B. The supporting shaft 20 is inserted into the through hole 3D on the bottom wall 3B of the outer tank 3, and a lower end of the supporting shaft 20 is located in the lower side Z2 of the bottom wall 3B.

[0050] The rotary wing 5, i.e. so-called impeller, is formed in a discoid shape by taking the central axis 17 as a circle center, and is concentrically arranged with the dewatering tank 4 along the bottom wall 4B in the dewatering tank 4. A plurality of blades 5A radially configured are arranged on an upper surface of the rotary ring 5 facing the entrance 18 of the dewatering tank 4 from the lower side Z2. A rotating shaft 21 extending toward the lower side Z2 from a circle center of the rotary wing 5 along the central axis 17 is arranged on the rotary wing 5. The rotating shaft 21 is inserted into a hollow part of the supporting shaft 20, and a lower end of the rotating shaft 21 is located in the lower side Z2 of the bottom wall 3B of the outer tank 3.

[0051] In the present embodiment, the motor 6 is realized through a variable frequency motor. The motor 6 is arranged in the lower side Z2 of the outer tank 3 in the housing 2, and is provided with an output shaft 22 rotating by centering the central axis 17. The transmission mechanism 7 is located between the lower ends of both the supporting shaft 20 and the rotating shaft 21, and an upper end of the output shaft 22. The transmission mechanism 7 selectively transmits a driving force outputted by the motor 6 from the output shaft 22 to one or both of the supporting shaft 20 and the rotating shaft 21. A widely known transmission mechanism can be taken as the transmission mechanism 7.

[0052] The dewatering tank 4 and the rotary wing 5 rotates around the central axis 17 when the driving force from the motor 6 is transmitted to the supporting shaft 20 and the rotating shaft 21. The washings Q in the dewatering tank 4 are stirred through the rotating dewatering tank 4 and the blades 5A of the rotary wing 5 during a washing operation and a rinsing operation. In addition, a centrifugal force acts on the washings Q in the dewatering tank 4 through high-speed integrated rotation of the dewatering tank 4 and the rotary wing 5 during a dewatering operation after the rinsing operation. Thus, the washings Q are dewatered. A rotation direction of the dewatering tank 4 and the rotary wing 5 is consistent with a circumferential direction X of the dewatering tank 4.

[0053] FIG. 2 is a block diagram illustrating an electric structure of the dewatering machine 1.

[0054] By referring to FIG. 2, the dewatering machine 1 includes: a control part 30 served as a dewatering preparation unit, an information value acquisition unit, a counting unit, a calculation unit, a determination unit, a stopping unit, an information correction unit, an execution unit, an acceleration unit, a duty ratio acquisition unit, a conversion unit, a threshold changing unit, a threshold correction unit and a suspending unit. The control part 30 is configured as a micro-computer including: for example, CPU 31; memory 32 such as a ROM, a RAM; a timer 33; and as a counter 34 served as the counting unit, and the control part 30 is internally placed in the housing 2 (referring to FIG. 1).

[0055] The dewatering machine 1 further includes: a water level sensor 35, a safety switch 36 as a detection unit, and a rotating speed reading apparatus 37. The water level sensor 35, the safety switch 36, the rotating speed reading apparatus 37, the motor 6, the transmission mechanism 7, the feeding valve 14, the drainage valve 16 and the operation part 10 are electrically connected with the control part 30 respectively.

[0056] The control part 30 switches a transmission target of the driving force of the motor 6 to one or both of the supporting shaft 20 and the rotating shaft 21 by controlling the transmission mechanism 7. The control part 30 controls opening and closing of the feeding valve 14 and the drainage valve 16. As mentioned above, when the user selects the dewatering condition and the like of the washings Q by operating the operating part 10, the control part 30 receives the

selection.

[0057] The water level sensor 35 is a sensor for detecting the water level of the outer tank 3 and the dewatering tank 4, and a detection result of the water level sensor 35 is inputted into the control part 30 in real time.

[0058] The safety switch 36 is a switch for detecting a vibration of the outer tank caused by an eccentric rotation of the dewatering tank 4 along with bias of the washings Q in the dewatering tank 4, and is arranged at a position away from the outer tank 3 by a specified interval along the horizontal direction HD in the housing 2 (referring to FIG. 1). When the outer tank 3 is caused to vibrate along the horizontal direction HD substantially due to the eccentric rotation of the dewatering tank 4 along with the bias of the washings Q in the dewatering tank 4, the outer tank 3 comes into contact with the safety switch 36 in forward and transverse directions. Thus, the safety switch 36 is changed into "on", so as to detect the vibration of the outer tank 3 mechanically, namely, the eccentric rotation of the dewatering tank 4. The detection result of the safety switch 36 is inputted into the control part 30 in real time.

[0059] The rotating speed reading apparatus 37 is an apparatus for reading a rotating speed of the motor 6, and more specifically, is an apparatus for reading a rotating speed of the output shaft 22 of the motor 6, and consists of for example a plurality of Hall IC40. The rotating speed read by the rotating speed reading apparatus 37 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, so that the motor 6 rotates with a desired rotating speed. On the other hand, the control part 30 applies a brake to the rotation of the motor 6 to stop the rotation of the dewatering tank 4 based on a fact that the eccentric rotation of the dewatering tank 4 is detected by the safety switch 36. The braker herein can cause a control part 30 to control the duty ratio to stop the rotation of the motor 6 urgently, and also can cause the control part 30 to start a brake device by additionally arranging the brake device (not shown), thereby stopping the rotation of the motor 6 urgently.

[0060] For example, the number of Hall IC40 is 3 in the present embodiment. The Hall IC40 are divided into a first Hall IC41, a second Hall IC42 and a third Hall IC43. Herein, the motor 6 has a rotor (not shown) integrally rotating with the output shaft 22, and magnets in a N-pole and magnets in a S-pole are arranged alternately in rows in a rotation direction of the rotor on an external circumferential surface of the rotor. If a group consisting of adjacent magnets in the N-pole and magnets in the S-pole are called as a "NS group", a plurality of NS groups are arranged along the rotation direction side by side on the external circumferential surface of the rotor. The first Hall IC41, the second Hall IC42, and the third Hall IC43 are arranged along the rotation direction of the rotor at regular intervals side by side according to such sequence. As the rotor rotates, each NS group passes through each Hall IC40 along the rotation direction in sequence. When the NS group passes through, each Hall IC40 transmits a pulse P. The rotating speed reading apparatus 37 reads the rotating speed of the motor 6 through a size of an interval of the adjacent pulses P.

[0061] FIG. 3 is a sequence diagram illustrating a state of an output signal of the Hall IC40 forming the rotating speed reading apparatus 37. In the sequence diagram of FIG. 3, a horizontal axis indicates an elapsed time, and a vertical axis indicates an "on" and "off' state of the output signal of each Hall IC. As shown in FIG. 3, there exists a deviation between times that the first Hall IC41, the second Hall IC42 and the third Hall IC43 produce the pulse P. Therefore, when a certain NS group passes through each Hall IC40 in sequence, the first Hall IC41, the second Hall IC42 and the third Hall IC43 produce the pulses P respectively according to such sequence.

[0062] An "on" state indicating a state in which the pulse P is produced and an "off' state other than the "on" state are presented in a waveform of an output signal of each Hall IC40. "Interruption W" is defined as switching from the "off' state to the "on" state and switching from the "on" state to the "off' state. The interruption W has a time at which the pulse P is produced and a time at which the pulse P is disappeared twice in one pulse P. When the interruption W occurs, the object of such situation is to input from the rotating speed reading apparatus 37 to the control part 30 in real time. It shall be noted that, the times that the rotor 1 of the motor 6 produces the interruption W during rotation are different due to number of poles of the motor 6.

[0063] As shown in FIG. 3, when there are three Hall IC40 like in the present embodiment, for example, in a period R of the first Hall IC41 from the time at which the pulse P1 disappears to a time at which the next pulse P2 is produced and then disappears, the three Hall IC40 produce six interruptions W in total. With respect to the entire three Hall IC 40, it is desired that an interval I from some interruption W to the next interruption W is always the same in a steady rotation state of the motor 6.

[0064] However, the interval I may also be disordered even if the motor 6 rotates steadily, due to an installation error of the NS group of the motor 6 and an installation error of each Hall IC40. It shall be noted that, generally, the interval I is slowly decreased when the motor 6 is in an acceleration state. The interval I can be a value which is the same as a time unit (such as second), and can also be a summing value of counts in each interval I when the counter 34 (referring to FIG. 2) counts once according to a fixed period.

[0065] Then, description is made to the dewatering operation conducted in the dewatering machine 1.

[0066] FIG. 4 is a sequence diagram illustrating a state of a rotating speed of the motor 6 in the dewatering operation process. In the sequence diagram of FIG. 4, a horizontal axis indicates the elapsed time, and a vertical axis indicates a rotating speed of the motor 6 (unit: rpm). It shall be noted that, the rotating speed of the dewatering tank 4 is the same as that of the motor 6 during the dewatering operation.

[0067] By referring to FIG. 4, at the beginning of the dewatering operation, a preparation stage, i.e., a dewatering preparation interval, of the washings Q is provided. In the dewatering preparation interval, the control part 30 adjusts a position relationship between the washings Q in the dewatering tank 4 and liquid in the balancing ring 19. After the dewatering preparation interval, the control part 30 starts the rotation of the motor 6, so as to dewater the washings Q.

[0068] Specifically, after the dewatering preparation interval, the control part 30 causes the motor 6 to rotate steadily at 120rpm after the rotating speed of the motor 6 being increased from 0rpm to 120rpm, i.e. a first rotating speed. The first rotating speed is greater than a rotating speed (such as 50rpm~60rpm) at which a transverse resonance occurred on the dewatering tank 4, and is smaller than a rotating speed (such as 200rpm~220rpm) at which a longitudinal resonance occurred on the dewatering tank 4. After the motor 6 rotates at 120rpm steadily, the control part 30 causes the motor 6 to rotate steadily at 240rpm after the rotating speed of the motor 6 being increased from 120rpm to 240rpm, i.e. a second rotating speed. The second rotating speed is slightly greater than the rotating speed at which the longitudinal resonance is occurred. Next, the control part 30 causes the motor 6 to rotate steadily at 800rpm after the rotating speed of the motor 6 being increased from 240rpm to 800rpm, i.e. a target rotating speed. The washings Q in the dewatering tank 4 are formally dewatered through the steady rotation of the motor 6 at 800rpm.

[0069] In this way, the control part 30 causes the motor 6 to accelerate through three stages i.e., a first acceleration stage of enabling the motor 6 to rotate to 120rpm from the beginning, a second acceleration stage of rotating from 120rpm to 240rpm, and a third acceleration stage of rotating from 240rpm to 800rpm, so as to reach a target 800rpm. Different from such situation, if the motor 6 is accelerated to 800rpm from 0rpm uninterruptedly, a drainage state of the drainage pipeline 15 may be deteriorated since a lot of water leaks from the washings Q, or the drainage pipeline 15 is jammed with foam. However, in the present embodiment, the motor 6 is accelerated stepwise so that a lot of water will not leak from the washings Q at one time. Therefore, such bad condition can be prevented.

[0070] When the washings Q in the dewatering tank 4 are in a bias configuration state of being distributed on the circumferential direction X (referring to FIG. 1) of the dewatering tank 4 unevenly, the washings Q are biased in the dewatering tank 4. If the dewatering operation is carried out in such state, the dewatering tank 4 may be substantially shaken due to the eccentric rotation thereof, thereby applying great vibration to the dewatering machine 1, producing noise.

[0071] Therefore, the control part 30 detects whether the washings Q in the dewatering tank 4 are biased during the dewatering operation, and stops the motor 6 when detecting that the washings Q are biased. The control part 30 performs four electric detections, i.e. detection 1, detection 2, detection 3 and detection 4, in such detection mode. It shall be noted that, the mechanical detection of the safety switch 36 (referring to FIG. 1) is performed in the whole period of the dewatering operation. It shall be noted that, the term "detection" below refers to an action of inspecting, and the term "check" refers to an action of finding some result during the detection.

[0072] Detection 1 is performed at the first acceleration stage. Detection 2 is performed at the second acceleration stage. Detection 3 and detection 4 are performed at the third acceleration stage. Specifically, detection 1 to detection 3 are performed in the whole period of the corresponding acceleration stages in the first acceleration stage to the third acceleration stage, and relative to this, detection 4 is performed in a midway of the third acceleration stage. In this way, the motor 6 is accelerated in three stages in the dewatering machine 1, thereby monitoring a rotation state of the dewatering tank 4 through detections 1-4 while avoiding performing the dewatering slowly at the rotating speeds at which the transverse resonance and the longitudinal resonance occurred, namely, 120rpm and 240rpm. Description is made to the dewatering preparation stage and detections 1-4 in sequence below.

[0073] Firstly, description is made to the dewatering preparation stage. FIG. 5 is a schematic diagram illustrating an interior of the dewatering tank 4. FIG. 5 shows an interior of the dewatering tank 4 viewed along a direction of the central axis 17 of the dewatering tank 4. A front position biasing toward the front side Y1 and a deep position biasing toward the rear side Y2 are presented in the dewatering tank 4. Since the central axis 17 is arranged obliquely towards the front side Y1 relative to the up-down direction Z, the front position is located at a position closer to the lower side Z1 than the deep position (referring to FIG. 1). Since the liquid accommodated in the balancing ring 19 is free of the effect of the centrifugal force generated by the rotation of the dewatering tank 4 in a state that the dewatering tank 4 is static and that the dewatering tank 4 rotates at a very low speed, the liquid accommodated in the balancing ring 19 is provided at the front position in the balancing ring 19 due to a self-weight and biased towards the lower side Z2.

[0074] In the case that the washings Q are placed in the dewatering tank 4 in a manner of being biased along the circumferential direction X, when the dewatering tank 4 starts to rotate, relative to the central axis 17, the washings Q are preferably located at the deep position at a side opposite to the liquid biased to the front position in the lower side Z2 in the balancing ring 19. If the washings Q are in such state, the eccentric rotation of the dewatering tank 4 can be inhibited from the beginning of the rotation since the dewatering tank 4 starts to rotate in a state that the washings Q and the liquid in the balancing ring 19 are roughly balanced.

[0075] In contrast, it is assumed that, in the dewatering tank 4, the washings Q are biased in the circumferential direction X of the dewatering tank 4 at a position same as the position where the liquid in the balancing ring 19 is biased towards the lower side Z2. In the state, when the dewatering tank 4 starts to rotate to dewater the washings Q, the

dewatering tank 4 carries out the eccentric rotation when starting to rotate.

[0076] FIG. 6 is a sequence diagram illustrating a state of the rotating speed of the motor 6 at the preparation stage of dewatering operation. In the sequence diagram of FIG. 6, a horizontal axis indicates the elapsed time, and a vertical axis indicates the rotating speed of the motor 6 (unit: rpm). The dewatering tank 4 rotates steadily at a very low speed at the preparation stage. It shall be noted that, the rotating speed of the motor 6 at this time is lower than a minimum rotating speed when a resonance occurred on the dewatering tank 4. The minimum rotating speed is different due to different sizes of the dewatering tank 4, and is a rotating speed when the transverse resonance occurred on the dewatering tank 4 in the present embodiment, namely, 50rpm-60rpm described above. In this case, for example, the rotating speed of the motor 6 at the preparation stage is 10rpm-30rpm, preferably 20rpm.

[0077] If the dewatering tank 4 rotates steadily at the very low speed when the washings Q are placed in the dewatering tank 4 in a manner of being biased in the circumferential direction X, the rotating speed of the motor 6 is changed like that shown in FIG. 6. Specifically, the washings Q are moved toward the upper side Z1 when going to the deep position from the front position, which causes a burden to the motor 6. Therefore, the rotating speed of the motor 6 is reduced. On the contrary, the rotating speed of the motor 6 is increased due to the reduction of the previous burden when the washings Q are moved to the front position from the deep position. Therefore, it can be known that, the washings Q are located at the front position when the rotating speed of the motor 6 is maximum, and the washings Q are located at the deep position when the rotating speed of the motor 6 is minimum. In this way, since the dewatering tank 4 rotates at very low speed, a biased position of the washings Q in the dewatering tank 4 in the circumferential direction X can be detected according to the rotating speed of the motor 6.

[0078] FIG. 7 is a flow chart illustrating a control action at the preparation stage of dewatering operation.

[0079] According to the above contents, the control part 30 causes the motor 6 to start to rotate at very low speed at the dewatering preparation stage, so that the dewatering tank 4 rotates at very low speed (step S1). It shall be noted that, prior to the dewatering operation, if the water in the outer tank 3 and the dewatering tank 4 is discharged after the washings Q are rinsed, the motor 6 starts to rotate at the very speed in step S1 according to a current station that the discharging is finished. When the motor 6 rotates at the very low speed, the control part 30 detects the biased position of the washings Q in the dewatering tank 4 in real time according to an output result from the rotating speed reading apparatus 37 (step S2). Next, the control part 30 brakes the motor to stop the rotation of dewatering tank 4 immediately before the washings Q reach at the deep position according to the detected biased position (step S3).

[0080] If the rotation of the dewatering tank 4 is stopped when the washings Q biased in the dewatering tank 4 are located at a side opposite to the liquid in the balancing ring 19 relative to the central axis 17, the washings Q will finally arrive at a side same as that of the liquid in the balancing ring 19 because the rotation might not be stopped timely or the dewatering tank 4 might rotate again due to inertia when the brake is relieved after the dewatering tank 4 is stopped.

[0081] In view of this, the control part 30 causes the dewatering tank 4 to stop rotating immediately before the washings Q biased in the dewatering tank 4 is located at a side opposite to, relative to the central axis 17, the liquid biased towards the lower side Z2 in the balancing ring 19. Therefore, after the dewatering tank 4 is stopped, the washings Q biased in the dewatering tank 4 and the liquid biased towards the lower side Z2 in the balancing ring 19 are maintained at a state of being located at roughly opposite sides relative to the central axis 17. In addition, since the dewatering tank 4 is supported through a one-way bearing in a unidirectional rotation manner, the stopped dewatering tank 4 does not reverse, and is in a static state. After such preparation stage, when the dewatering tank 4 rotates to dewater, the dewatering tank 4 rotates in a state that the liquid in the balancing ring 19 and the washings Q are roughly balanced. Thus, the eccentric rotation of the biased dewatering tank 4 can be inhibited early.

[0082] Next, description is made to the first acceleration stage after subjecting to the dewatering preparation interval. It shall be noted that, since the liquid in the balancing ring 19 is not biased toward the lower side Z2 due to an effect of the centrifugal force after the first acceleration stage, the liquid substantively does not cause the eccentric rotation of the dewatering tank 4.

[0083] FIG. 8 is a flow chart illustrating a control action in the first acceleration stage. By referring to FIG. 8, after the dewatering preparation interval, the control part 30 causes the motor 6 to accelerate to reach a target rotating speed (i.e.,120rpm) so as to start the dewatering operation (step S11). Once the above interruption W is inputted ("yes" in step S12), the control part 30 enables a count value n with an initial value "zero" to add by 1 (+1) (step S13). Then, the control part 30 starts detection 1 in the first acceleration stage (step S14). When detection 1 is "OK" ("yes" in step S15), that is, under a condition that the control part 30 determines that the washings Q are not biased, the control part 30 resets the count value n to zero (step S17) if detection 1 is ended ("yes" in step S16). Then, when the rotating speed of the motor 6 reaches 120rpm ("yes" in step S18), the control part 30 causes the motor 6 to rotate steadily at 120rpm (step S19).

[0084] FIG. 9A and FIG. 9B are flow charts illustrating a control action regarding detection 1. By referring to FIG. 9A, the control part 30 starts detection 1 in the above step S14, and once the interruption W is inputted ("yes" in step S21), a timing value An is obtained (step S22). The timing value An is referred to as An below. An is the interval I between the inputted interruption W and the previous interruption W (referring to FIG. 3) and is a positive value measured by the timer 33. Under a condition that there does not exist a previous interruption W, the interval I from a start time of detection

1 to the initial interruption W is An. It shall be noted that, when the interruption W is inputted, since the count value n is added by 1 (step S13) while An is obtained, a suffix "n" in the An is consistent with the count value n added by 1. Therefore, for example, when the initial interruption W is inputted, the count value n becomes 1, and An becomes A_1. When a next interruption W is inputted, the count value n becomes 2, and An becomes A_2.

[0085] Next, the control part 30 calculates a moving average value B_n of An (step S23). Hereinafter, the moving average value B_n is sometimes referred to as B_n. B_n is a value obtained by dividing a summing value of An and previous A_{n-1}~A_{n-5} by 6. Herein, 6 is divided so as to be in combination with the situation that there exists six interruptions W during the period R from the time that the pulse P disappears to the time that the next pulse P is produced and then disappears (referring to FIG. 3).

[0086] Next, the control part 30 calculates a moving average value C_n of B_n (step S24). Hereinafter, the moving average value C_n is sometimes referred to as C_n. C_n is a value obtained by dividing a summing value of B_n and previous B_{n-1}~B_{n-5} by 6.

[0087] In an acceleration state of the motor 6 for accelerating to the target rotating speed, the control part 30 enables the count value n to be added by 1 in step S13 (referring to FIG. 8) once the interruption W is inputted, and obtains C_n successively in step S24. Therefore, in fact, the operation for adding the count value n by 1 and the operation for obtaining C_n are conducted simultaneously. That is, the control part 30 enables the count value n to be added by 1 every time C_n is obtained.

[0088] According to experiences, the obtained A_n~C_n are not stable until the count value n reaches a specified starting value ("no" in step S25), and the count value n is inapplicable to detection 1. The starting value refers to, such as, 75, in the present embodiment. When the count value n reaches the starting value ("yes" in step S25), the control part 30 calculates a difference D_n obtained by subtracting the previous C_{n-1} from C_n (step S26). Then, the control part 30 calculates a moving average value E_n of the difference D_n (step S27). The moving average value E_n is a value obtained by dividing a summing value of the difference D_n and previous differences D_{n-1}~D_{n-5} by 6. Hereinafter, the difference D_n is referred to as D_n, and the moving average value E_n is referred to as E_n.

[0089] With respect to respective meanings of D_n and E_n, description is made by taking C_{11} (= $(B_6+B_7+B_8+B_9+B_{10}+B_{11})/6$) and C_{17} (= $(B_{12}+B_{13}+B_{14}+B_{15}+B_{16}+B_{17})/6$) as an example. E_{17}, the count value n of which is consistent with that of C_{17}, is a value obtained by dividing D_{12}~D_{17} by 6. E_{17} may be expressed with C_n as shown in the following formula (1), and may be expressed with B_n as shown in the following formula (2).

$$E_{17}=(D_{12}+D_{13}+D_{14}+D_{15}+D_{16}+D_{17})/6$$
$$=(C_{12}-C_{11}+C_{13}-C_{12}+C_{14}-C_{13}+C_{15}-C_{14}+C_{16}-C_{15}+C_{17}-C_{16})/6$$
$$=(C17-C11)/6 \quad \ldots \qquad \text{Formula (1)}$$

$$E_{17}=((B_{12}+B_{13}+B_{14}+B_{15}+B_{16}+B_{17})-(B_6+B_7+B_8+B_9+B_{10}+B_{11}))/36 \quad \ldots \text{Formula (2)}$$

[0090] As mentioned above, with respect to the total three Hall IC40, there exists six interruptions W during the period R of one Hall IC40 from the time at which a pulse P disappears to the time at which the next pulse P is produced and then disappears (referring to FIG. 3). The installation error of the Hall IC40 can be eliminated through B_n. Moreover, according to Formula (2), E_n is equivalent to a difference of a summing value of B_n~B_{n+5} related to six interruptions W produced when a certain NS group passes one Hall IC40 and a summing value of B_{n+6}~B_{n+11} related to six interruptions W produced when a next NS group passes the Hall IC40. An error due to a relevant position of the adjacent NS groups can be roughly eliminated through E_n calculated with multiple B_n.

[0091] FIG. 10 is a diagram illustrating a relationship between a count value n and C_n, where a horizontal axis indicates the count value n, and a vertical axis indicates C_n. By referring to FIG. 10, although An decreases with a rotating speed increase caused by the acceleration of the motor 6, the change of An is disordered due to the installation error of the NS group and the installation error of each Hall IC40. The actual An increases and decreases as shown by the dotted line. B_n is obtained through the moving average in S23 with the installation error of each Hall IC40 being eliminated, and C_n is obtained through the moving average in S24 with the noise of Bn being eliminated. Then, D_n is obtained through C_n, and E_n is obtained through D_n. An, B_n, C_n, D_n and E_n are relevant information values regarding the rotation state of the motor 6.

[0092] In the case that the dewatering tank 4 does not rotate eccentrically because the washings Q are not biased, C_n should decrease with the increase of the rotating speed of the motor 6 (referring to an arrow in a dot and dash line), as shown by a solid line in FIG. 10. In addition, since the moving average value of An is B_n and the moving average value of B_n is C_n, An and B_n should also decreas with the increase of the rotating speed of the motor 6 although both

of An and B_n have noise respectively.

[0093] In the case that the dewatering tank 4 does not rotate eccentrically, since C_n always decreases in the acceleration process of the motor 6, the difference D_n obtained by subtracting the previous C_{n-1} from C_n becomes not greater than zero, and the moving average value E_n of D_n also becomes not greater than zero. By referring to FIG. 9B, if E_n is not greater than zero ("yes" in step S28), the control part 30 enables a variable F_n to be zero (step S29). On the other hand, in the case that the dewatering tank 4 rotates eccentrically because the washings Q in the dewatering tank 4 are biased, C_n which should decrease may be changed and increase with the increase of the rotating speed of the motor 6. In this case, D_n and E_n at a time, at which C_n increased, become greater than zero ("no" in step S28), and the control part 30 sets the variable F_n as E_n per se (step S30).

[0094] The control part 30 calculates an accumulated value G ($=F_1+F_2+...$) of F_n once F_n is obtained (step S31). The accumulated value G is also an accumulated value of the moving average value E_n of the difference D_n between C_n and C_{n-1} in the case that C_n is greater than the previous C_{n-1}.

[0095] FIG. 11 is a diagram illustrating a relationship between the count value n and the accumulated value G, where a horizontal axis indicates the count value n, and a vertical axis indicates the accumulated value G. In the case that the motor 6 accelerates while the dewatering tank 4 eccentrically rotates continuously, the accumulated value G increases stepwise, as shown in FIG. 11. With respect to the accumulated value G, first thresholds are determined according to each specified count value n. The first thresholds are correlated with the count value n and stored in the memory 32 (referring to FIG. 2). The first thresholds are positive values.

[0096] Returning to FIG. 9B, when the accumulated value G for count value n with a specified value reaches a first threshold for count value n with the specified value ("yes" in step S32), the control part 30 sets the detection result as NG, and determines that the dewatering tank 4 is largely eccentric and the washings Q are biased (step S33).

[0097] On the other hand, if the accumulated value G is less than the corresponding first threshold ("no" in step S32), the control part 30 sets the detection result as OK, and determines that the washings Q are not biased (step S34). Then, the control part 30 carries out steps S21~S34 repeatedly, until the count value n becomes an end value indicating that the first acceleration stage is ended ("no" in step S35). The end value of the count value n in the present embodiment is, for example, 245. When the count value n becomes the end value ("yes" in step S35), detection 1 is ended by the control part 30 (step S36). The processes of steps S21~S34 are equivalent to the process of the above step S15, and the processes of steps S35~S36 are equivalent to the process of the above step S16 (referring to FIG. 8).

[0098] FIG. 12 is a flow chart illustrating a control action in the case that the detection result is NG. By referring to FIG. 12, the control part 30 causes the motor 6 to stop rotating (step S41), i.e. causes the dewatering tank 4 to stop rotating, when the detection result is determined as NG. Thus, in the case that the washings Q in the dewatering tank 4 are biased, the eccentric rotation of the dewatering tank 4 can be inhibited early when the motor 6 is in the acceleration state.

[0099] Especially, prior to calculating the accumulated value G, the control part 30 first corrects a calculation basis (i.e., An) of the accumulated value G through performing the moving average in step S23 and step S24 repeatedly. Therefore, C_n obtained as a correction result becomes a high precision value with the error being eliminated. Therefore, an accumulated value G with high precision is calculated according to C_n, the precision of which is improved through the correction, and the bias of the washings Q is detected with high precision through the accumulated value G, thus the eccentric rotation of the dewatering tank 4 can be inhibited early.

[0100] After the dewatering tank 4 stops rotating, the control part 30 determines whether the current state is a state before the dewatering operation is restarted (step S42). Restarting of the dewatering operation refers to a restarting process, through which the control part 30 starts the dewatering operation again by enabling the dewatering tank 4 to rotate again immediately after the dewatering tank 4 is caused to stop rotating to suspend the dewatering operation. Sometimes, the restarting process may also be conducted even if the biasing of the washings Q is small.

[0101] Before the restarting of the restarting process is implemented ("yes" in step S42), the control part 30 performs the restarting process (step S43). It shall be noted that, prior to the restarting process, a drainage can be first conducted in the outer tank 3. In the case that the drainage pipeline 15 is jammed with foams, the foams can be discharged outside of the drainage pipeline 15 through the drainage herein, and thus, the situation that the drainage pipeline 15 is jammed with the foams can be eliminated.

[0102] If it is not a state before restarting ("no" in step S42), the control part 30 performs a correction process (step S44). In the correction process, the control part 30 closes the drainage valve 16 and opens the feeding valve 14 so as to feed water into the dewatering tank 4 to a specified water level, so that the washings Q in the dewatering tank 4 are immerged into water and are easy to loosen. In this state, the control part 30 causes the washings Q attached to the internal circumferential surface of the dewatering tank 4 to peel off and stir by causing the dewatering tank 4 and the rotary wing 5 to rotate, thereby correcting the biasing of the washings Q in the dewatering tank 4.

[0103] In this way, the control part 30 performs either the restarting process or the correction process alternatively in the case that the dewatering tank 4 has stopped rotating. If the biasing of the washings Q is small enough so that the dewatering tank 4 does not rotate eccentrically, the dewatering is started again through the restarting process. Therefore,

a time required in the whole dewatering process can be shortened as far as possible. If the biasing of the washings Q is large enough so that the dewatering tank 4 rotates eccentrically again in the next dewatering process, the biasing of the washings Q can be reliably corrected through the correction process.

[0104] After performing the restarting process for a specified number (which is 1 herein) and enabling the dewatering tank 4 to stop rotating ("no" in step S42), the control part 30 selects to not perform the restarting process and selects to perform the correction process (step S44). That is, in the case that the restarting process has been performed for the specified number and the dewatering tank 4 has stopped rotating, the biasing of the washings Q is large and needs to be corrected. In this case, the correction process is quickly performed rather than spending time on the restarting process and stopping the rotation of the dewatering tank 4. Therefore, the biasing is corrected reliably. Therefore, the eccentric rotation of the dewatering tank 4 can be inhibited early. It shall be noted that, in the present embodiment, although the specified time is set as 1, it can also be set as more than 2.

[0105] Then, description is made to the second acceleration stage after the steady rotation at 120rpm. FIG. 13 is a flow chart illustrating a control action in the third acceleration stage. By referring to FIG. 13, the control part 30 causes the motor 6 to accelerate to a target rotation speed of 240rpm at the second acceleration stage (step S51). The control part 30 enables the count value n to add by 1 (step S53) once the interruption W is inputted ("yes" in step S52). It shall be noted that, the count value n at the beginning of the second acceleration stage is zero.

[0106] Next, in the second acceleration stage, the control part 30 starts detection 2 (step S54). In the case that detection 2 is OK ("yes" in step S55), that is, in the case that the control part 30 determines that the washings Q are not biased in the second acceleration stage, the control part 30 resets the count value n to zero (step S57) at the end of detection 2 ("yes" in step S56). Then, when the rotating speed of the motor 6 reaches 240rpm ("yes" in step S58), the control part 30 causes the motor 6 to rotate steadily at 240rpm (step S59).

[0107] The content of detection 2 is the same as that of detection 1. Therefore, the processes of above steps S21~S34 are equivalent to the process of step S55, and the processes of step S35 and S36 are equivalent to the process of step S56 (referring to FIG. 9B). The first threshold in detection 2 is set as to be different from that in detection 1. In addition, with respect to detection 2, since the rotating speed of the motor 6 is higher than that in detection 1, the starting value in step S25 (referring to FIG. 9A) is accordingly less than the starting value in detection 1, which is, for example, 17 in the present embodiment. In the case that the detection result of detection 2 is NG ("no" in step S55), that is, in the case that the control part 30 determines that the washings Q in the dewatering tank 4 are biased, the control part 30 performs the processes of steps S41~S44 as it did in detection 1 (referring to FIG. 12).

[0108] It shall be noted that, with respect to the dewatering operation under the restarting process after detection 2, the duration of the steady rotation at 120rpm (referring to FIG. 4) can be shortened to be shorter than the duration of the steady rotation at 120rpm of the previous dewatering operation which is stopped. With respect to the restarting process, since the washings Q are attached to the internal circumferential surface of the dewatering tank 4 to a certain extent and in a state of roughly being dewatered, the duration of the steady rotation at 120rpm can be shortened. Thus, the time of the dewatering operation can be shortened.

[0109] Next, description is made to the third acceleration stage after the steady rotation at 240rpm. FIG. 14 is a flow chart illustrating a control action in the third acceleration stage. By referring to FIG. 14, the control part 30 causes the motor 6 to accelerate to a target rotating speed 800rpm in the third acceleration stage (step S61). The control part 30 enables the count value n to be added by 1 (step S63) once the interruption W is inputted ("yes" in step S62). In addition, the count value n at the beginning of the third acceleration stage is zero.

[0110] In the third acceleration stage, the control part 30 starts detection 3 (step S64). Next, in the case that detection 3 is OK ("yes" in step S65), that is, in the case that the control part 30 determines that the washings Q are not biased, the control part 30 stops detection 3 when the rotating speed of the motor 6 reaches 800rpm ("yes" in step S66), and resets the count value n as zero, so that the motor 6 rotates steadily at 800rpm to continue to dewater (step S67).

[0111] The content of detection 3 is substantively the same as those of detections 1 and 2. Therefore, the processes of the above steps S21~S34 are equivalent to the process of step S65 (referring to FIG. 9A and FIG. 9B). The first threshold in detection 3 is set as to be different from those of detections 1 and 2 respectively. It shall be noted that, the starting value in step S25 (referring to FIG. 9A) in detection 3 is the same as that in detection 2. In the case that the detection result of detection 3 is NG ("no" in step S65), that is, in the case that the control part 30 determines that the washings Q in the dewatering tank 4 are biased, the control part 30 also performs the processes of steps S41~S44 as it does in detections 1 and 2 (referring to FIG. 12).

[0112] It shall be noted that, with respect to dewatering operation under the restarting process after detection 3, as described regarding detection 2, the duration of the steady rotation at 120rpm may be shortened to be shorter than the duration of the steady rotation at 120rpm of the previous dewatering operation which is stopped. Moreover, the difference between detection 3 and detections 1, 2 lies in: after n becomes the end value in step S35 (referring to FIG. 9B), the processes in step S21~step S34 may also be repeated during the period that the rotating speed of the motor 6 reaches 800rpm. At the beginning of repeating such processes, respective values of n and A_n~G are reset to zero.

[0113] As described above, in detection 1 of the first acceleration stage, detection 2 of the second acceleration stage

and detection 3 of the third acceleration stage, the control part 30 acquires information values of A_n~E_n and the like respectively, enables the count value to be added by 1 so as to calculate the accumulated value G. When the accumulated value G reaches a corresponding first threshold, the control part 30 determines that the washings Q are biased in the dewatering tank 4 and causes the dewatering tank 4 to stop rotating. That is, since the detection of the biasing of the washings Q begins in the first acceleration stage after the motor 6 starts to rotate, eccentric rotation of the dewatering tank 4 may be inhibited early. Moreover, since the detection of the biasing of the washings Q is carried out in three stages in a sequence of the first acceleration stage, the second acceleration stage, and the third acceleration stage, the biasing of the washings Q can be reliably detected, so that eccentric rotation of the dewatering tank 4 may be inhibited as early as possible.

[0114] In detection 3, the control part 30 executes detection in a first mode. As described above, In the detection in the first mode, the biasing of the washings Q in the dewatering tank 4 is detected according to whether the accumulated value G reaches the first threshold. The control part 30 may also execute a detection in a second mode rather than executing the detection in the first mode. In the detection in the second mode, the biasing of the washings Q is detected according to whether a variation of the accumulated value G reaches a third threshold. Different from the first threshold, the third threshold is preset and stored in the memory 32 (referring to FIG. 2). The third threshold is a positive value. Like in the third acceleration stage, when the rotating speed of the motor 6 rises to a certain extent, for example, 400rpm, an eccentric state of the washings Q in the dewatering tank 4 may be deteriorated because water of the washings Q is removed due to previous dewatering. As a result, the vibration of the dewatering tank 4 becomes larger. On the other hand, as the characteristics of the accumulated value G, although the accumulated value G sharply increases when the rotating speed of the motor 6 is low, the accumulated value G increases slowly as the rotating speed approaches the target rotating speed.

[0115] Thus, merely for the detection in the first mode, when the rotating speed rises to some extent, the accumulated value G may be lower than the first threshold no matter whether the vibration of the dewatering tank 4 is large or small, so that the dewatering tank 4 fails to stop rotating. Accordingly, both of the detections in the first mode and the second mode may be executed. As for the detection in the second mode, when the variation of the accumulated value G, i.e., a variation degree of the accumulated value G, reaches the third threshold, the control part 30 determines that the washings Q are biased and causes the dewatering tank 4 to stop rotating. Thus, the accumulated value G may always be small and fails to reach the first threshold no matter whether the dewatering tank 4 is in a state of large amplitude vibration, and with such situation, state variation of the washings Q during dewatering may also be sensitively reflected by focusing on the variation of the accumulated value G. Therefore, the eccentric rotation of the dewatering tank 4 can be reliably inhibited early. Certainly, the detection in the second mode not only can be executed in detection 3, but also can be executed in detection 1 and detection 2.

[0116] Next, description is made to detection 4 which is executed in parallel with the detection 3 in the third acceleration stage. Detection 4 consists of detection 4-1 and detection 4-2. Detections 1-3 are detections for detecting the biasing of the washings Q by using interruption W related to the motor 6 in an acceleration state. Relative to this, detection 4-1 and detection 4-2 are detections for detecting the biasing of washings Q by using the duty ratio. FIG. 15 is a flow chart illustrating schemas of detection 4-1 and detection 4-2.

[0117] Referring to FIG. 15, as the third acceleration stage, the control part 30 causes the motor 6 to accelerate from 240rpm to 800rpm in step S61 (referring to FIG. 14).

[0118] In a state that the motor 6 is accelerated, when the rotating speed of the motor 6 reaches 300rpm, the control part 30 acquires a duty ratio of the voltage applied to the motor 6 at this moment as α value (step S71). The rotating speed 300rpm does not refer to a rotating speed in a state that water is stored in the dewatering tank 4, but refers to a rotating speed which is not influenced by eccentricity of the dewatering tank 4 most. Thus, the α value at 300rpm is the duty ratio in a state that it is not influenced by eccentricity of the dewatering tank 4 most, but only is influenced by a load of the washings Q.

[0119] Moreover, in a state that the motor 6 continues to accelerate, during a period in which the rotating speed rises from 600rmp to 729rpm, the control part 30 implements detection 4-1 (step S72). Under a condition that detection 4-1 is not OK ("no" in step S72), that is, under a condition that the control part 30 determines that the washings Q are biased, the control part 30 executes the processes in step S41~step S44 as it does in detections 1-3 (referring to FIG. 12). It shall be noted that, as described in detection 2 and detection 3, with respect to the dewatering operation in the restarting process after detection 4-1, the duration of the steady rotation at 120rpm may be shortened to be shorter than the duration of the steady rotation at 120rpm of the previous dewatering operation which is stopped.

[0120] On the other hand, under a condition that detection 4-1 is OK ("yes" in step S72), that is, under a condition that the control part 30 determines in detection 4-1 that the washings Q are not biased, the control part 30 continues to implement detection 4-2 in a state that the motor 6 continues to accelerate from 730rpm (step S77).

[0121] Under a condition that detection 4-2 is OK ("yes" in step S77), that is, under a condition that the control part 30 determines in detection 4-2 that the washings Q are not biased, the control part 30 causes the motor 6 to stably rotate at 800rpm after accelerating the motor 6 to the target rotating speed of 800rpm, so as to cause the washings Q to be

dewatered continuously (step S78).

[0122] On the other hand, under a condition that detection 4-2 is not OK ("no" in step S77), that is, under a condition that the control part 30 determines that the washings Q are biased, the control part 30 causes the motor 6 to stably rotate at a rotating speed less than 800rpm, so as to cause the washings Q to be dewatered continuously (step S79).

[0123] Next, detection 4-1 and detection 4-2 are described in detail respectively.

[0124] FIG. 16 is a flow chart illustrating a control action with respect to detection 4-1. Referring to FIG. 16, in the state that the motor 6 continues to accelerate after step S71 (referring to FIG. 15), the control part 30 starts to carry out detection 4-1 (step S80) as the rotating speed of the motor 6 reaches 600rpm.

[0125] Next, the control part 30 starts to count through the counter 34 (step S81), and initializes the counter 34 every 0.3s so as to count within 0.3s (step S82 and step S83).

[0126] The control part 30 acquires the rotating speed of the motor 6 at the time of each counting and a duty ratio d_m(m: a count value) of the voltage applied to the motor 6 at the time of counting (step S84). That is, the control part 30 acquires the rotating speed and the duty ratio d_m of the motor 6 at specified moment in the third acceleration stage in which the rotating speed of the motor 6 rises from 240rpm to 800rpm. The duty ratio d_m is an information value related to the rotation state of the motor 6.

[0127] Moreover, in step S84, the control part 30 calculates a correction value B_m according to the following formula (3), where B_m is obtained by correcting the duty ratio d_m with the α value. It shall be noted that X and Y in the formula (3) are constants solved through experiments and the like. Different from simple ratio calculation, a weight is changed through the formula (3), so that the duty ratio d_m is corrected, and detection 4-1 may be executed with good accuracy through the obtained correction value B_m.

$$B_m=d_m-(\alpha\times X+Y)\ldots \quad \text{formula (3)}$$

[0128] Moreover, in step S84, the control part 30 calculates a moving accumulated value C_m (m: count value) of the correction value B_m. The moving accumulated value C_m is a value obtained by summing 5 consecutive correction values B_m in a counting sequence. Additionally, as for a certain moving accumulated value C_m and a moving accumulated value C_{m-1} previous to C_m, the last 4 correction values B_m among the 5 correction values B_m for forming the moving accumulated value C_{m-1} and the front 4 correction values B_m among the 5 correction values B_m for forming the moving accumulated value C_m are same values respectively. It shall be noted that the number of the correction values B_m for forming the moving accumulated value C_m is not limited to 5. The moving accumulated value C_m is a specified index value transformed from the duty ratio d_m by the control part 30.

[0129] Next, the control part 30 calculates a second threshold (step S85) related to the moving accumulated value C_m according to the following formula (4). The second threshold is a positive value.

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

a and b in the formula (4) are constants solved through experiments and the like and stored in the memory 32. Moreover, the constants a, b are different depending on the rotating speed of the motor 6 at the current moment and a selected dewatering condition. Thus, as for the second threshold herein, multiple values exist at the same rotating speed. It shall be noted that the second threshold is a value not influenced by the α value, and this case is further defined through the formula (4).

[0130] Then, the control part 30 confirms whether the rotating speed of the motor 6 at the current moment is less than 730rpm (step S86).

[0131] Under a condition that the rotating speed of the motor 6 at the current moment is less than 730rpm ("yes" in step S86),the control part 30 determines whether a newest moving accumulated value C_m falls in the range of detection 4-1 (step S87).

[0132] FIG. 17 is a diagram illustrating a relationship between the rotating speed and the moving accumulated value C_m in combination with detection 4-1 and detection 4-2. In FIG. 17, a horizontal axis represents the rotating speed (unit: rpm), and a longitudinal axis represents the moving accumulated value C_m. Referring to FIG. 17, the second thresholds calculated in step S85 are set to be two thresholds including an upper second threshold represented by a dot dash line and a lower second threshold represented by a double dot dash line. The upper second threshold is higher than the lower second threshold. The upper second threshold and the lower second threshold vary along with the rotating speed.

[0133] As for the dewatering conditions, there exists the following three dewatering conditions: carrying out the dewatering operation after "water storage rinsing" of rinsing the washings Q with the water stored in the dewatering tank 4; "water splashing and dewatering" of carrying out the dewatering operation by draining water when splashing the water

to the washings Q; the above "restarting process", etc. The dewatering conditions are selected by the user through operating the operation part 10, and the selection is received by the control part 30. In the dewatering operation after washing operation and water storage rinsing, of the motor 6 is hard to accelerate since the washings Q contain a great quantity of water, while under the condition of water splashing and dewatering and the restarting process, acceleration of the motor 6 may be realized with very tiny force because the water is removed from the washings Q to some extent.

[0134] In the dewatering operation after the washing operation and water storage rinsing, the control part 30 uses the upper second threshold higher than the lower second threshold because it is difficult to execute detection with the lower second threshold. On the other hand, in the dewatering operation after water splashing and dewatering and the restarting process, the control part 30 uses the lower second threshold lower than the upper second threshold because the detection is not accurate if the upper second threshold is used. Thus, under either the condition that the washings Q contain a great quantity of water or under the condition that the water of the washings Q are removed to some extent, detection 4-1 is executed with the second threshold suitable for the respective conditions.

[0135] Moreover, based on the objective same as a difference between such dewatering conditions, under the condition that the load of the washings Q in the dewatering tank 4 is large, the control part 30 uses the upper second threshold higher than the lower second threshold in detection 4-1 because it is difficult to execute the detection with the lower second threshold. Moreover, under the condition that the load of the washings Q in the dewatering tank 4 is small, the control part 30 uses the lower second threshold lower than the upper second threshold in detection 4-1 because the detection is not accurate if the upper second threshold is used. Thus, detection 4-1 is executed with the second threshold suitable for different loads of the washings Q respectively.

[0136] It shall be noted that in FIG, 17, although the two second thresholds including the upper second threshold and the lower second threshold are illustrated, more than 3 second thresholds may also be set according to various dewatering conditions and the loads.

[0137] Moreover, compared with the condition that the washings Q are not biased due to smaller eccentricity (referring to a solid line in FIG. 17), under the condition that the washings Q are biased due to larger eccentricity (referring to the dotted lines in FIG. 17), the moving accumulated value C_m at each rotating speed is larger. If the washings Q are greatly biased, the moving accumulated value C_m is larger than the set second threshold, i.e. a corresponding one of the upper second threshold and the lower second threshold.

[0138] Returning to FIG. 16, when the newest moving accumulated value C_m reaches the second threshold for a corresponding moment, the control part 30 determines that the washings Q are biased in the dewatering tank 4 and the moving accumulated value C_m falls in the range of detection 4-1 ("yes" in step S87).

[0139] When the control part 30 determines that the moving accumulated value C_m falls in the range of detection 4-1 ("yes" in step S87), the processes in steps S41~S44 will be executed (referring to FIG. 12). The processes in steps S80~S87 are included in the above step S72 (referring to FIG. 15).

[0140] Next, if it is determined in detection 4-1 that the washings Q are not biased, the control part 30 ends detection 4-1 and then starts detection 4-2 (step S88) when the rotating speed of the motor 6 reaches 730rpm ("no" in step S86).

[0141] FIG. 18 is a flow chart illustrating a control action regarding detection 4-2. Referring to FIG. 18, in the case that the motor 6 continues to accelerate, the control part 30 starts detection 4-2 (step S88) as the rotating speed of the motor 6 reaches 730rpm.

[0142] Next, the control part 30 starts to count through the counter 34 (step S89), and initializes the counter 34 per 0.3s so as to carry out counting within each 0.3s (steps S90~S91).

[0143] Similar to step S84 in detection 4-1, upon each counting, the control part 30 acquires the rotating speed of the motor 6 at the time of each counting and the duty ratio d_m of the voltage applied to the motor 6 at the time of counting, and calculates the correction value B_m and the moving accumulated value C_m (step S92).

[0144] Next, the control part 30 calculates the second threshold (step S93) related to the moving accumulated value C_m according to the formula (4). The constants "a", "b" included in the formula are same as those used in detection 4-1, and are different depending on the rotating speed of the motor 6 at the current moment and the selected dewatering condition. Therefore, at the same rotating speed, the second threshold herein may have multiple values like the upper second threshold and the lower second threshold described above.

[0145] Next, the control part 30 confirms whether the rotating speed of the motor 6 at the current moment reaches the target rotating speed (800rpm) (step S94).

[0146] In the case that the rotating speed of the motor 6 at the current moment dos not reach the target rotating speed ("yes" in step S94), the control part 30 determines whether the newest moving accumulated value C_m falls in the range of the detection 4-2 (step S95) as it does in detection 4-1 (step S87).

[0147] Specifically, by referring to FIG. 17, compared with the situation that the washings Q are not biased due to small eccentricity (referring to the solid line in FIG. 17), in the situation that the washings Q are biased due to larger eccentricity (referring to the dotted line in FIG. 17), the moving accumulated value C_m for each rotating speed is larger. If the washings Q are greatly biased, the moving accumulated value C_m is larger than the set second thresholds, i.e., a corresponding one of the upper second threshold and the lower second threshold.

[0148] Returning to FIG. 18, if the newest moving accumulated value C_m is not less than the set second threshold, the control part 30 determines that the washings Q are biased in the dewatering tank 4 and the moving accumulated value C_m falls in the range of detection 4-2 ("yes" in step S95).

[0149] When it is determined that the moving accumulated value C_m falls in the range of detection 4-2 ("yes" in step S95), the control part 30 acquires the rotating speed L of the motor 6 (step S96) at the judged time point, i.e., the time point when it is detected in detection 4-2 that the washings Q are biased.

[0150] Next, the control part 30 causes the motor 6 to stably rotate at the acquired rotating speed L, strictly speaking, a rotating speed obtained by rounding off the digit in the units position of the rotating speed L, so that the washings Q are continuously dewatered (step S79). At this moment, the control part 30 prolongs dewatering time at the rotating speed L so as to obtain a dewatering effect same as that obtained through the dewatering at the original target rotating speed of 800rpm.

[0151] Next, if it is determined in detection 4-2 that the washings Q are not biased, the control part 30 ends detection 4-2 and causes the motor 6 to stably rotate at 800rpm so as to continue to dewater the washings Q (the above step S78) when the rotating speed of the motor 6 reaches the target rotating speed ("no" in step S94).

[0152] In this way, in the third acceleration stage, the biasing of the washings Q in the dewatering tank 4 is double detected in a mode adopting information values (such as C_n) and the first threshold (i.e., detections 1~3), and a mode adopting the duty ratio d_m and the second thresholds (i.e., detection 4), so that eccentric rotation of the dewatering tank 4 may be reliably inhibited early.

[0153] The present disclosure is not limited to the embodiments as described above, but various changes may be made within a scope recorded in the claims.

[0154] FIG. 19 is a flow chart illustrating a first modification of the control action of detection 3 in the third acceleration stage. It shall be noted that, throughout the drawings including FIG. 19, same reference numerals are used for same steps in other diagrams, and detailed description with respect to the repeated steps is omitted. By referring to FIG. 19, like in detection 3, the control part 30 causes the motor 6 to accelerate to the target rotating speed of 800rpm (step S61), and enabled the count value "n" to be added by 1 (step S63) once the interruption W is inputted ("yes" in step S62). In the third acceleration stage, the control part 30 starts detection 3 (step S64). Next, after it is determined that the detection 3 is OK ("yes" in step S65), the control part 30 ends detection 3 and resets the count value n to zero when the rotating speed of the motor 6 reaches 800rpm ("yes" in step S66), so that the motor 6 stably rotates at 800rpm, and dewatering continues (step S67).

[0155] In the first modification, during detection 3, the control part 30 monitors a maximum G_{max} of G when the rotating speed of the motor 6 is 250~300rpm (step S68). With respect to the maximum G_{max}, a specified reference value smaller than the first threshold is set and stored in the memory 32. If the maximum G_{max} does not exceed the reference value ("yes" in step S68), the control part 30 increases all of the second thresholds adopted in detection 4 (step S69).

[0156] That is, if the maximum G_{max} in detection 3 is less than the reference value, the dewatering tank 4 is at least in a state of being in static balance. If the dewatering tank 4 is in a state that the balance can be achieved statically or dynamically, although it is OK in both of detection 3 and detection 4, longitudinal shaking of the dewatering tank 4 may also be sensitively detected by the concurrently executed detection 4 even if detection 3 is OK in a state of dynamic imbalance. Thus, it can be imagined that, if the C_m in detection 4 is too large, the NG is caused. As a result, a poor condition of rotation stopping of the dewatering tank 4 may occur when detection 4 is carried out although vibrations of the outer tank 3 and the dewatering tank 4 are not large.

[0157] In order to prevent such poor condition, the control part 30 estimates that the vibrations of the outer tank 3 and the dewatering tank 4 are not large and carries out a control of widening the second thresholds of detection 4 in step S69 as long as the maximum G_{max} in detection 3 is a low value below the reference value ("yes" in step S68). That is, error detection of detection 4 adopting the duty ratio d_m is prevented through detection 3.

[0158] FIG. 20 relates to a second modification of the control action in detection 3, and is a schematic diagram illustrating the interior of the dewatering tank 4 in the dewatering operation. For example, as shown in FIG. 20(a), the washings Q in the dewatering tank 4 might be arranged in the dewatering tank 4 with a first washing Q1 and a second washing Q2 being placed at a half of the dewatering tank 4 relative to the central axis 17. When the dewatering tank 4 rotates at the high speed of 800rpm in the state, the dewatering tank 4 which is perfectly round initially deforms into an elliptic shape with a long edge formed in an opposite position direction of the first washing Q1 and the second washing Q2, as shown in FIG. 20 (b), and may contact with the circumferential wall 3A of the outer tank 3. In order to prevent such problem, in the third acceleration stage, control of detection 3 of the second modification shown in FIG. 21 may be implemented.

[0159] By referring to FIG. 21, the control part 30 causes the motor 6 to accelerate to the target rotating speed of 800rpm (step S61), and enables the count value n to be added by 1 (step S63) once the interruption W is inputted ("yes" in step S62), as it does in detection 3. In the third acceleration stage, the control part 30 starts detection 3 (step S64). Next, after it is determined that detection 3 is OK ("yes" in step S65), the control part 30 ends detection 3, resets the count value n to zero and causes the motor 6 to steadily rotate at 800rpm so as to continuously carry out dewatering (step S67) when the rotating speed of the motor 6 reaches 800rpm ("yes" in step S66).

[0160] With respect to the maximum G_{max} in detection 1, a specified first reference value smaller than the first threshold is set; with respect to the maximum G_{max} in detection 2, a specified second reference value smaller than the first reference value is set; and with respect to the maximum G_{max} in detection 3 when the rotating speed of the motor 6 is 250~300rpm, a specified third reference value smaller than the second threshold is set. The first reference value -the third reference value are stored in the memory 32.

[0161] As for detection 3 of the second modification, the previous maximum G_{max} in detection 1 never exceeds the first reference value ("yes" in step S101), the previous maximum G_{max} in detection 2 never exceeds the second reference value ("yes" in step S102), and if the maximum G_{max} in detection 3 when the rotating speed of the motor 6 is 250~300rpm never exceeds the third reference value ("yes" in step S103), the control part 30 decreases all the second thresholds in detection 4 (step S104).

[0162] That is, as long as the maximums G_{max} in respective detection among detections 1~3 are smaller values below the corresponding reference values ("yes" in steps S101~S103), the washings Q in the dewatering tank 4 may be in a state of being evenly distributed in the dewatering tank 4 or in a state of being tidily divided into two parts, as shown in FIG. 20.

[0163] Thus, as long as the maximums G_{max} in respective detection among detections 1~3 are smaller values below the corresponding reference values ("yes" in steps S101~S103), the control part 30 decreases the second thresholds (step S104) if the washings Q in the dewatering tank 4 are assumed to be in a state of being divided into two parts. Therefore, in detection 4 which is executed in parallel with detection 3, before the dewatering tank 4 deforms greatly toward the elliptic shape, detection 4-2 is enabled to be NG in step S95, so as to continue the dewatering operation at the rotating speed that makes the dewatering tank 4 not contact with the outer tank 3 in step S79 (referring to FIG. 18).

[0164] As described above, in the modifications 1 and 2, the control part 30 properly changes the second thresholds according to the maximum G_{max} of the accumulated values G in at least one of the first acceleration stage, the second acceleration stage and the third acceleration stage. Therefore, by changing the second thresholds to be suitable for the current situation in the dewatering tank 4, the biasing of the washings Q may be detected with high accuracy, so that eccentric rotation of the dewatering tank 4 is inhibited early. It shall be noted that, controls of the modification 1 and the modification 2 may also be carried out in parallel.

[0165] FIG. 22 and FIG. 23 are flow charts illustrating a control action of a third modification in the dewatering operation. As described above, the dewatering machine 1 may electrically detect eccentric rotation of the dewatering tank 4 through detections 1~4, and may also mechanically detect eccentric rotation of the dewatering tank 4 through the safety switch 36. That is, the biasing of the washings Q may be double detected in an electric mode and a mechanical mode. The electric mode is a mode of carrying out detection based on a relationship of information values (i.e., the accumulated value G, the moving accumulated value C_m, the first threshold and the second threshold) related to the rotation state of the motor 6 at 800rpm, and the mechanical mode is a mode of carrying out detection through contact between the safety switch 36 and the outer tank 3. Therefore, either in the case that it is determined in detections 1~4 that the washings Q are biased, or in the case that the eccentric rotation of the dewatering tank 4 is detected by the safety switch 36, the control part 30 causes the dewatering tank 4 to stop rotating.

[0166] Both of the mechanical mode and the electric mode are expected to detect eccentric rotation of the dewatering tank 4 at a same moment. However, in the dewatering machine 1 in a shipment stage, due to a difference between relative positions of the dewatering tank 4 and the safety switch 36 caused by an inclined error of the dewatering tank 4 among individuals of the dewatering machine 1, the first thresholds and the second thresholds of some dewatering machines 1 may not be proper. As a result, there is a time deviation between the mechanical detection and the electrical detection. Then, when the dewatering machine 1 is used, the deviation may be eliminated by correcting the first thresholds and the second thresholds. Although description is made regarding correcting the first thresholds in detection 1, the present disclosure is not limited to only correcting the first thresholds in detection 1, and the first thresholds in detections 2-3 and the second thresholds in detection 4 may also be corrected.

[0167] By referring to FIG. 22, the control part 30 causes the dewatering tank 4 to rotate and start dewatering as the initial dewatering operation after shipment starts (step S111). Along with starting of dewatering, detection 1 is carried out in the first stage. At this time, when the safety switch 36 is switched to "on" ("yes" in step S112), the control part 30 uses the count value n at this time as n_x and uses the accumulated value G at this time as G_x (step S113). The first threshold when the count value n is n_x is a value acquired by subtracting the first specified value from n_x in the present embodiment. The first specified value is a positive value.

[0168] The control part 30 determines whether a value obtained by subtracting G_x from the previous first threshold is above a second specified value J (step S114). The second specified value J is a positive value. In the case that a difference between the first threshold and the G_x is below the second specified value J ("no" in step S 114), since there substantially does not exist a time deviation between the moment that the eccentric rotation is detected by detection 1 and the moment that the eccentric rotation is detected by the safety switch 36, the first threshold may be determined as proper, and the control part 30 continuously carries out operation without changing the first threshold (step S 115).

[0169] In the case that the difference between the first threshold and G_x is above the second specified value J ("yes"

in step S 114), it can be determined that there exists a time deviation between the moment at which the eccentric rotation is detected by detection 1 and the moment at which the eccentric rotation is detected by the safety switch 36. Therefore, it can be determined that the moment at which the eccentric rotation is detected by detection 1 may be slower than that at which the eccentric rotation is detected by the safety switch 36. However, since the deviation may have occurred by accident, the control part 30 enables a correction alternate value U, the factory default of which is zero, to be added by 1 temporarily (step S116). If the correction alternate value U added by 1 is smaller than a specified upper limit value (which is 3 herein) ("no" in step S1117), the control part 30 does not change the first threshold and enables operation to continue (step S118).

[0170] On the other hand, if the correction alternate value U added by 1 reaches the upper limit value ("yes" in step S 117), the current first threshold is not proper because there apparently exists a time deviation between the moment at which the eccentric rotation is detected by detection 1 and the moment at which the eccentric rotation is detected by the safety switch 36. Therefore, the control part 30 sets a value acquired by subtracting the second specified value J from the first threshold as a new first threshold, so as to change and decrease the first threshold (step S 119). Next, the control part 30 resets the correction alternate value U to zero (step S120) and enables operation to continue (step S121).

[0171] In this way, if a difference between the accumulated value G_x and the first threshold when eccentric rotation of the dewatering tank 4 is detected by the safety switch 36 is above a specified value ("yes" in step S114), the control part 30 corrects the first threshold (step S119). Therefore, in detection 1 of dewatering after the first threshold being corrected, whether the washings Q are biased may be detected with high accuracy through the corrected first threshold, so that eccentric rotation of the dewatering tank 4 is inhibited early.

[0172] By referring to FIG. 23, under a condition that the safety switch 36 is not started ("no" in step S 112), if the accumulated value G does not exceed the first threshold ("no" in step S113), the control part 30 does not change the correction alternate value which is zero initially (step S132) and enables the operation to continue (step S133).

[0173] On the other hand, under a condition that the safety switch 36 is not started ("no" in step S112), when the accumulated value G reaches the first threshold and the detect result of detection 1 is NG ("yes" in step S113), the control part 30 sets the count value n at this moment to be n_y and set the accumulated value G at this moment to be G_y. The first threshold when the count value n is n_y is a value acquired by subtracting the first specified value from n_y in the present embodiment.

[0174] The control part 30 determines whether G_y is above a value T obtained by adding the first threshold and a third specified value together (step S135). The third specified value is a positive value. Under a condition that G_y is less than T ("no" in step S135), since there substantially exists no time deviation between the moment at which the eccentric rotation is detected by detection 1 and the moment at which the eccentric rotation is detected by the safety switch 36, the first threshold is determined to be proper. Therefore, the control part 30 does not change the first threshold and enables the operation to continue (step S136).

[0175] Under a condition that G_y is above T ("yes" in step S135), it can be determined that there exists a time deviation between the moment at which the eccentric rotation is detected by detection 1 and the moment at which the eccentric rotation is detected by the safety switch 36, and the moment at which the eccentric rotation is detected by detection 1 is much earlier than that at which the eccentric rotation is detected by the safety switch 36. However, since the deviation might have occurred by accident, the control part 30 enables a correction alternate value V to be added by 1 temporarily (step S137). Under a condition that the correction alternate value V added by 1 is less than a specified upper limit value (which is 3 herein) ("no" in step S138), the control part 30 does not change the first threshold and enables the operation to continue (step S139).

[0176] On the other hand, under a condition that the correction alternate value V added by 1 reaches the specified upper limit value ("yes" in step S138), the first threshold is not proper because there apparently exists a time deviation between the moment at which the eccentric rotation is detected by detection 1 and the moment at which the eccentric rotation is detected by the safety switch 36. Therefore, the control part 30 sets a value obtained by adding the first threshold and the third specified value together to be a new first threshold, thereby changing the first threshold and enabling the first threshold to be widened (step S140). Next, the control part 30 resets the correction alternate value V to zero (step S141) and enables the operation to continue (step S142).

[0177] In this way, if the control part 30 determines that the washings Q are biased before eccentric rotation is detected by the safety switch 36 ("yes" in step S131), the first threshold is corrected (step S140). Thus, in detection 1 of dewatering after the first threshold being corrected, biasing of the washings Q may be detected with high accuracy through the corrected first threshold, so that eccentric rotation of the dewatering tank 4 is inhibited early. It shall be noted that, the modification 3 may also be combined with modification 1 and modification 2.

[0178] Next, description is made to a fourth modification. With respect to the safety switch 36, the following conditions may be imagined: although vibration of the dewatering tank 4 is not so large, due to a moving mode of the outer tank 3, the safety switch 36 may be started by light contact with the outer tank 3. In order to prevent the dewatering tank 4 from stopping rotating caused by error detection of such mechanical mode, a control action of the fourth modification is carried out in parallel with detection 1. In the control action of the fourth modification, a threshold, different from the first threshold,

is used (which is set to be a fourth threshold). The fourth threshold may also be a value same as the first threshold. However, preferably, the fourth threshold is a value lower than the first threshold. In the following, description is made on a premise that the fourth threshold is slightly less than the first threshold.

[0179] FIG. 24 is a flow chart illustrating a control action of the fourth modification. By referring to FIG. 24, the control part 30 enables the dewatering tank 4 to rotate and starts dewatering (step S151) along with starting of the dewatering operation. Along with dewatering, detection 1 is carried out in the first acceleration stage. At this time, when the safety switch 36 is switched to "on" ("yes" in step S152), the control part 30 sets the accumulated value G at this time to be G_z (step S153).

[0180] The control part 30 determines whether G_z is above the fourth threshold (step S154). If G_z is above the fourth threshold ("yes" in step S154), a result of starting the safety switch 36, i.e., detection carried out by the safety switch 36, is normal since the moment at which eccentric rotation is detected by detection 1 and the moment at which eccentric rotation is detected by the safety switch 36 are deemed to be consistent approximately. Therefore, the control part 30 determines that the washings Q are biased and causes the dewatering tank 4 to stop rotating (step S155). It shall be noted that, since detection 1 is executed simultaneously, the control part 30 may also determine that the washings Q are biased (step S33 in FIG. 9B) and cause the dewatering tank 4 to stop rotating (step S41 in FIG. 12) when the accumulated value G becomes above the first threshold ("yes" in step S32 in FIG. 9B), even if the safety switch 36 is not started ("no" in step S152).

[0181] On the other hand, under a condition that G_z when the safety switch 36 is started is less than the fourth threshold ("no" in step S 154), the control part 30 determines that vibration of the dewatering tank 4 is negligibly small, the safety switch 36 is considered to be subjected to false starting and the operation is continued (step S156). Therefore, a success rate of the dewatering operation may be improved.

[0182] However, when the safety switch 36 is restarted while the operation is continuing hereafter, and the starting number of the safety switch 36 reach a specified number (which is 3 herein) from the beginning of dewatering operation ("yes" in step S157), the control part 30 determines that the safety switch 36 is started normally and the washings Q are biased, and causes the dewatering tank 4 to stop rotating (step S155). In other words, until times of eccentric rotation detected by the safety switch 36 before it is determined that the washings Q are biased reach the specified number ("no" in step S157), the control part 30 suspends rotation stopping of the dewatering tank 4, and the operation continues. Therefore, rotation stopping of the dewatering tank 4 caused by false detection of the mechanical mode of the safety switch 36 may be prevented, and eccentric rotation of the dewatering tank 4 is inhibited early. It shall be noted that, the specified number herein is not limited to 3 and may also be 1. Moreover, preferably, the control action of the modification 4 is executed in the first acceleration stage where the rotating speed is low to an extent that no problem is generated even ignoring starting of the safety switch 36 in step S156. Certainly, the modification 4 may also be combined with modification 1, modification 2 and modification 3.

[0183] In addition, a modification 5, as a further modification of the modification 4, may also carry out the control action shown in FIG. 25. In modification 5, steps S153 and S154 in modification 4 are omitted. In this case, beginning from dewatering starting (step S151), even if the safety switch 36 is switched on ("yes" in step S152), the control part 30 may also determines that the safety switch 36 is started by mistake and causes the operation to continue (step S156) if the starting number of the safety switch 36 do not reach the specified number (which is 3 herein) ("no" in step S157). However, as described above, since detection 1 is executed simultaneously, the control part 30 may cause the dewatering tank 4 to stop rotating (step S41 in FIG. 12) when the accumulated value G becomes above the first threshold ("yes" in step S32 in FIG. 9B). That is, if the accumulated value G is less than the first threshold, the control part 30 may neglect starting of the safety switch 36 when the starting number is not greater than 2.

[0184] On the other hand, when the starting number of the safety switch 36 reach 3 ("yes" in step S157), the control part 30 determines that a result detected by the safety switch 36 is normal and the washings Q are biased, thereby enabling the dewatering tank 4 to stop rotating (step S155). In other words, even in modification 5, like modification 4, until times of eccentric rotation detected by the safety switch 36 before it is determined that the washings Q are biased reaches the specified number ("no" in step S157), the control part 30 suspends rotation stopping of the dewatering tank 4, and the operation continues. Besides modification 4, modification 5 may also be combined with modifications 1~3. However, in modification 4, since false starting of the safety switch 36 is determined based on the fourth threshold less than the first threshold (referring to FIG. 24), the biasing of the washings Q may be determined earlier compared with modification 5 so as to cause the dewatering tank 4 to stop rotating.

[0185] In the above present embodiment, on the premise that the motor 6 is a variable frequency motor, the motor 6 is controlled based on the duty ratio. However, under a condition that the motor 6 is a brush motor, the motor 6 is controlled based on the voltage applied to the motor 6 instead of the duty ratio.

[0186] Moreover, in the above description, although specific numerical values including 120rpm, 240rpm, 800rpm, etc. are used as the rotating speed, the specific numerical values are varied according to the performance of the dewatering machine 1. Moreover, in the above description, in detections 1~3, the accumulated value G is calculated based on the moving average value C_n. However, if not influenced by errors, etc, the accumulated value G may also be

calculated based on any information value of other information values such as An and B_n, which may be reduced as the rotating speed of the motor 6 increases. In addition, although the accumulated value G is an accumulated value of the moving average values E_n, the accumulated value G may also be an accumulated value of difference D_n if influences including opposite position errors of NS groups do not exist. In addition, in detection 4, although the duty ratio is acquired to perform determination, the acquired duty ratio may be original data of the acquired duty ratios, may also be a correction value corrected as needed and may also be an index value acquired by transforming the duty ratio just like the moving accumulated value C_m.

Claims

1. A dewatering machine, comprising:

a dewatering tank, formed in a cylindrical shape with a central axis extending in a direction inclined relative to an up-down direction, wherein the dewatering tank is configured to contain washings, and rotate around the central axis so as to dewater the washings;
a balancing ring, formed in a hollow annular shape, wherein the balancing ring is coaxially arranged in the dewatering tank, and liquid for achieving rotational balance of the dewatering tank is contained in the balancing ring and flows freely; and
a dewatering preparation unit, configured to cause the dewatering tank, in a dewatering preparation stage for the washings, to rotate at a rotating speed lower than a lowest rotating speed at which the dewatering tank resonates, so as to detect a biased position of the washings in the dewatering tank; and cause the dewatering tank to stop rotating immediately before the washings biased in the dewatering tank are positioned, relative to the central axis, at an opposite side of the liquid biased downward in the balancing ring.

2. A dewatering machine, comprising:

a dewatering tank, formed in a cylindrical shape with a central axis extending in a direction inclined relative to an up-down direction, wherein the dewatering tank is configured to contain washings, and rotate around the central axis so as to dewater the washings;
an electric motor, configured to cause the dewatering tank to rotate;
an information value acquisition unit, configured to, when the electric motor is in an acceleration state of accelerating to a target rotating speed used for formally dewatering the washings, sequentially acquire an information value that should be decreased as a rotating speed of the electric motor increases;
a counting unit, configured to add a count value with an initial value of zero by 1 once the information value acquisition unit acquires the information value;
a calculation unit, configured to calculate an accumulated value of a difference between the information value and a previous information value under a condition that the information value is larger than the previous information value;
a determination unit, configured to determine that the washings are biased in the dewatering tank under a condition that the accumulated value when the count value is a specified value reaches a first threshold when the count value is the specified value; and
a stopping unit, configured to cause the dewatering tank to stop rotating when it is determined by the determination unit that the washings are biased.

3. The dewatering machine according to claim 2, further comprising an information correction unit, wherein information correction unit is configured to correct the information value through moving average before the accumulated value is calculated by the calculation unit.

4. The dewatering machine according to claim 2 or 3, further comprising an execution unit, wherein the execution unit is configured to alternatively execute any of a restarting process and a correction process under a condition that the dewatering tank is stopped rotating through the stopping unit, wherein the restarting process is a process for restarting to dewater the washings by causing the dewatering tank to rotate again, and the correction process is a process for correcting the biasing of the washings in the dewatering tank; and
the execution unit is configured to select to execute the correction process rather than selecting to execute the restarting process in the following situation: the restarting process has been executed for a specified number, and the dewatering tank is caused to stop rotating by the stopping unit.

5. The dewatering machine according to any one of claims 2-4, further comprising an acceleration unit, wherein the acceleration unit causes the electric motor to accelerate in three stages including a first acceleration stage, a second acceleration stage and a third acceleration stage, wherein
the first acceleration stage refers to an acceleration stage, in which the motor accelerates toward the target rotating speed from starting rotating until the rotating speed of the motor reaches a first rotating speed, wherein the first rotating speed is higher than a rotating speed at which the dewatering tank resonates transversely and lower than a rotating speed at which the dewatering tank resonates longitudinally,
the second acceleration stage is an acceleration stage, in which the rotating speed of the motor increases from the first rotating speed to a second rotating speed higher than the first rotating speed,
the third acceleration stage is an acceleration stage, in which the rotating speed of the motor increases from the second rotating speed to the target rotating speed,
the first threshold is independently set in the first acceleration stage, the second acceleration stage and the third acceleration stage respectively, and
the information value acquisition unit is configured to acquire the information value in the first acceleration stage, the second acceleration stage and the third acceleration stage respectively, the counting unit causes the count value to be added by 1 and calculates the accumulated value, and the determination unit determines that the washings are biased in the dewatering tank when the accumulated value reaches the first threshold.

6. The dewatering machine according to claim 5, further comprising:

a duty ratio acquisition unit, configured to acquire a duty ratio of voltage applied to the motor at each specified time in the third acceleration stage; and
a transformation unit, configured to transform the duty ratio acquired by the duty ratio acquisition unit into a specified index value,
when the index value reaches a second threshold for a corresponding time, the determination unit determines that the washings are biased in the dewatering tank.

7. The dewatering machine according to claim 6, further comprising a threshold modification unit, wherein the threshold modification unit is configured to modify the second threshold according to the accumulated value in at least one acceleration stage of the first acceleration stage, the second acceleration stage and the third acceleration stage.

8. The dewatering machine according to any one of claims 5-7, wherein when a variation of the accumulated value reaches a third threshold, the determination unit determines that the washings are biased in the dewatering tank.

9. A dewatering machine, comprising:

a dewatering tank, formed in a cylindrical shape with a central axis extending in a direction inclined relative to an up-down direction, wherein the dewatering tank is configured to contain washings, and rotate around the central axis so as to dewater the washings;
an outer tank, configured to contain the dewatering tank;
an electric motor, configured to cause the dewatering tank to rotate;
a determination unit, configured to determine that the washings are biased in the dewatering tank when an information value, relevant to a rotation state of the electric motor before a rotating speed of the electric motor reaches a target rotating speed used for formally dewatering the washings, reaches a threshold;
a detection unit, configured to mechanically detect eccentric rotation of the dewatering tank by contacting the outer tank when the dewatering tank eccentrically rotates along with biasing of the washings in the dewatering tank and the outer tank is caused to vibrate;
a stopping unit, configured to cause the dewatering tank to stop rotating in one of the following situations: it is determined by the determination unit that the washings are biased; the eccentric rotation of the dewatering tank is detected by the detection unit; and
a threshold correction unit, configured to correct the threshold in one of the following situations: a difference between the information value and the threshold is above the specified value when the eccentric rotation of the dewatering tank is detected by the detection unit; it is determined by the determination unit that the washings are biased before the eccentric rotation is detected by the detection unit.

10. A dewatering machine, comprising:

a dewatering tank, formed in a cylindrical shape with a central axis extending in a direction inclined relative to

an up-down direction, wherein the dewatering tank is configured to contain washings, and rotate around the central axis so as to dewater the washings;

an outer tank, configured to contain the dewatering tank;

an electric motor, configured to cause the dewatering tank to rotate;

a determination unit, configured to determine that the washings are biased in the dewatering tank when an information value, relevant to a rotation state of the electric motor before a rotating speed of the electric motor reaches a target rotating speed used for formally dewatering the washings, reaches a threshold;

a detection unit, configured to mechanically detect eccentric rotation of the dewatering tank by contacting the outer tank when the dewatering tank eccentrically rotates along with biasing of the washings in the dewatering tank and the outer tank is caused to vibrate;

a stopping unit, configured to cause the dewatering tank to stop rotating in one of the following situations: it is determined by the determination unit that the washings are biased; the eccentric rotation of the dewatering tank is detected by the detection unit; and

a suspending unit, configured to suspend an operation performed by the stopping unit for stopping the rotation of the dewatering tank, until a detection number of the detection unit reaches a specified number before it is determined by the determination unit that the washings are biased.

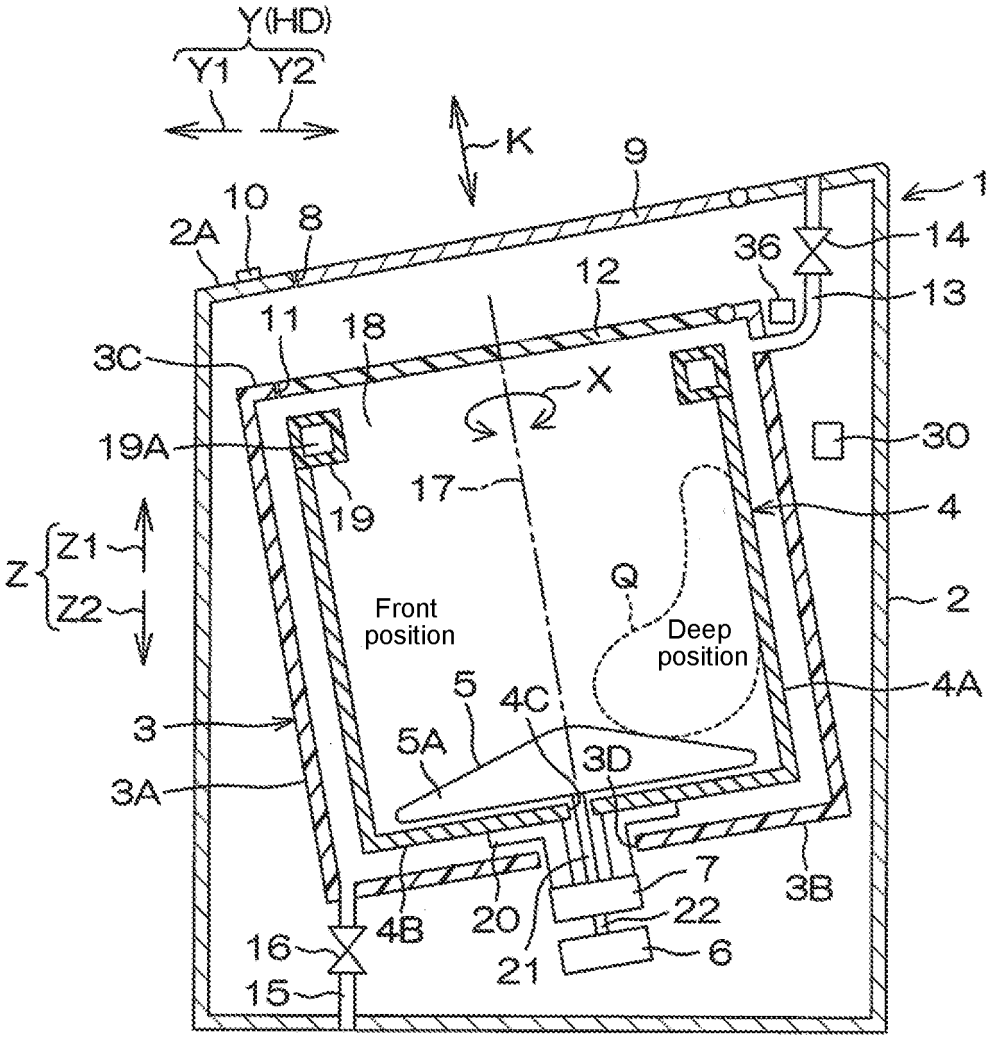

Y(HD)
Y1
Y2
K
9
1
10
8
2A
14
36
12
13
11
18
3C
X
19A
30
19
17
4
Z
Z1
Z2
Q
2
Front
position
Deep
position
5
4C
4A
3
5A
3D
3A
7
3B
4B
20
22
16
21
6
15

FIG.1

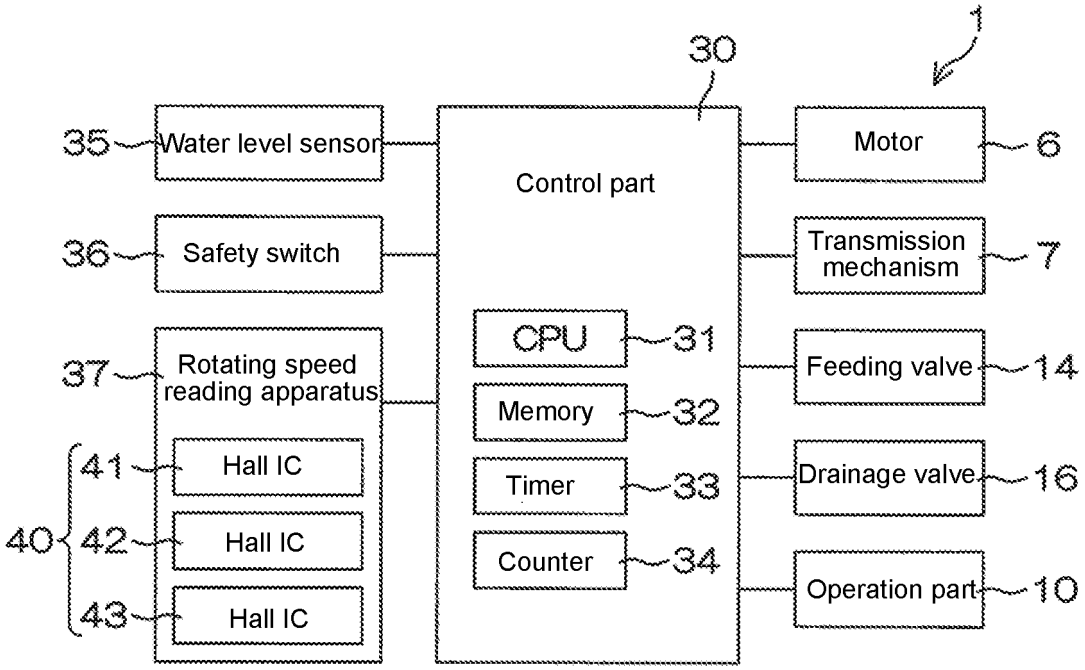

1
30
35
Water level sensor
36
Safety switch
37
Rotating speed reading apparatus
40
41
Hall IC
42
Hall IC
43
Hall IC
Control part
CPU
31
Memory
32
Timer
33
Counter
34
Motor
6
Transmission mechanism
7
Feeding valve
14
Drainage valve
16
Operation part
10

FIG.2

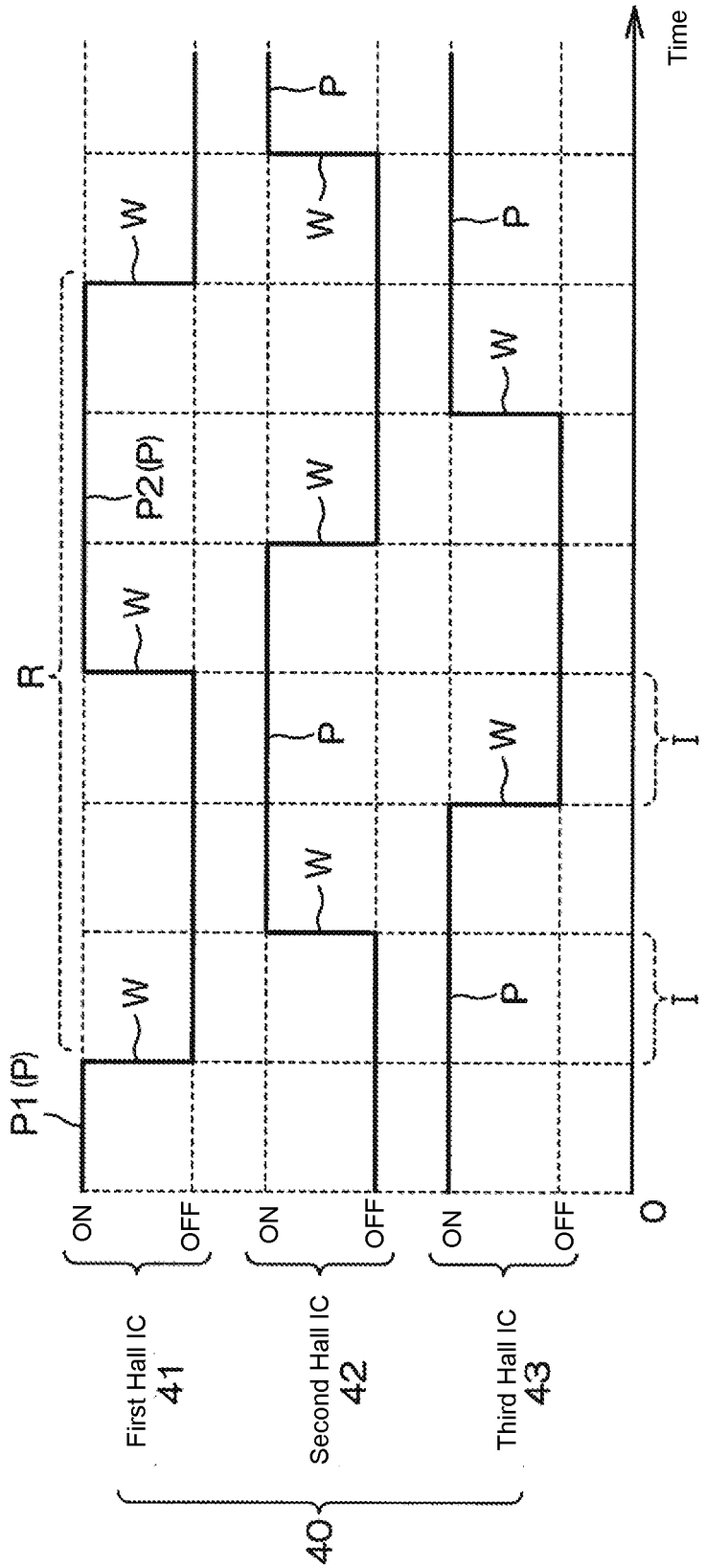

Time
O
I
I
R
P1 (P)
P2 (P)
W
P
ON
OFF
First Hall IC
41
Second Hall IC
42
Third Hall IC
43
40

FIG.3

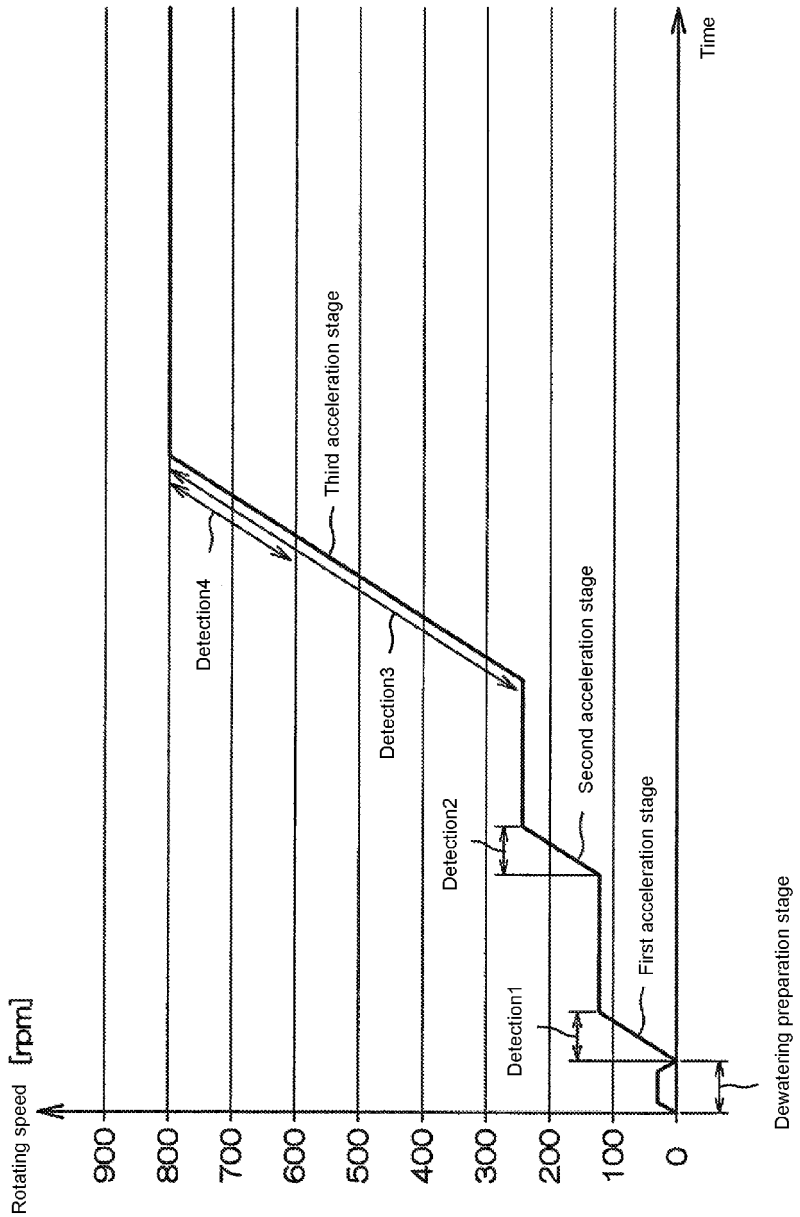

Rotating speed [rpm]
900
800
700
600
500
400
300
200
100
0
Time
Detection4
Third acceleration stage
Detection3
Detection2
Second acceleration stage
Detection1
First acceleration stage
Dewatering preparation stage

FIG.4

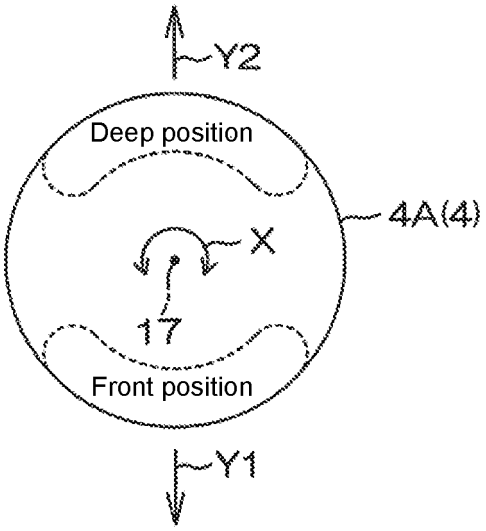


FIG.5

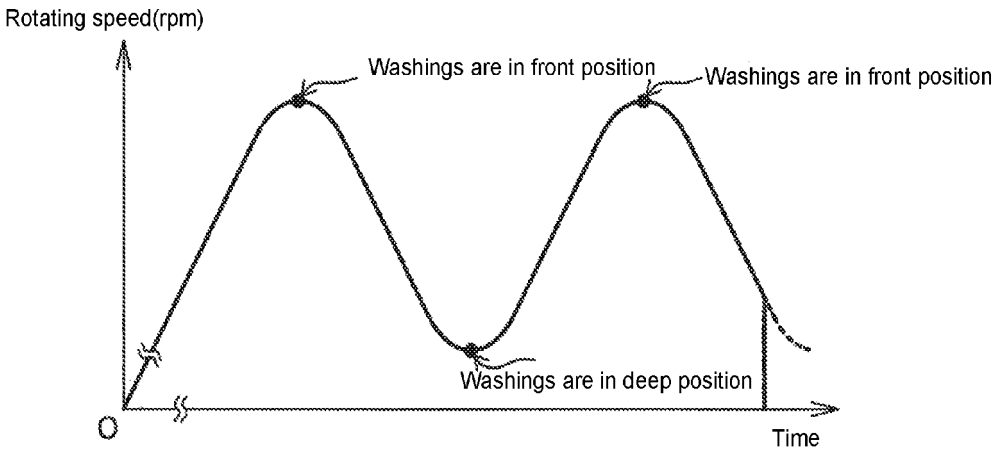


FIG.6

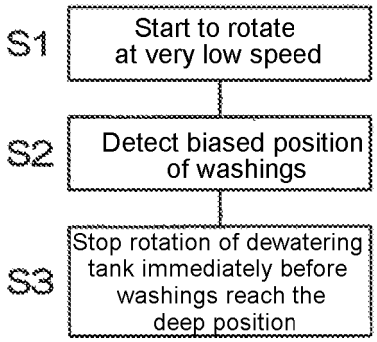


FIG.7

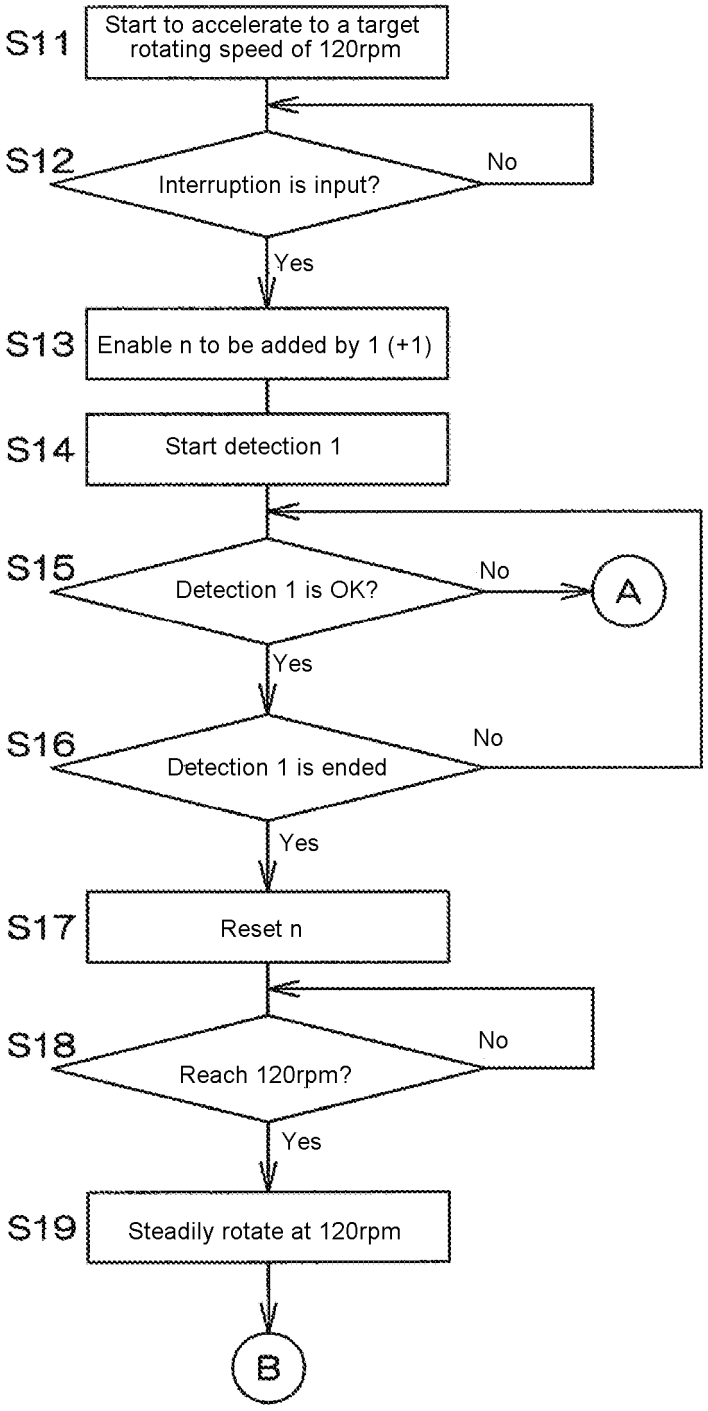

S11
Start to accelerate to a target rotating speed of 120rpm
S12
Interruption is input?
No
Yes
S13
Enable n to be added by 1 (+1)
S14
Start detection 1
S15
Detection 1 is OK?
No
A
Yes
S16
Detection 1 is ended
No
Yes
S17
Reset n
S18
Reach 120rpm?
No
Yes
S19
Steadily rotate at 120rpm
B

FIG.8

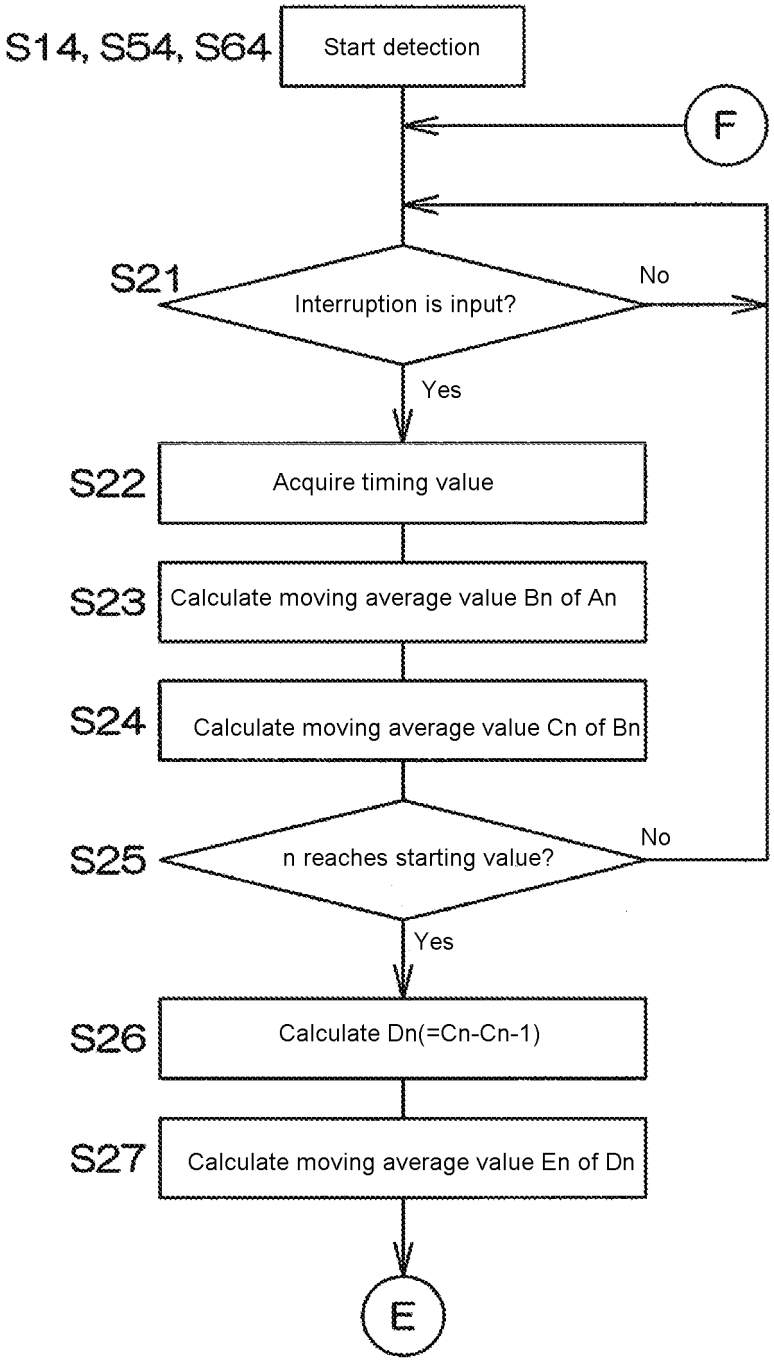

S14, S54, S64
Start detection
F
S21
Interruption is input?
No
Yes
S22
Acquire timing value
S23
Calculate moving average value Bn of An
S24
Calculate moving average value Cn of Bn
S25
n reaches starting value?
No
Yes
S26
Calculate Dn(=Cn-Cn-1)
S27
Calculate moving average value En of Dn
E

FIG.9A

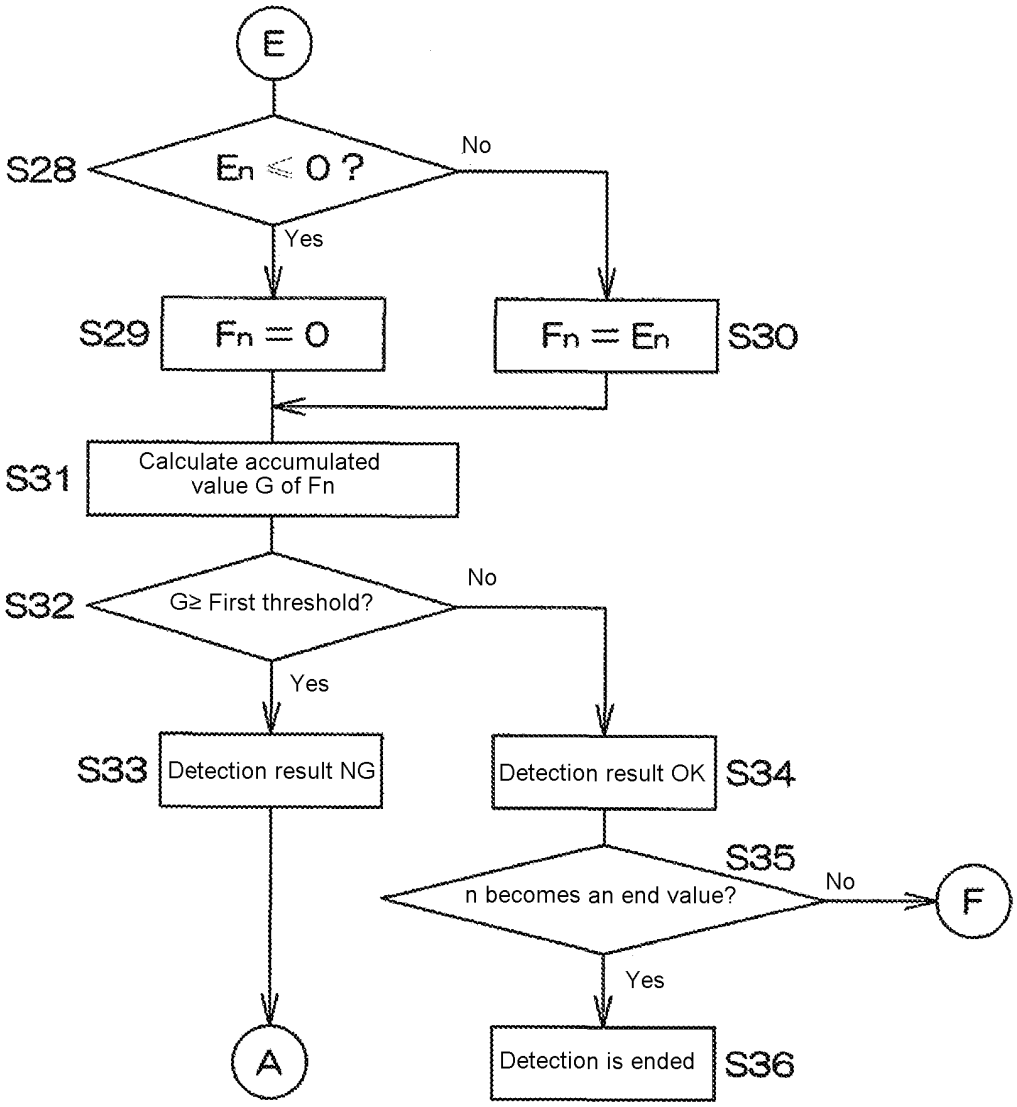

E
S28
En ≤ 0 ?
No
Yes
S29
Fn = 0
Fn = En
S30
S31
Calculate accumulated value G of Fn
S32
G≥ First threshold?
No
Yes
S33
Detection result NG
Detection result OK
S34
S35
n becomes an end value?
No
F
Yes
A
Detection is ended
S36

FIG.9B

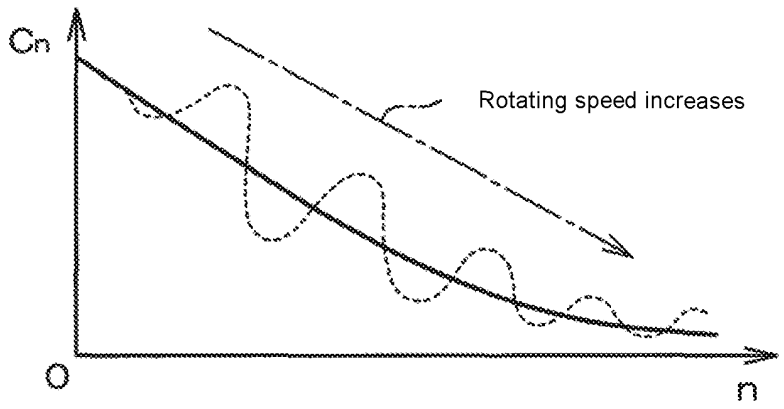

Cn
Rotating speed increases
O
n

FIG.10

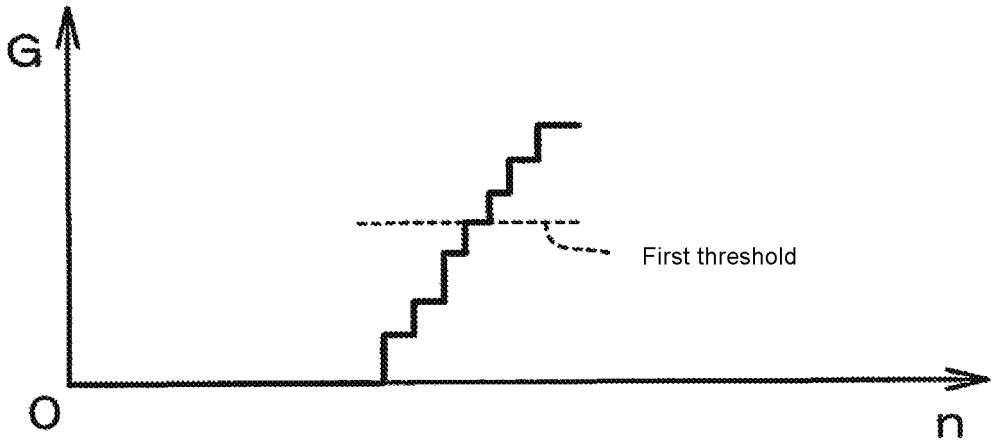

G
First threshold
O
n

FIG.11

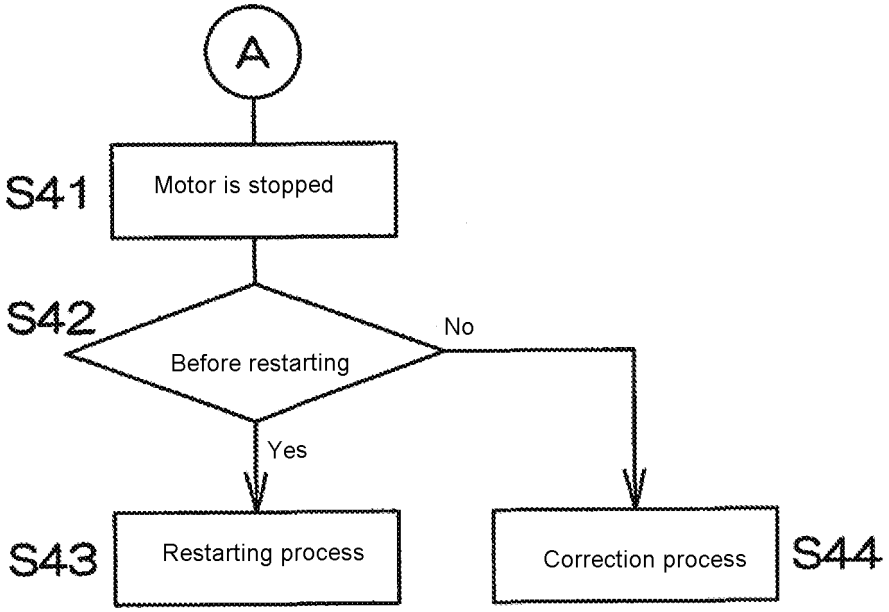

A
S41
Motor is stopped
S42
Before restarting
No
Yes
S43
Restarting process
Correction process
S44

FIG.12

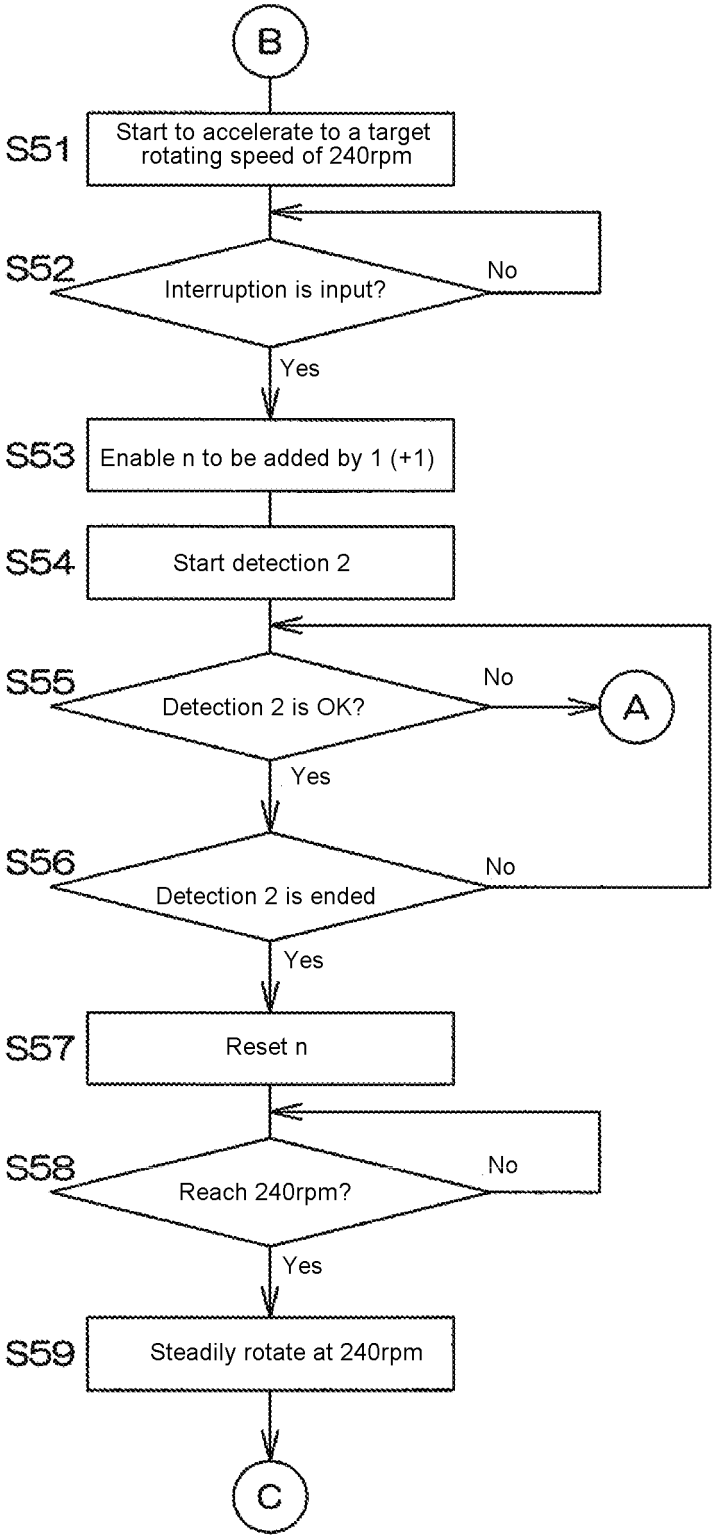

B
S51
Start to accelerate to a target rotating speed of 240rpm
S52
Interruption is input?
No
Yes
S53
Enable n to be added by 1 (+1)
S54
Start detection 2
S55
Detection 2 is OK?
No
A
Yes
S56
Detection 2 is ended
No
Yes
S57
Reset n
S58
Reach 240rpm?
No
Yes
S59
Steadily rotate at 240rpm
C

FIG.13

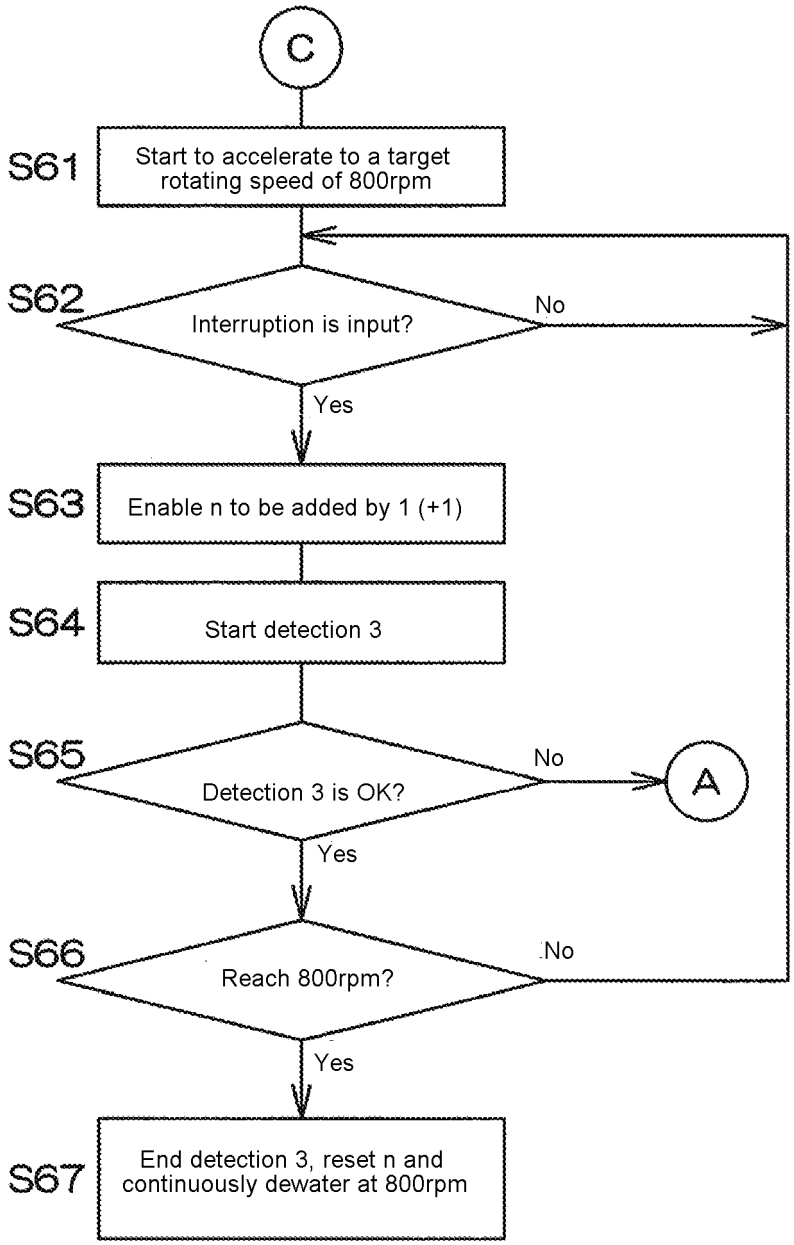

C
S61
Start to accelerate to a target rotating speed of 800rpm
S62
Interruption is input?
No
Yes
S63
Enable n to be added by 1 (+1)
S64
Start detection 3
S65
Detection 3 is OK?
No
A
Yes
S66
Reach 800rpm?
No
Yes
S67
End detection 3, reset n and continuously dewater at 800rpm

FIG.14

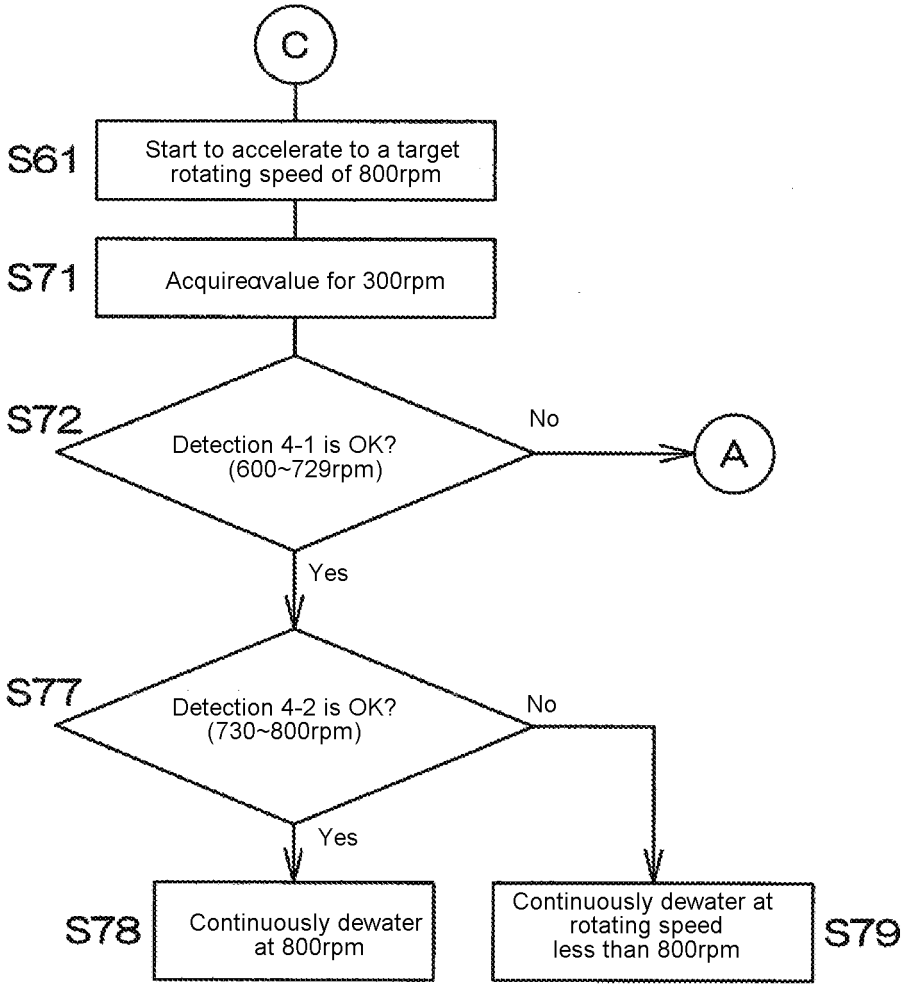

C
S61
Start to accelerate to a target rotating speed of 800rpm
S71
Acquire α value for 300rpm
S72
Detection 4-1 is OK? (600~729rpm)
No
A
Yes
S77
Detection 4-2 is OK? (730~800rpm)
No
Yes
S78
Continuously dewater at 800rpm
Continuously dewater at rotating speed less than 800rpm
S79

FIG.15

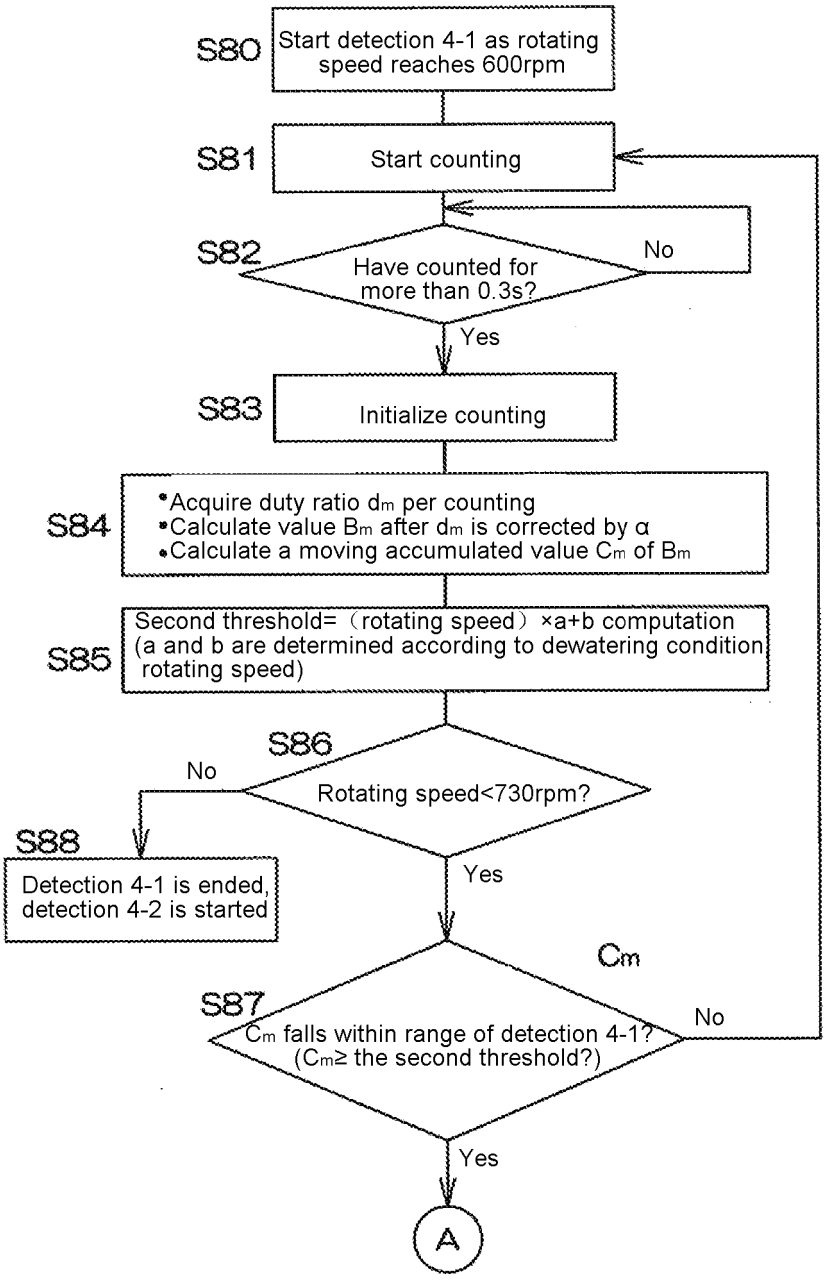

S80
Start detection 4-1 as rotating speed reaches 600rpm
S81
Start counting
S82
Have counted for more than 0.3s?
No
Yes
S83
Initialize counting
S84
•Acquire duty ratio dm per counting
•Calculate value Bm after dm is corrected by α
•Calculate a moving accumulated value Cm of Bm
S85
Second threshold=（rotating speed）×a+b computation
(a and b are determined according to dewatering condition rotating speed)
S86
Rotating speed<730rpm?
No
Yes
S88
Detection 4-1 is ended, detection 4-2 is started
Cm
S87
Cm falls within range of detection 4-1? (Cm≥ the second threshold?)
No
Yes
A

FIG.16

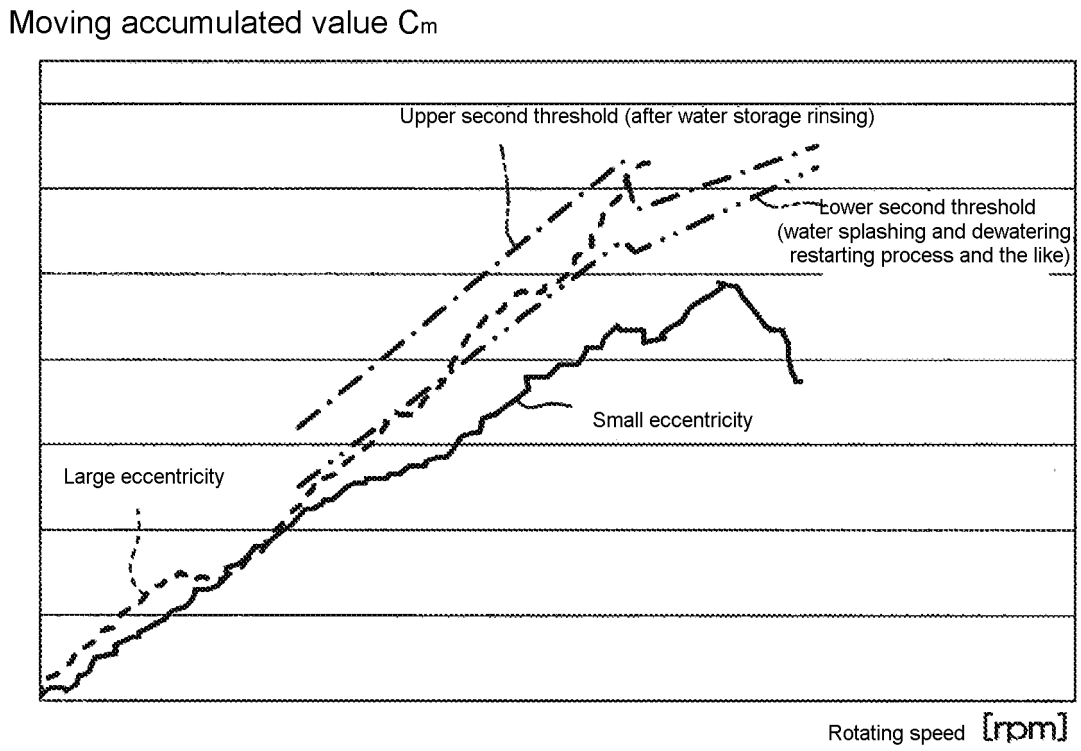

Moving accumulated value Cm
Upper second threshold (after water storage rinsing)
Lower second threshold
(water splashing and dewatering
restarting process and the like)
Small eccentricity
Large eccentricity
Rotating speed [rpm]

FIG.17

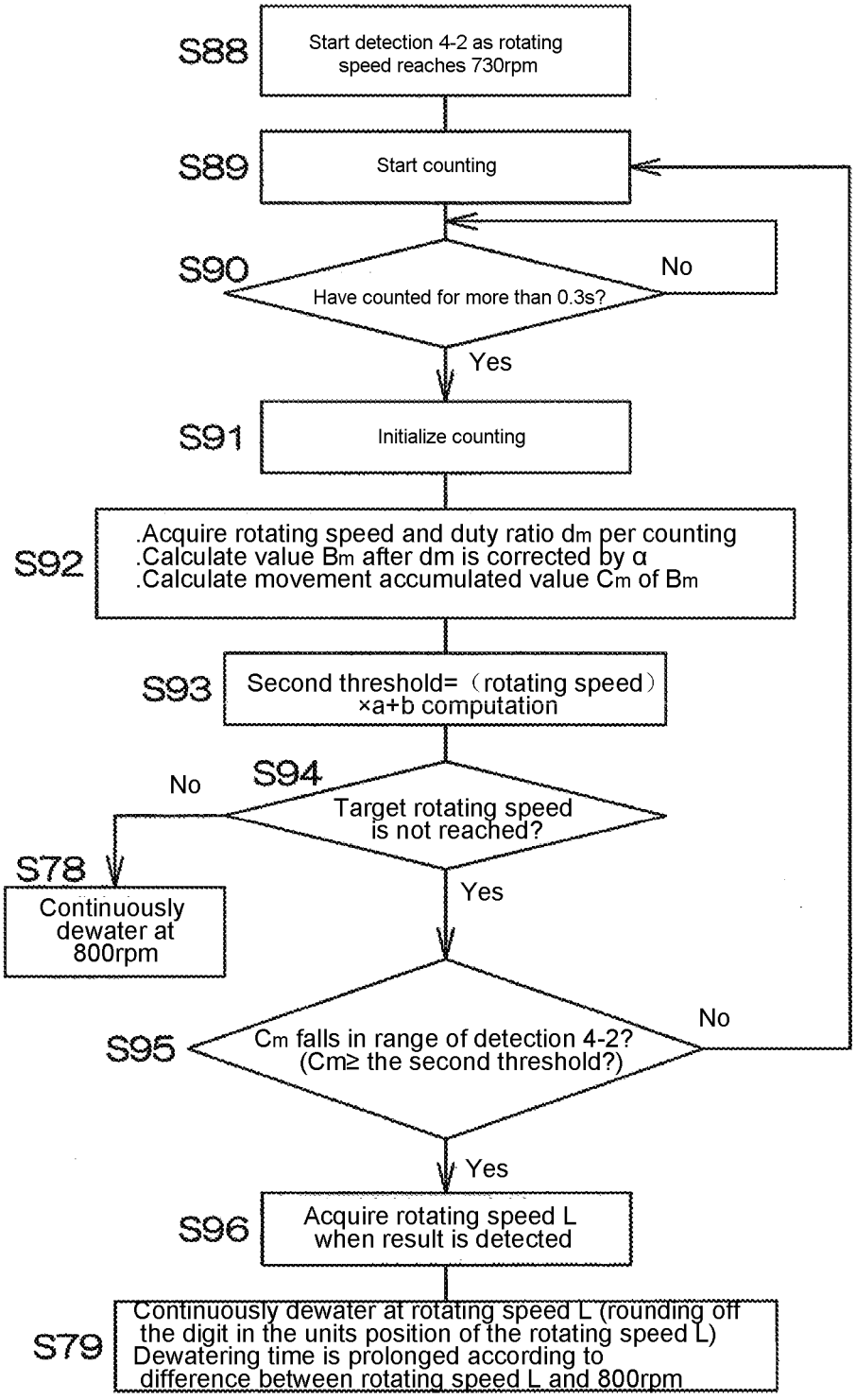

S88
Start detection 4-2 as rotating speed reaches 730rpm
S89
Start counting
S90
Have counted for more than 0.3s?
No
Yes
S91
Initialize counting
S92
.Acquire rotating speed and duty ratio dm per counting
.Calculate value Bm after dm is corrected by α
.Calculate movement accumulated value Cm of Bm
S93
Second threshold=（rotating speed）×a+b computation
S94
Target rotating speed is not reached?
No
Yes
S78
Continuously dewater at 800rpm
S95
Cm falls in range of detection 4-2? (Cm≥ the second threshold?)
No
Yes
S96
Acquire rotating speed L when result is detected
S79
Continuously dewater at rotating speed L (rounding off the digit in the units position of the rotating speed L)
Dewatering time is prolonged according to difference between rotating speed L and 800rpm

FIG.18

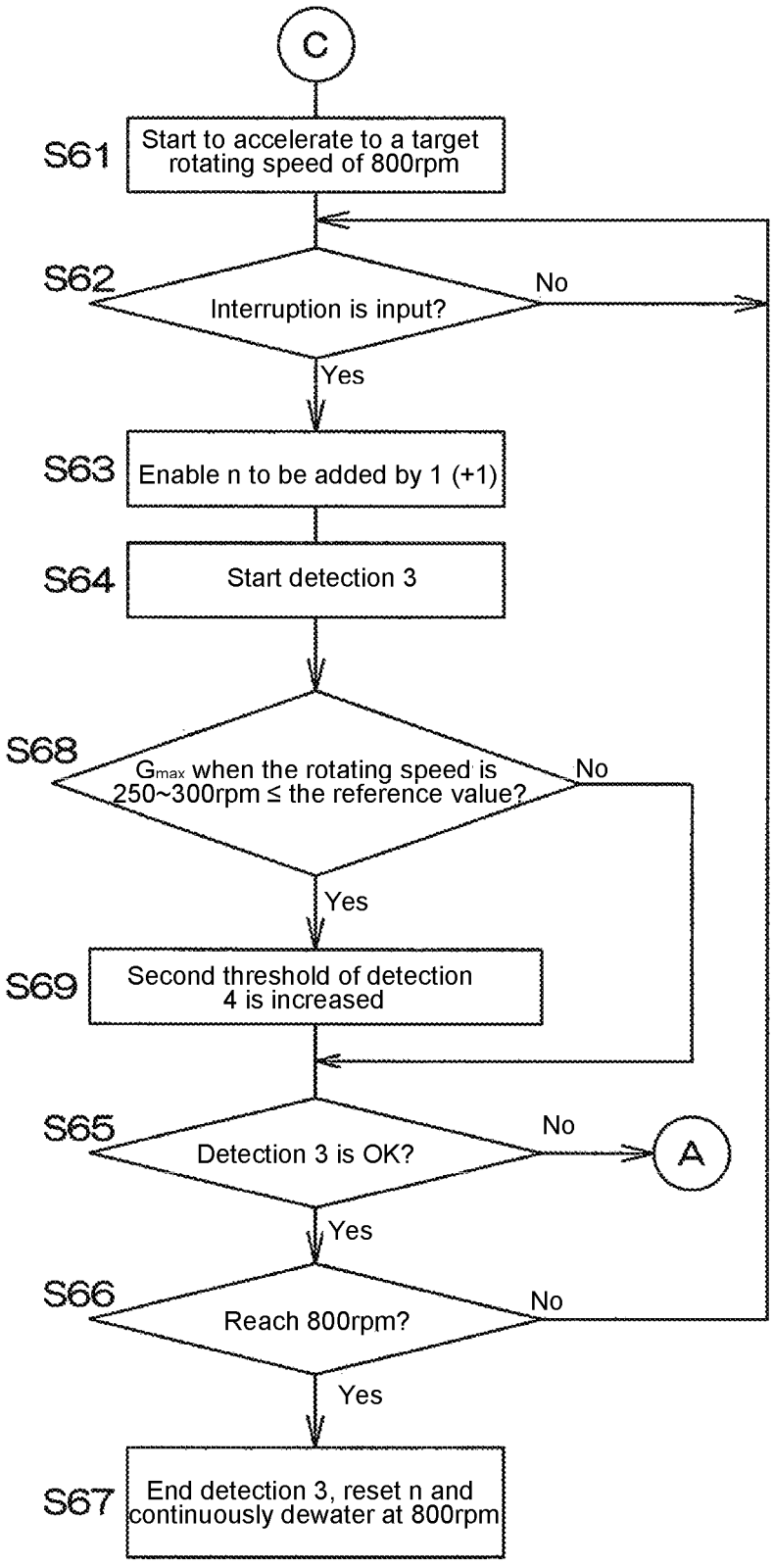

C
S61
Start to accelerate to a target rotating speed of 800rpm
S62
Interruption is input?
No
Yes
S63
Enable n to be added by 1 (+1)
S64
Start detection 3
S68
Gmax when the rotating speed is 250~300rpm ≤ the reference value?
No
Yes
S69
Second threshold of detection 4 is increased
S65
Detection 3 is OK?
No
A
Yes
S66
Reach 800rpm?
No
Yes
S67
End detection 3, reset n and continuously dewater at 800rpm

FIG.19

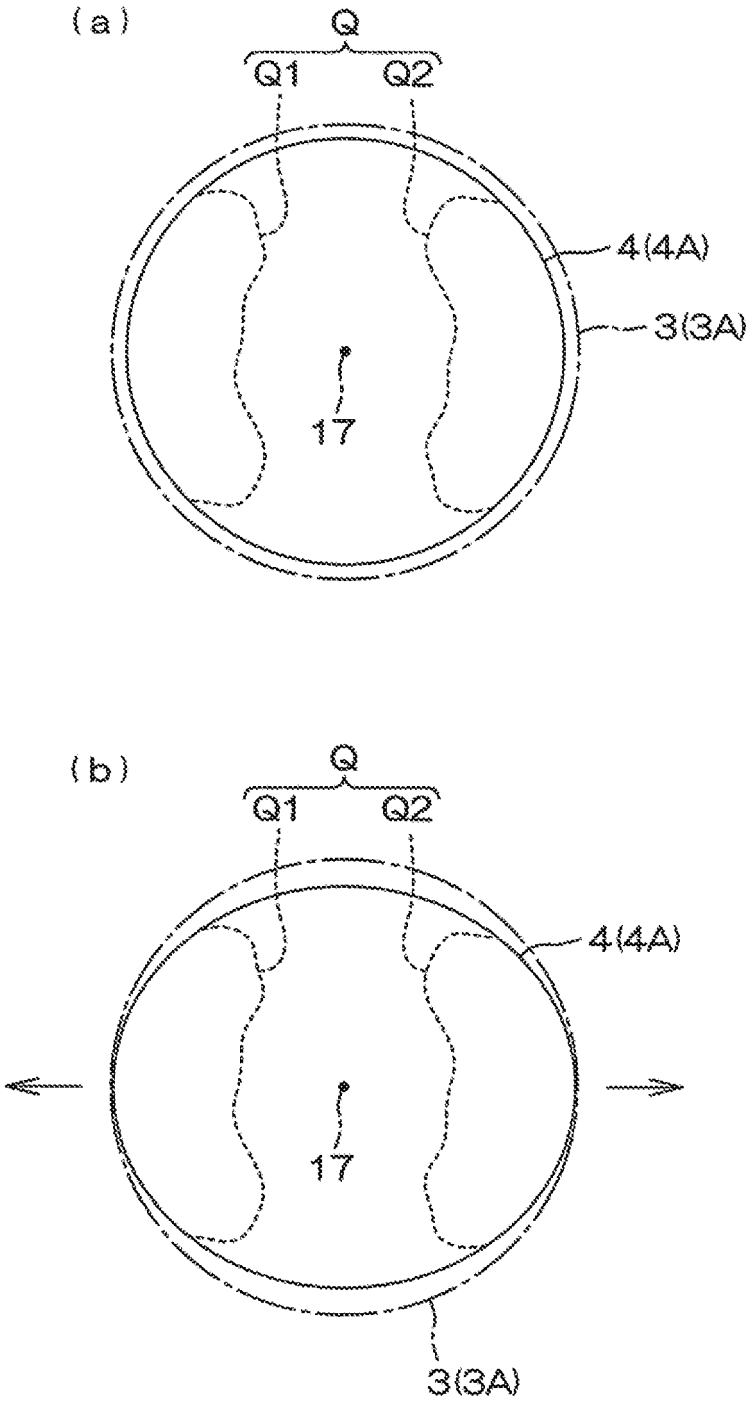


FIG.20

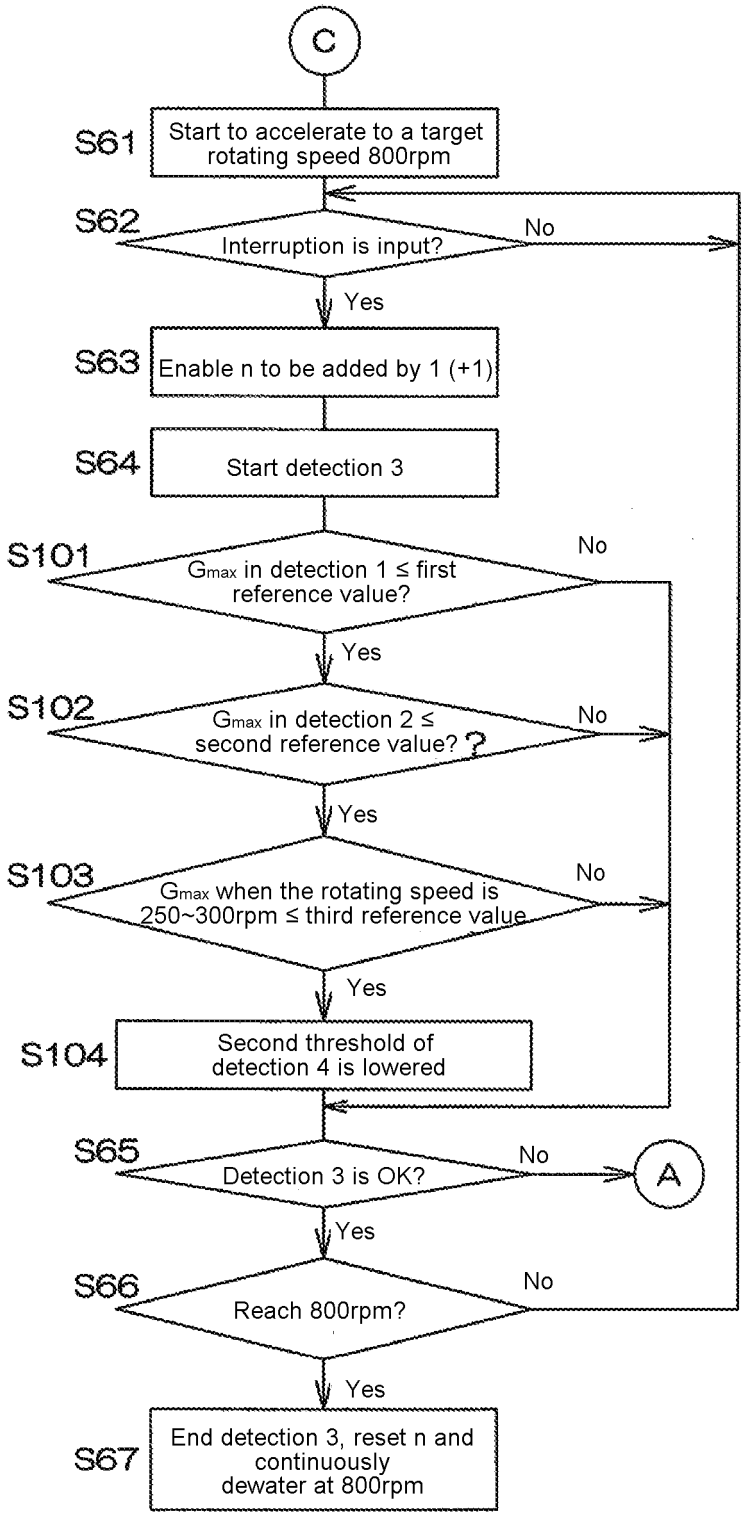

C
S61
Start to accelerate to a target rotating speed 800rpm
S62
Interruption is input?
No
Yes
S63
Enable n to be added by 1 (+1)
S64
Start detection 3
S101
Gmax in detection 1 ≤ first reference value?
No
Yes
S102
Gmax in detection 2 ≤ second reference value?
No
Yes
S103
Gmax when the rotating speed is 250~300rpm ≤ third reference value
No
Yes
S104
Second threshold of detection 4 is lowered
S65
Detection 3 is OK?
No
A
Yes
S66
Reach 800rpm?
No
Yes
S67
End detection 3, reset n and continuously dewater at 800rpm

FIG.21

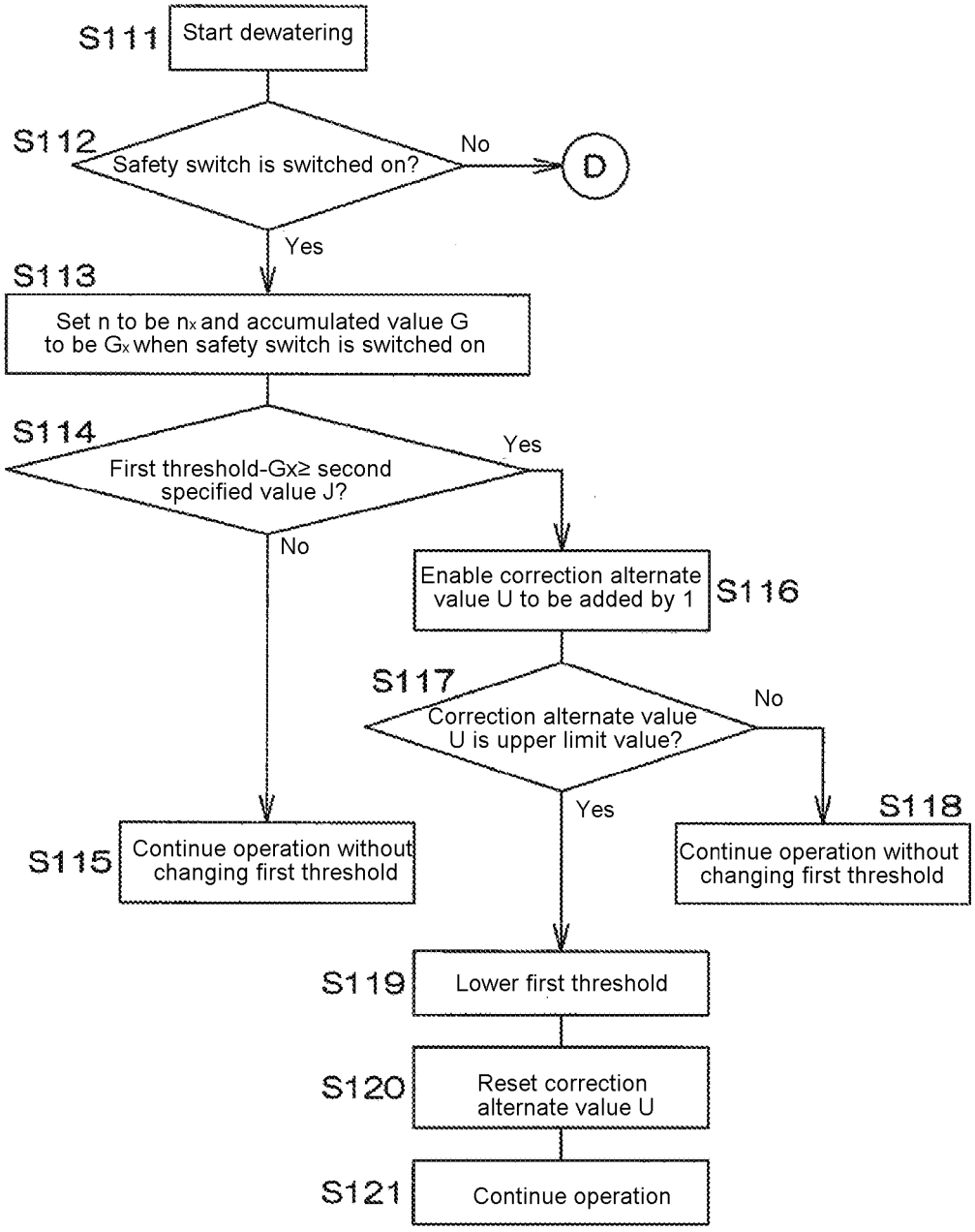

S111
Start dewatering
S112
Safety switch is switched on?
No
D
Yes
S113
Set n to be nx and accumulated value G to be Gx when safety switch is switched on
S114
First threshold-Gx≥ second specified value J?
Yes
No
Enable correction alternate value U to be added by 1
S116
S117
Correction alternate value U is upper limit value?
No
Yes
S118
Continue operation without changing first threshold
S115
Continue operation without changing first threshold
S119
Lower first threshold
S120
Reset correction alternate value U
S121
Continue operation

FIG.22

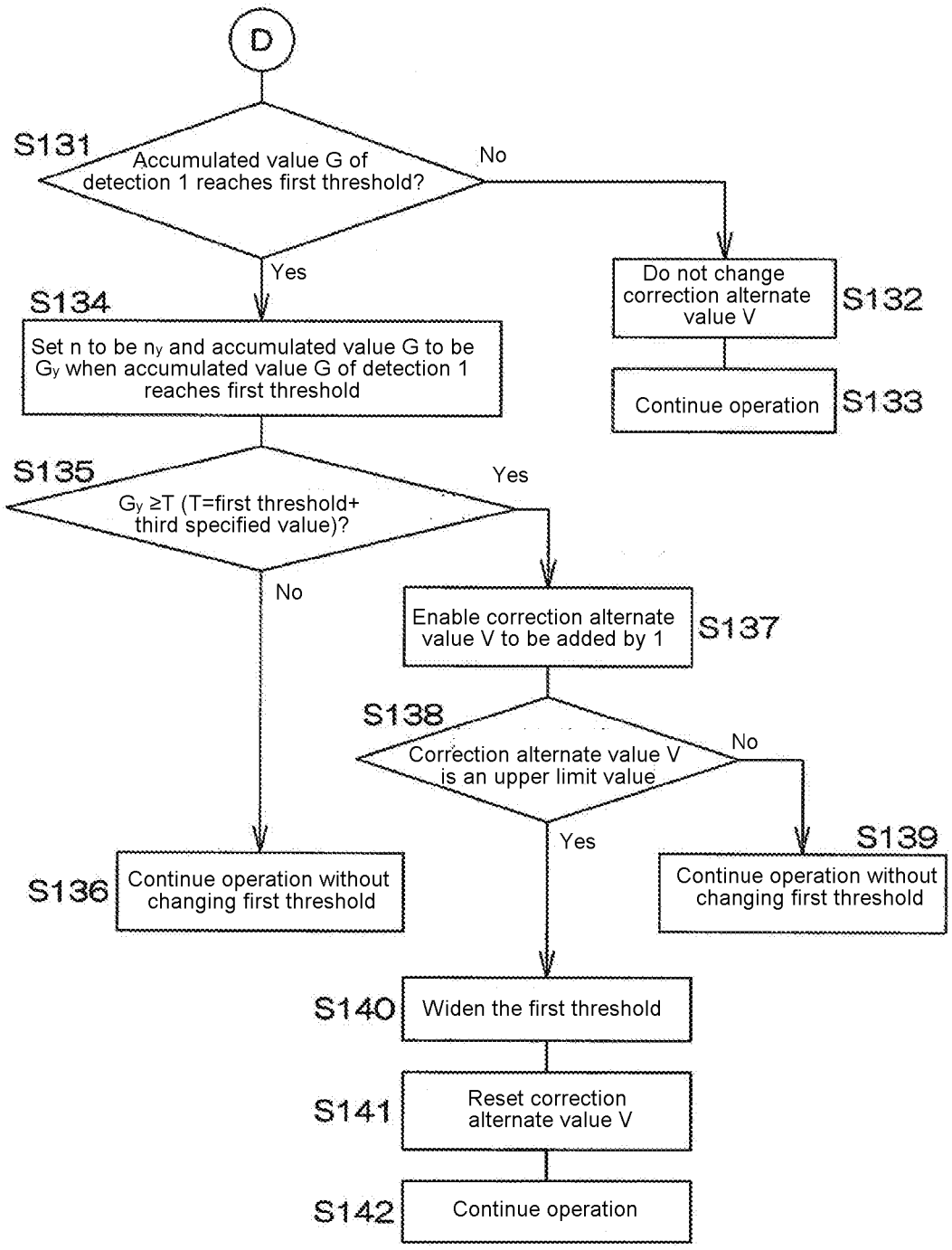

D
S131
Accumulated value G of detection 1 reaches first threshold?
No
Yes
S132
Do not change correction alternate value V
S133
Continue operation
S134
Set n to be n_y and accumulated value G to be G_y when accumulated value G of detection 1 reaches first threshold
S135
$G_y \geq T$ (T=first threshold+ third specified value)?
Yes
No
S136
Continue operation without changing first threshold
S137
Enable correction alternate value V to be added by 1
S138
Correction alternate value V is an upper limit value
No
Yes
S139
Continue operation without changing first threshold
S140
Widen the first threshold
S141
Reset correction alternate value V
S142
Continue operation

FIG.23

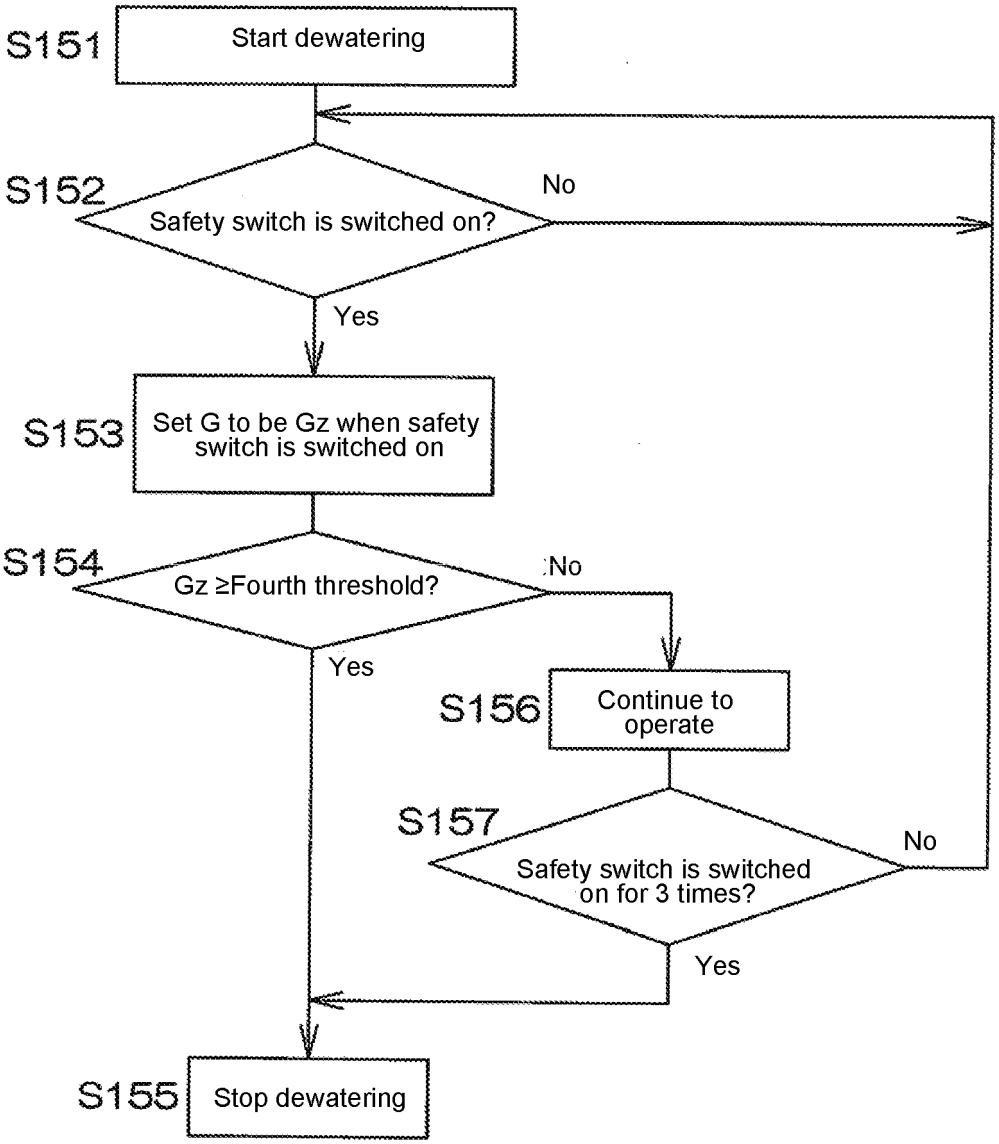

S151
Start dewatering
S152
Safety switch is switched on?
No
Yes
S153
Set G to be Gz when safety switch is switched on
S154
Gz ≥Fourth threshold?
No
Yes
S156
Continue to operate
S157
Safety switch is switched on for 3 times?
No
Yes
S155
Stop dewatering

FIG.24

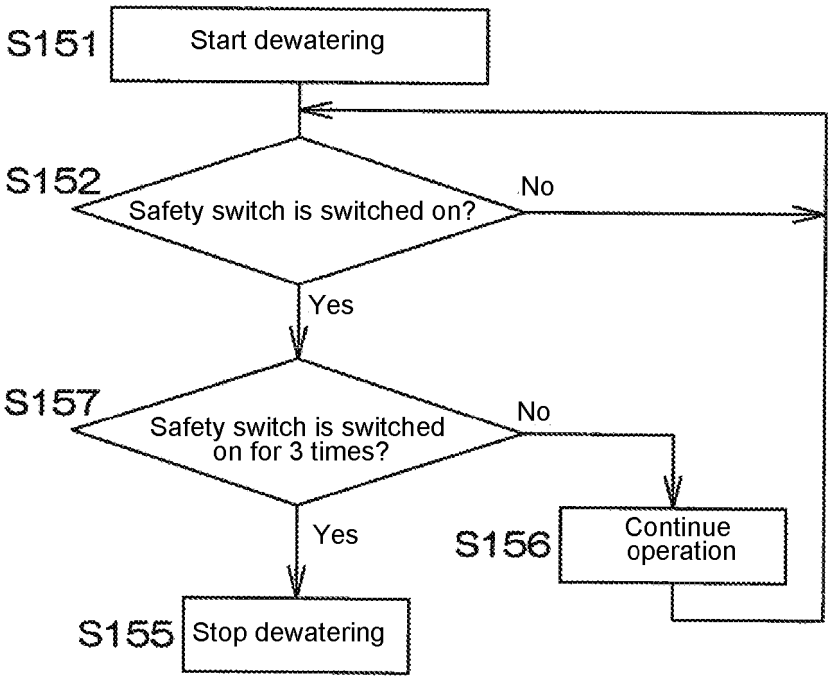

S151
Start dewatering
S152
Safety switch is switched on?
No
Yes
S157
Safety switch is switched on for 3 times?
No
Yes
S156
Continue operation
S155
Stop dewatering

FIG.25

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2015/097173

A. CLASSIFICATION OF SUBJECT MATTER

D06F 23/06 (2006.01) i; D06F 33/02 (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; VEN; CNKI: HAIER, SANYO, deflection, unbalance, shake, swing, detect, measure, monitor, sense, spin-dry, interval, high level, low level, rotating speed, reduce, touch, switch, equilibr+, balanc+, eccentric+, bias???, skew???, spin+, dehydrat+, dewater+, tilt???, inclin+ slant+, slop???, obliqu+, vibrancy, vibration, librat+, oscillat+, damp+, hall, pulse?, impulse+, velocity, speed, revolution, rpm

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2008073311 A (MITSUBISHI ELECTRIC CORP.), 03 April 2008 (03.04.2008), description, paragraphs [0007]-[0019], and figures 1-7	1
A	CN 102251367 A (SANYO ELECTRIC CO., LTD. et al.), 23 November 2011 (23.11.2011), description, paragraphs [0179]-[0197], and figures 1-7	2-10
A	CN 104005200 A (HEFEI RONGSHIDA SANYO ELECTRIC CO., LTD.), 27 August 2014 (27.08.2014), the whole document	9-10
A	CN 1916267 A (KABUSHIKI KAISHA TOSHIBA et al.), 21 February 2007 (21.02.2007), the whole document	1-10
A	CN 1572954 A (SANYO ELECTRIC CO., LTD.), 02 February 2005 (02.02.2005), the whole document	1-10

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

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"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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
08 March 2016 (08.03.2016)	**16 March 2016 (16.03.2016)**
Name and mailing address of the ISA/CN: State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088, China Facsimile No.: (86-10) 62019451	Authorized officer **LIU, Jing** Telephone No.: (86-10) **62084545**

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2015/097173

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2012120687 A (SAMSUNG YOKOHAMA RES INST CO.), 28 June 2012 (28.06.2012), the whole document	1-10
A	JP 2010125083 A (SAMSUNG ELECTRONICS CO., LTD.), 10 June 2010 (10.06.2010), the whole document	1-10

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2015/097173

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
JP 2008073311 A	03 April 2008	None	
CN 102251367 A	23 November 2011	JP 2011240041 A	01 December 2011
		TW 201200665 A	01 January 2012
		TW I451011 B	01 September 2014
		CN 102251367 B	21 August 2013
		VN 10013638 B	25 February 2015
		VN 27972 A	25 November 2011
CN 104005200 A	27 August 2014	None	
CN 1916267 A	21 February 2007	TW I317393 B	21 November 2009
		JP 2007050114 A	01 March 2007
		CN 100523354 C	05 August 2009
		TW 200718820 A	16 May 2007
		KR 20070021935 A	23 February 2007
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CN 1572954 A	02 February 2005	KR 100671193 B1	18 January 2007
		KR 20040108547 A	24 December 2004
		CN 100338288 C	19 September 2007
		JP 2005046170 A	24 February 2005
JP 2012120687 A	28 June 2012	None	
JP 2010125083 A	10 June 2010	None	

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2000312795 A **[0003]**