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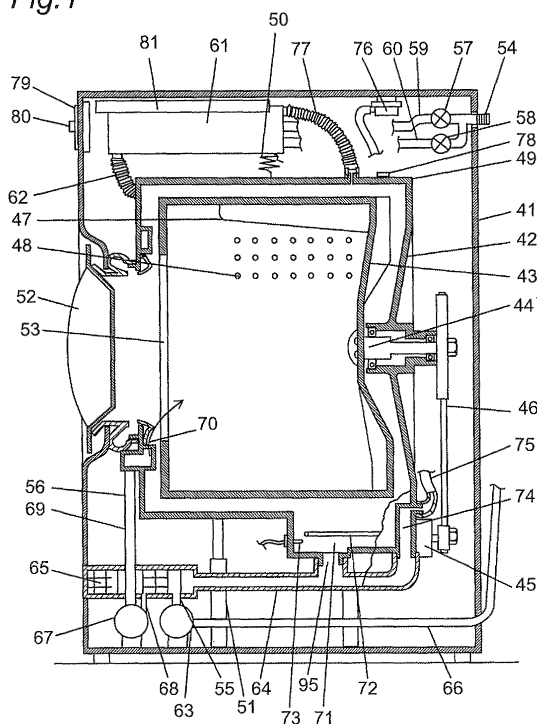
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(54) **DRUM-TYPE WASHING MACHINE**

(57) A drum-type washing machine according to the present invention is adapted to have a mode for selecting a detection axis along which vibration values in a water tank (42) in three-dimensional directions, which have been detected by a vibration detector (78), indicate a maximum value, and for restarting a spin-drying operation when the vibration value detected along this detection axis exceeds a first threshold value defined for each rotation-speed range of a rotary drum (43) but is less than a second threshold value, in spin-drying processes. With this structure, the drum-type washing machine can early detect imbalance abnormalities and can safely stop running.

Fig.1



Description

TECHNICAL FIELD

[0001] The present invention relates to drum-type washing machine for washing a laundry contained in a rotary drum.

BACKGROUND ART

[0002] Conventionally, as a drum-type washing machine of this type, for example, there has been known a washing machine described in Patent Document 1. The washing machine in Patent Document 1 employs a control scheme for performing spin-drying operations while grasping the presence or absence of imbalance abnormalities based on output signals from a vibration detector, during spin-drying processes.

[0003] Fig. 5 is a flow chart of a spin-drying process in the conventional drum-type washing machine described in Patent Document 1.

[0004] After a spin-drying process is started in a step 100, a drainage operation is performed in a step 101. Thereafter, in a step 102, the rotary drum is operated to rotate forwardly and reversely (disentangling processes) at a predetermined rotation speed (e.g., about 40 r/min), in order to disentangle laundries such as clothes which are unevenly laid.

[0005] Next, in a step 103, the rotation speed of the rotary drum is mildly increased to a rotation speed (about 70 r/min) which is enough to cause the laundries to be adhered to the inner surface of the rotary drum. Thereafter, in a step 104, the rotation speed of the rotary drum is increased to a rotation speed (e.g., about 80 r/min) which is lower than the primary resonance rotation speed, and the rotary drum is controlled to be maintained at this rotation speed for a predetermined time period. Further, at this time, detections of the presence or absence of rotational unevenness, namely imbalance abnormalities, are performed. If there is an imbalance abnormality equal to or higher than a predetermined level, it is determined that there is larger rotational unevenness and the laundries are in a poor balance state, and the control shifts to a step 105.

[0006] In the step 105, it is determined whether or not N has gotten to be equal to 4 (N indicates the number of times the steps 102 to 104 have been performed). If N is less than 4, the rotary drum is temporarily stopped in a step 106, further, 1 value is added to the current N value in a step 107, and the control returns to the step 102. When N has gotten to be 4 or more after the operations in the steps 102 to 107 have been repeated, it is regarded that the unevenness of the laundries could not be resolved in the disentangling process in the step 102, and the control shifts to a step 108.

[0007] In the step 108, it is determined whether or not N has gotten to be equal to 10. If N is less than 10, the control shifts to a step 110. In the step 110, an operation

for supplying washing water into the rotary drum to modifying the unevenness of the laundries is performed. After the completion of this operation, the control returns to the step 101. On the other hand, if N is 10 or more in the step 108, the control shifts to a step 109. In the step 109, it is regarded that the unevenness of the laundries could not be resolved and, thus, the occurrence of an imbalance abnormality is displayed, and the running is stopped.

[0008] On the other hand, if there is no imbalance abnormality equal to or higher than the predetermined level in the step 104, it is determined that there is smaller rotational unevenness, and the laundries are in a preferable balance state, and the control shifts to a step 111.

[0009] In the step 111, the rotation speed of the rotary drum is increased to near the primary resonance rotation speed (e.g., 120 to 140 r/min), and the presence or absence of an imbalance abnormality at this rotation speed is determined, based on output signals (which are also referred to as vibration output values) from the vibration detector. If there has occurred an imbalance abnormality, the control shifts to a step 105. If there has occurred no imbalance abnormality and the operation is normal, the control shifts to a step 112.

[0010] In the step 112, the rotation speed of the rotary drum is increased to near the secondary resonance rotation speed (e.g., 141 to 330 r/min), and the presence or absence of an imbalance abnormality at this rotation speed is determined, based on output signals from the vibration detector. If there has occurred an imbalance abnormality, the control shifts to the step 105. If there has occurred no imbalance abnormality and the operation is normal, the control shifts to a step 113.

[0011] In the step 113, the rotation speed of the rotary drum is increased to near a rotation speed (e.g., 800 to 900 r/min) which makes it harder to resolve the adhesion of the laundries to the rotary drum, and the presence or absence of an imbalance abnormality at this rotation speed is determined, based on output signals from the vibration detector. If there has occurred an imbalance abnormality, the control shifts to the step 105. If there has occurred no imbalance abnormality and the operation is normal, the control shifts to a step 114.

[0012] In the step 114, the rotation speed of the rotary drum is increased to a rotation speed (e.g., 900 r/min or more) which makes it harder to resolve the adhesion of the laundries to the rotary drum, and the presence or absence of an imbalance abnormality at this rotation speed is determined, based on output signals from the vibration detector. If there has occurred no imbalance abnormality and the operation is normal, the control shifts to a step 115.

[0013] In the step 115, the rotation speed of the rotary drum is gradually increased toward a maximum rotation speed, and every time the rotation speed has been increased, the control returns to the step 114 where the presence or absence of an imbalance abnormality at this rotation speed is determined. If there has occurred no

imbalance abnormality and the operation is normal, the control shifts to the step 115 where the rotation speed of the rotary drum is increased to the maximum rotation speed. Thereafter, the control shifts to a step 117. On the other hand, if there has occurred an imbalance abnormality, the control shifts to a step 116 where the rotary drum is operated for a predetermined time period while being maintained at the rotation speed which has induced the imbalance abnormality. Thereafter, the control shifts to the step 117. In the step 117, the rotation of the rotary drum is stopped. Thereafter, the control shifts to a subsequent process in a step 118.

PATENT DOCUMENT

[0014] Patent Document 1: JP-A No. 2009-213803

SUMMARY OF THE INVENTION

Problems to be solved by the Invention

[0015] The aforementioned conventional drum-type washing machine has had the problem that it cannot accurately detect imbalance abnormalities and cannot safely stop running, in cases of performing spin-drying on waterproof clothes and water-repellent clothes such as outdoor clothes, namely laundries which are not permeable to water or are less permeable to water.

[0016] If the rotary drum containing laundries is rotated at a higher speed, water is separated from the laundries due to centrifugal forces, and the separated water moves to the outside of the rotary drum. In this manner, spin-drying operations are performed. However, in cases of performing spin-drying operations on laundries which are waterproof-finished or water-repellent-finished, separated water may be inhibited from moving to the outside of the rotary drum due to their waterproof surfaces and the water-repellent surfaces. In this case, even when the laundries within the rotary drum are in an imbalance state, the weight distribution within the rotary drum is in a relatively-balanced state. Consequently, output signals from the vibration detector are made smaller, and the rotation speed of the rotary drum is increased to a higher-speed range. However, if the laundries within the rotary drum are changed in attitude even slightly due to centrifugal forces caused by the rotation of the rotary drum, the water within the rotary drum may be ejected, at a dash, to the outside of the rotary drum, which may suddenly induce an imbalance abnormality. In this case, the rotation speed of the rotary drum has been increased to the higher-speed range, which may make it impossible to safely stop running.

[0017] It is an object of the present invention to overcome the aforementioned conventional problem and to provide a drum-type washing machine capable of early detecting imbalance abnormalities and safely stopping running.

Means to Solve the Problems

[0018] In order to solve the above problems, a drum-type washing machine of the invention comprises:

- a rotary drum;
- a water tank containing the rotary drum;
- a motor rotating the rotary drum;
- a washing machine housing elastically supporting the water tank;
- a vibration detector detecting vibration components in three-dimensional directions in the water tank;
- a rotation speed detector detecting a rotation speed of the rotary drum;
- an operation display including an input setting portion and a display portion; and
- a controller controlling the motor to perform laundering processes including a spin-drying process; wherein
- the controller has a mode for selecting a detection axis along which the vibration values detected by the vibration detector indicate a maximum value in the three-dimensional directions in the water tank, and for restarting a spin-drying operation when the vibration value detected along the selected detection axis exceeds a first threshold value defined for each rotation-speed range of the rotary drum but is less than a second threshold value, in the spin-drying process.

Effects of the Invention

[0019] The drum-type washing machine according to the present invention is capable of early detecting imbalance abnormalities and safely stopping running.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] These aspects and features of the invention will be apparent from the following description concerning a preferred embodiment with respect to the accompanying drawings, in which:

Fig. 1 is a longitudinal cross-sectional view of a drum-type washing machine according to an embodiment of the present invention.

Fig. 2 is a circuit diagram illustrating structures relating to a control device in the drum-type washing machine in Fig. 1, by indicating a portion thereof in a block manner;

Fig. 3A is a flowchart of control in the drum-type washing machine in Fig. 1, mainly illustrating laundering processes corresponding to an OutDoor Clothes course;

Fig. 3B is a flowchart of control in the drum-type washing machine in Fig. 1, mainly illustrating laundering processes corresponding to an OutDoor Clothes course;

Fig. 4 is a graph illustrating the relationship between

vibration values of a water tank unit and threshold values, during spin-drying processes, when the Out-Door Clothes course has been selected; and Fig. 5 is a flowchart of control in a conventional drum-type washing machine.

DESCRIPTION OF EMBODIMENTS

[0021] According to a first aspect of the invention, there is provided a drum-type washing machine, comprising:

- a rotary drum;
- a water tank containing the rotary drum;
- a motor rotating the rotary drum;
- a washing machine housing elastically supporting the water tank;
- a vibration detector detecting vibration components in three-dimensional directions in the water tank;
- a rotation speed detector detecting a rotation speed of the rotary drum;
- an operation display including an input setting portion and a display portion; and
- a controller controlling the motor to perform laundering processes including a spin-drying process; wherein

the controller has a mode for selecting a detection axis along which the vibration values detected by the vibration detector indicate a maximum value in the three-dimensional directions in the water tank, and for restarting a spin-drying operation when the vibration value detected along the selected detection axis exceeds a first threshold value defined for each rotation-speed range of the rotary drum but is less than a second threshold value, in the spin-drying process.

[0022] According to a second aspect of the invention, there is provided the drum-type washing machine according to the first aspect, wherein

the controller executes the mode on receiving a command for washing waterproof or water-repellent clothes, from the operation display.

[0023] According to a third aspect of the invention, there is provided the drum-type washing machine according to the first or second aspect, wherein

a spin-drying operation is interrupted and an abnormality is displayed on the operation display, when the vibration value detected along the selected detection axis exceeds the first threshold value and the second threshold value.

[0024] Hereinafter, an embodiment of the present invention will be described with reference to the drawings. It should be noted that the present invention is not limited to this embodiment.

(Embodiment)

[0025] Fig. 1 is a longitudinal cross-sectional view of a drum-type washing machine according to an embodiment of the present invention.

[0026] As illustrated in Fig. 1, within a washing machine housing 41, there is provided a water tank unit 49. The water tank unit 49 includes a water tank 42, a rotary drum 43, and a motor 45. The water tank 42 is placed swingably inside the washing machine housing 41. Within the water tank 42, the rotary drum 43 is rotatably placed. The rotary drum 43 is provided, at the rotational center portion thereof, with a rotation shaft (a rotational center shaft) 44 which extends in the horizontal direction. The motor 45, which is placed near the rear surface of the water tank 42, is coupled to the rotation shaft 44 via a belt 46. The motor 45 drives and rotates the rotary drum 43 in the forward direction or in the reverse direction. On the inner wall surface of the rotary drum 43, there are provided a plurality of protuberances 47 for stirring laundries. Further, the rotary drum 43 is provided, in its outer peripheral surface, with a plurality of water passage holes 48.

[0027] The water tank 42 is supported, in an anti-vibration manner, by a plurality of anti-vibration dampers 51 which are mounted to a lower portion of the washing machine housing 41. Between the water tank 42 and the upper portion of the washing machine housing 41, there are a plurality of spring bodies 50 for swingably supporting them in an anti-vibration manner, as illustrated in Fig. 1.

[0028] Further, the washing machine housing 41 is provided with a housing opening portion, at a position faced to a load outlet/inlet 53 in the rotary drum 43. A lid body 52 is provided in such a way as to cover the housing opening portion, in an openable and closable manner. By opening the lid body 52, it is possible to remove or put laundries into the rotary drum 43 through the load outlet/inlet 53.

[0029] Further, a control device 81 is provided, at an upper portion within the washing machine housing 41. The control device 81 is constituted by a microcomputer or the like. The control device 81 controls the motor 45, a first electromagnetic valve 57, a second electromagnetic valve 58, a drainage pump 63, and a circulation pump 67, according to mode settings and control programs, in order to execute laundering processes including washing processes, rinsing processes and spin-drying processes.

[0030] Further, within the washing machine housing 41, there are provided a water supply passage 54 for supplying a washing water (e.g., a tap water) into the water tank 42, a drainage passage 55 for discharging the washing water within the water tank 42 to the outside of the washing machine housing 41, and a water circulation passage 56 for circulating the washing water within the water tank 42.

[0031] The water supply passage 54 is constituted by a first water supply hose 59, a second water supply hose 60, a detergent accommodating portion 61, and a water supply passage 62.

[0032] The first water supply hose 59 is provided with the first electromagnetic valve 57. The second water supply hose 60 is provided with the second electromagnetic

valve 58. The detergent accommodating portion 61 accommodates a drawer portion (not illustrated) which contains a detergent or a softening agent, such that it can be pulled out therefrom from the outside. By opening the first electromagnetic valve 57 or the second electromagnetic valve 58, a washing water is flowed into the first water supply hose 59 or the second water supply hose 60. The washing water having flowed into the first water supply hose 59 or the second water supply hose 60 passes through the detergent accommodating portion 61 and the water supply passage 62 and, further, is supplied to the inside of the water tank 42.

[0033] The drainage passage 55 is constituted by a drainage tube 64, a filter 65, a drainage pump 63, and a drainage hose 66.

[0034] The drainage tube 64 is connected to the filter 65 and to a drainage port 95 provided in a recessed portion 71 in the bottom portion of the water tank 42. The filter 65, which is for collecting lint and the like within the washing water, is adapted to be detachable from the outside.

[0035] The drainage pump 63 is connected to the filter 65 and to the drainage hose 66. The drainage hose 66 is provided to extend from the inside of the washing machine housing 41 up to outside and above the washing machine housing 41. At predetermined timings such as when a washing process has been completed or when a rinsing process has been completed, the drainage pump 63 is driven, which causes the washing water within the water tank 43 to be discharged to the outside by passing through the drainage tube 64, the filter 65, the drainage pump 63, and the drainage hose 66, in the mentioned order.

[0036] The water circulation passage 56 is provided for circulating the washing water within the water tank 42, at predetermined timings such as during a pre-washing process, a washing process or a rinsing process. With the water circulation passage 56, it is possible to cause the detergent to be early dissolved in the washing water and, also, it is possible to prevent unevenness of the detergent. This results in improvement of the washing and rinsing abilities of the drum-type washing machine.

[0037] The water circulation passage 56 is constituted by the drainage tube 64, the filter 65, an inflow side passage 68, the circulation pump 67, a discharge side passage 69, and jet ports 70. The inflow side passage 68 is a passage for connecting the filter 65 and the circulation pump 67 to each other. The discharge side passage 69 is a passage for connecting the circulation pump 67 and the jet ports 70 to each other. The jet ports 70 are provided in a front portion of the water tank 42 in such a manner as to eject, into the rotary drum 43, the washing water passing through the discharge side passage 69.

[0038] When the circulation pump 67 is driven, the washing water within the water tank 42 is passed through the drainage tube 64, the filter 65, the inflow side passage 68, the circulation pump 67, the discharge side passage 69, and the jet ports 70, in the mentioned order, and is

ejected into the rotary drum 43 as a circulated water indicated by a solid-line arrow. Further, a plurality of jet ports 70 are provided such that they are arranged in the circumferential direction of the rotary drum 43. Thus, the circulated water is sprinkled, in plural directions, toward the laundries within the rotary drum 43.

[0039] Further, in the recessed portion 71 which is formed in the bottom portion of the water tank 42 and is connected to the drainage tube 64, there is provided a heater 72 constituted by a sheathed heater or the like, in order to heat the washing water. The heater 72 is placed such that its longitudinal direction is coincident with or substantially coincident with the horizontal direction. The heater 72 heats the washing water within the water tank 42.

[0040] The washing water having been heated by the heater 72 is circulated through the water circulation passage 56, further is ejected into the rotary drum 43 and is sprinkled onto the laundries. Thereafter, the washing water having been sprinkled onto the laundries is moved into the water tank 42 through the water passage holes 48 and the washing water is heated by the heater 72. These operations are repeated. Since the washing water is heated, molecular activities in the washing water are revitalized and, also, the detergent is activated. This results in improvement of the washing ability of the washing water, thereby reducing washing unevenness in the laundries. Further, near the heater 72, there is provided a temperature detector 73 such as a thermistor for detecting the temperature of water.

[0041] Further, the water tank 42 is provided, in its side wall in the rear side of the bottom portion, with an air trap 74 so as to communicate with the drainage tube 64. The air trap 74 is connected to an air tube 75. The air tube 75 is connected to a water level detector 76 which is provided at an upper portion within the washing machine housing 41. For example, the water level detector 76 is constituted by a pressure sensor. The water level detector 76 is adapted to detect the water level of the washing water within the water tank 42, based on the water pressure of the washing water within the water tank 42, namely based on the pressure within the air trap 74 which corresponds thereto.

[0042] Further, at an upper portion within the washing machine housing 41, there is provided a coupling hose 77 which couples an upper portion of the water tank 42 to an upper portion of the rear surface of the detergent accommodating portion 61. The coupling hose 77 has the function of removing air within the water tank 42 which has been pressurized during laundering processes.

[0043] Further, at a rear portion of the upper surface of the water tank 42, there is placed a vibration detector 78 for detecting vibrations in the water tank unit 49. In the present embodiment, an acceleration sensor is employed as the vibration detector 78, wherein the acceleration sensor is adapted to detect vibration components in three-dimensional directions, which are the forward and rearward direction (the X-axis direction), the clock-

wise and counterclockwise direction (the Y-axis direction), and the upward and downward direction (the Z-axis direction), rather than vibrations only in a single direction. In this case, the each axis in the three-dimensional directions detected by the vibration detector 78 will be referred to as "detection axis". In actual, vibrations in the water tank unit 49 do not always occur only in a single direction. Therefore, by employing, as the vibration detector 78, the acceleration sensor adapted to detect vibrations in plural directions, it is possible to detect vibrations in the water tank unit 49 with higher accuracy. The control device 81 controls operations, based on results of detections by the vibration detector 78.

[0044] Further, the washing machine housing 41 is provided with an operation display 79, at an upper portion of its front surface. The operation display 79 is provided with an input setting portion 80 which enables making settings (selections) of various functions and modes such as running courses, and a display portion 96 (see Fig. 2) which displays information having been inputted to the input setting portion 80. The user can make settings of various functions and modes such as running courses, by performing inputting to the input setting portion 80.

[0045] Fig. 2 is a circuit diagram illustrating the structures relating to the control device in the drum-type washing machine according to the embodiment of the present invention, by indicating portions thereof in a block manner.

[0046] As illustrated in Fig. 2, the control device 81 includes a controller 82, and a load drive portion 86. If a power switch 84 is turned on, the controller 82 starts controlling respective portions, by being supplied with electric power from a commercial power source 83. The controller 82 controls the load drive portion 86, based on output signals from the water level detector 76, the temperature detector 73, a cloth amount detector 85, the vibration detector 78, and a rotation speed detector 90. The load drive portion 86 is constituted by a bidirectional thyristor, a relay, and the like. The load drive portion 86 operates the motor 45, the heater 72, the first electromagnetic valve 57, the second electromagnetic valve 58, the drainage pump 63, the circulation pump 67, and the like, under the control of the controller 82. Thus, washing processes, rinsing processes, and spin-drying processes are performed. Further, the cloth amount detector 85 is adapted to detect the amount of laundries within the rotary drum 43. Further, the rotation speed detector 90 is adapted to detect the rotation speed of the rotary drum 43, by detecting the number of rotations of the rotary drum 43 per unit time.

[0047] Further, the controller 82 displays information based on the contents of settings having been inputted to the input setting portion 80 on the display portion 96. Further, when some sorts of abnormalities in operations of the respective portions occur, the controller 82 displays the fact that there have occurred such abnormalities on the display portion 96 and, further, generates a notification through a notification portion 87.

[0048] The drum-type washing machine having the aforementioned structure will be described, with respect to operations thereof.

[0049] Figs. 3A and 3B illustrate flow charts of control in the drum-type washing machine according to the embodiment of the present invention, mainly illustrating laundering processes corresponding to an OutDoor Clothes course. Fig. 4 is a graph illustrating the relationship between vibration values of the water tank unit and threshold values, during spin-drying processes, when the OutDoor Clothes course has been selected.

[0050] At first, the user opens the lid body 52 and puts clothes into the rotary drum 43. Thereafter, the user selects a desired course, from various courses including the OutDoor Clothes course, and, then, pushes a start button (not illustrated), thereby starting running under the control of the controller 82. Further, in the present embodiment, the term "OutDoor clothes" refers to water-proof clothes or water-repellent clothes.

[0051] In a step S1, it is determined whether or not the OutDoor Clothes course has been selected. If the selected course is not the OutDoor Clothes course (in the case of No), laundering processes corresponding to this selected course are performed. If the selected course is the OutDoor Clothes course (in the case of Yes), a washing process is performed in a step S2, further, a rinsing (1) process is performed in a step S3, and a rinsing (2) process is performed in a step S4. When the step S4 has been completed, the control shifts to a step S5 where a spin-drying process is started.

[0052] In the step S5, the drainage pump 63 is driven, thereby discharging the washing water within the rotary drum 43. In a step S6, the motor 45 is driven to rotate the rotary drum 43 at a predetermined rotation speed (e.g., about 50 r/min), while reversing the direction of rotations thereof (changing the direction of rotations thereof so as to alternately rotate it clockwise and counterclockwise). Thus, the clothes having been entangled with one another during the washing process and the rinsing processes within the rotary drum 43 are disentangled (a disentangling process).

[0053] In a step S7, the rotation speed of the rotary drum 43 is increased in a stepwise manner. In a step S8, the vibration detector 78 detects vibration values of the water tank unit 49 in the three-dimensional directions when the rotation speed of the rotary drum 43 is 300 to 400 r/min, and the controller 82 selects the detection axis along which the vibration values indicate a maximum value in the three-dimensional directions. In this case, for ease of description, the description will be continued on the assumption that the selected detection axis is the Z axis.

[0054] In a step S9, the controller 82 compares the vibration value of the water tank unit 49 in the Z-axis direction (the upward and downward direction), which has been detected in the step S8, with a first threshold value a1 for the Z-axis direction, within the rotation-speed range of 300 to 400 r/min. If the vibration value of the

water tank unit 49 in the Z-axis direction, which has been detected in the step S8, is equal to or larger than the first threshold value a1 (in the case of No), the control shifts to a step S16.

[0055] In the step S16, the controller 82 compares the vibration value of the water tank unit 49 in the Z-axis direction, which has been detected in the step S8, with a second threshold value a2 for the Z-axis direction, within the rotation-speed range of 300 to 400 r/min. If the vibration value of the water tank unit 49 in the Z-axis direction, which has been detected in the step S8, is equal to or larger than the second threshold value a2 (in the case of No), the controller 82 determines that it is dangerous to further increase the rotation speed of the rotary drum 43, and the control shifts to a step S22. In the step S22, the controller 82 interrupts the spin-drying process, further causes the display portion 96 to display the fact that an abnormality has occurred and, further, causes the notification portion 87 to generate a notification thereof. If the vibration value of the water tank unit 49 in the Z-axis direction is smaller than the second threshold value a2 (in the case of Yes), the control shifts to a step S20.

[0056] In the step S20, the rotation of the rotary drum 43 is stopped. Subsequently, in a step S21, the controller 82 determines whether or not the number of times the rotation of the rotary drum 43 has been stopped (the cumulative number of times it has been stopped since the start of the spin-drying process) is less than 20. If the number of times the rotation of the rotary drum 43 has been stopped is less than 20 (in the case of Yes), the control returns to the step S6, in order to disentangle the clothes having been entangled with one another. If the number of times the rotation of the rotary drum 43 has been stopped has reached 20 (in the case of No), the controller 82 determines that the entanglement of the clothes cannot be resolved even if the spin-drying process is further continued and, thus, it is hard to restart a spin-drying operation, and the control shifts to the aforementioned step S22.

[0057] On the other hand, if the vibration value of the water tank unit 49 in the Z-axis direction is smaller than the first threshold value a1 in the step S9 (in the case of Yes), the control shifts to a step S10. In the step S10, the rotation speed of the rotary drum 43 is increased. In a step S11, the vibration detector 78 detects a vibration value of the water tank unit 49 when the rotation speed of the rotary drum 43 is 400 to 500 r/min, and the controller 82 compares this detected vibration value with a first threshold value b1 for the Z-axis direction within this rotation-speed range. If the vibration value of the water tank unit 49 in the Z-axis direction, which has been detected in the step S11, is equal to or larger than the first threshold value b1 (in the case of No), the control shifts to a step S17.

[0058] In the step S17, the controller 82 compares the vibration value of the water tank unit 49 in the Z-axis direction, which has been detected in the step S11, with a second threshold value b2 for the Z-axis direction, with-

in the rotation-speed range of 400 to 500 r/min. If the vibration value of the water tank unit 49 in the Z-axis direction is equal to or larger than the second threshold value b2 (in the case of No), the controller 82 determines that it is dangerous to further increase the rotation speed of the rotary drum 43, and the control shifts to the aforementioned step S22. If the vibration value of the water tank unit 49 in the Z-axis direction is smaller than the second threshold value b2 (in the case of Yes), the control shifts to the aforementioned step S20.

[0059] On the other hand, if the vibration value of the water tank unit 49 in the Z-axis direction is smaller than the first threshold value b1 in the step S11 (in the case of Yes), the control shifts to a step S12. In the step S12, the rotation speed of the rotary drum 43 is increased. In a step S13, the vibration detector 78 detects a vibration value of the water tank unit 49 when the rotation speed of the rotary drum 43 is 500 to 600 r/min, and the controller 82 compares this detected vibration value with a first threshold value c1 for the Z-axis direction within this rotation-speed range. If the vibration value of the water tank unit 49 in the Z-axis direction, which has been detected in the step S13, is equal to or larger than the first threshold value c1 (in the case of No), the control shifts to a step S18.

[0060] In the step S18, the controller 82 compares the vibration value of the water tank unit 49 in the Z-axis direction, which has been detected in the step S13, with a second threshold value c2 for the Z-axis direction, within the rotation-speed range of 500 to 600 r/min. If the vibration value of the water tank unit 49 in the Z-axis direction is equal to or larger than the second threshold value c2 (in the case of No), the controller 82 determines that it is dangerous to further increase the rotation speed of the rotary drum 43, and the control shifts to the aforementioned step S22. If the vibration value of the water tank unit 49 in the Z-axis direction is smaller than the second threshold value c2 (in the case of Yes), the control shifts to the aforementioned step S20.

[0061] On the other hand, if the vibration value of the water tank unit 49 in the Z-axis direction is smaller than the first threshold value c1 in the step S13 (in the case of Yes), the control shifts to a step S14. In the step S14, the rotation speed of the rotary drum 43 is increased. In a step S15, the vibration detector 78 detects a vibration value of the water tank unit 49 when the rotation speed of the rotary drum 43 is 600 to 700 r/min, and the controller 82 compares this detected vibration value with a first threshold value d1 for the Z-axis direction within this rotation-speed range. If the vibration value of the water tank unit 49 in the Z-axis direction, which has been detected in the step S15, is equal to or larger than the first threshold value d1 (in the case of No), the control shifts to a step S19.

[0062] In the step S19, the controller 82 compares the vibration value of the water tank unit 49 in the Z-axis direction, which has been detected in the step S15, with a second threshold value d2 for the Z-axis direction, with-

in the rotation-speed range of 600 to 700 r/min. If the vibration value of the water tank unit 49 in the Z-axis direction is equal to or larger than the second threshold value d2 (in the case of No), the controller 82 determines that it is dangerous to further increase the rotation speed of the rotary drum 43, and the control shifts to the aforementioned step S22. If the vibration value of the water tank unit 49 in the Z-axis direction is smaller than the second threshold value d2 (in the case of Yes), the control shifts to the aforementioned step S20.

[0063] On the other hand, if, in the step S15, the vibration value of the water tank unit 49 in the Z-axis direction is smaller than the first threshold value d1 (in the case of Yes), the control shifts to a step S23. In the step S23, the controller 82 determines that the imbalance state falls within a normal range, and the rotation speed of the rotary drum 43 is increased to 800 r/min, which is a maximum spin-drying rotation speed for the OutDoor Clothes course.

[0064] In a step S24, the rotary drum 43 is rotated for a predetermined time period, at the maximum spin-drying rotation speed. After the elapse of the predetermined time period, the rotation of the rotary drum 43 is stopped, and the spin-drying process is completed.

[0065] As described above, in the present embodiment, a selection is made for a detection axis along which vibration values of the water tank unit 49 in the three-dimensional directions, which have been detected by the vibration detector, indicate a maximum value. Further, if the vibration value detected along this detection axis exceeds the first threshold value defined for each rotation-speed range of the rotary drum 43 but is less than the second threshold value, a spin-drying operation is restarted. Thus, even in cases of performing spin-drying operations on laundries which are waterproof-finished or water-repellent-finished, such as outdoor clothes, it is possible to early detect imbalance abnormalities which may be induced due to the properties of such clothes. As a result thereof, it is possible to safely stop the running.

[0066] Further, the present invention is not limited to the aforementioned embodiment and can be implemented in other various aspects. For example, although the vibration detector 78 is adapted to detect vibrations in the water tank unit 49 in the aforementioned description, the vibration detector 78 can be also adapted to detect vibrations in the water tank 42, since vibrations in the water tank unit 49 are substantially the same as vibrations in the water tank 42. In this case, similarly, it is possible to obtain the same effects.

[0067] Further, although, without changing over from the detection axis selected in the aforementioned step S8, the determinations of abnormalities are performed based on vibration values along this detection axis, the present invention is not limited thereto. For example, the detection axis can be re-selected for each rotation-speed range.

[0068] Although the present invention has been fully described in connection with the preferred embodiment

thereof with reference to the accompanying drawings, it is to be noted that various changes and modifications are apparent to those skilled in the art. Such changes and modifications are to be understood as included within the scope of the present invention as defined by the appended claims unless they depart therefrom.

[0069] The entire disclosure of Japanese Patent Application No. 2011-036743 filed on February 23, 2011, including specification, drawings, and claims is incorporated herein by reference in its entirety.

Industrial Applicability

[0070] As described above, the drum-type washing machine according to the present invention is capable of early detecting imbalance abnormalities and safely stopping running and, therefore, can be applied to applications of other washing machines having spin-drying functions, and the like.

Claims

1. A drum-type washing machine, comprising:

- a rotary drum;
- a water tank containing the rotary drum;
- a motor rotating the rotary drum;
- a washing machine housing elastically supporting the water tank;
- a vibration detector detecting vibration components in three-dimensional directions in the water tank;
- a rotation speed detector detecting a rotation speed of the rotary drum;
- an operation display including an input setting portion and a display portion; and
- a controller controlling the motor to perform laundering processes including a spin-drying process; wherein
- the controller has a mode for selecting a detection axis along which the vibration values detected by the vibration detector indicate a maximum value in the three-dimensional directions in the water tank, and for restarting a spin-drying when the vibration value detected along the selected detection axis exceeds a first threshold value defined for each rotation-speed range of the rotary drum but is less than a second threshold value, in the spin-drying process.

2. The drum-type washing machine according to claim 1, wherein

the controller executes the mode on receiving a command for washing waterproof or water-repellent clothes, from the operation display.

3. The drum-type washing machine according to claim

1 or 2, wherein

a spin-drying operation is interrupted and an abnormality is displayed on the operation display, when the vibration value detected along the selected detection axis exceeds the first threshold value and the second threshold value.

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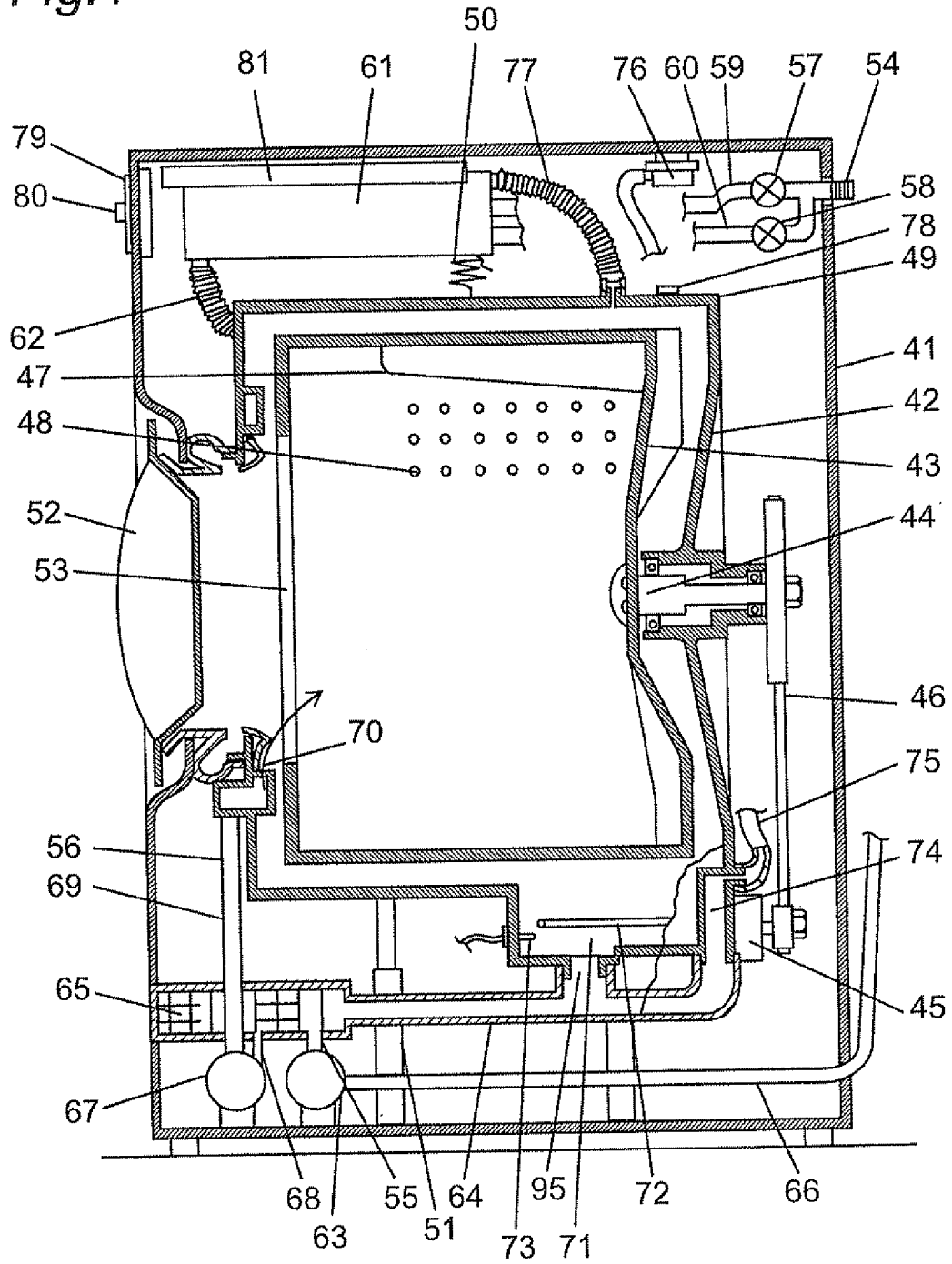
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Fig. 1



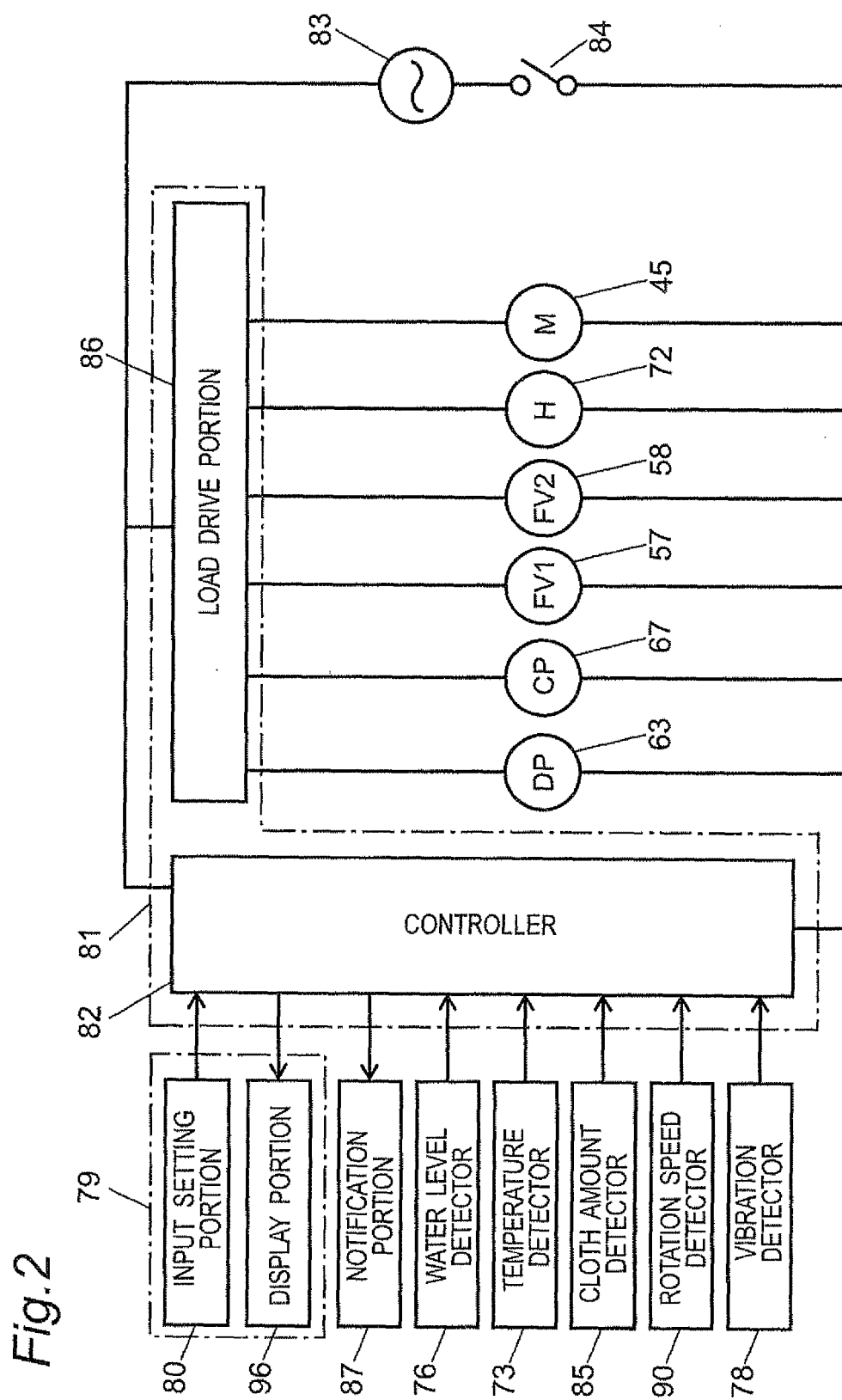


Fig.3A

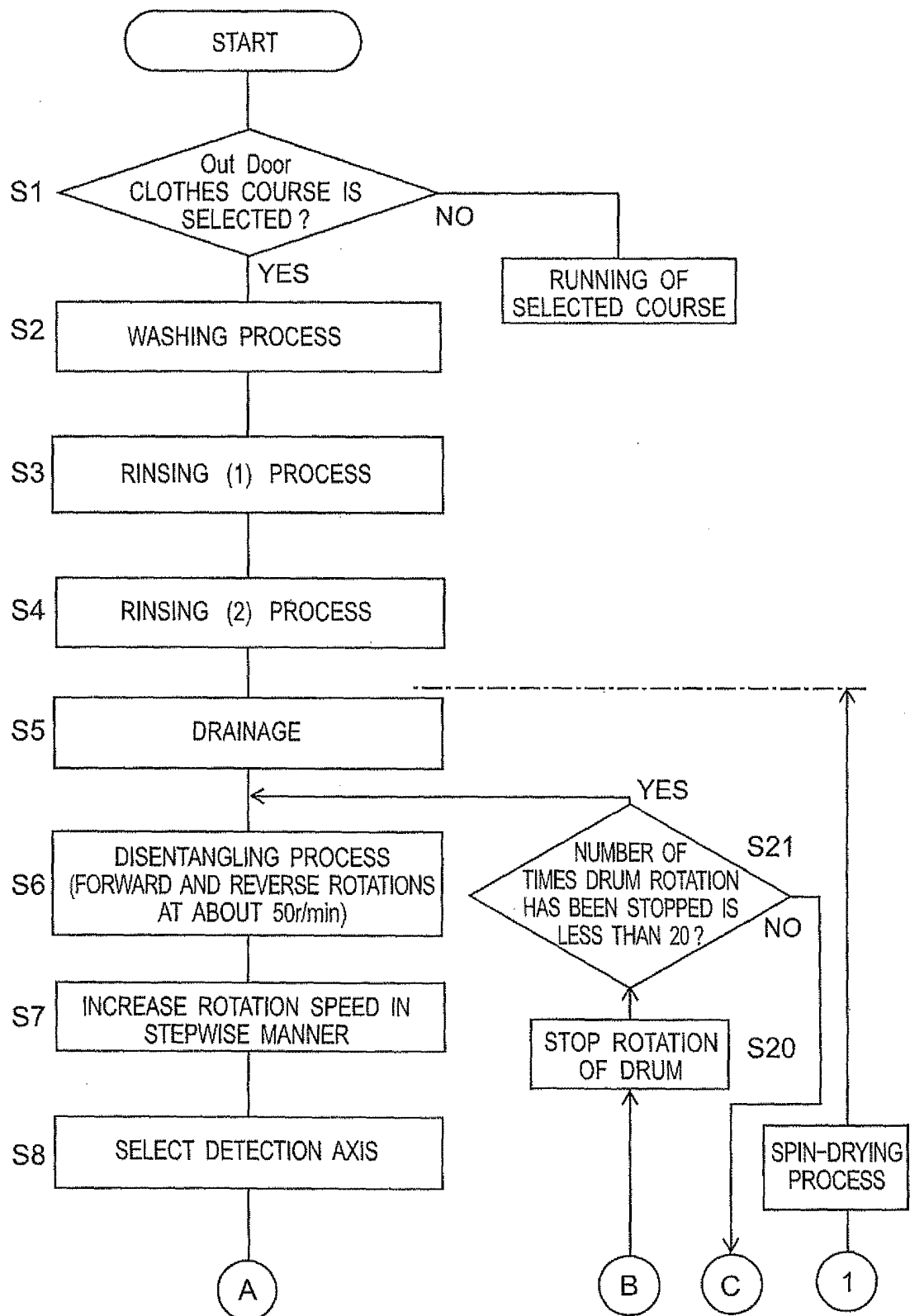


Fig.3B

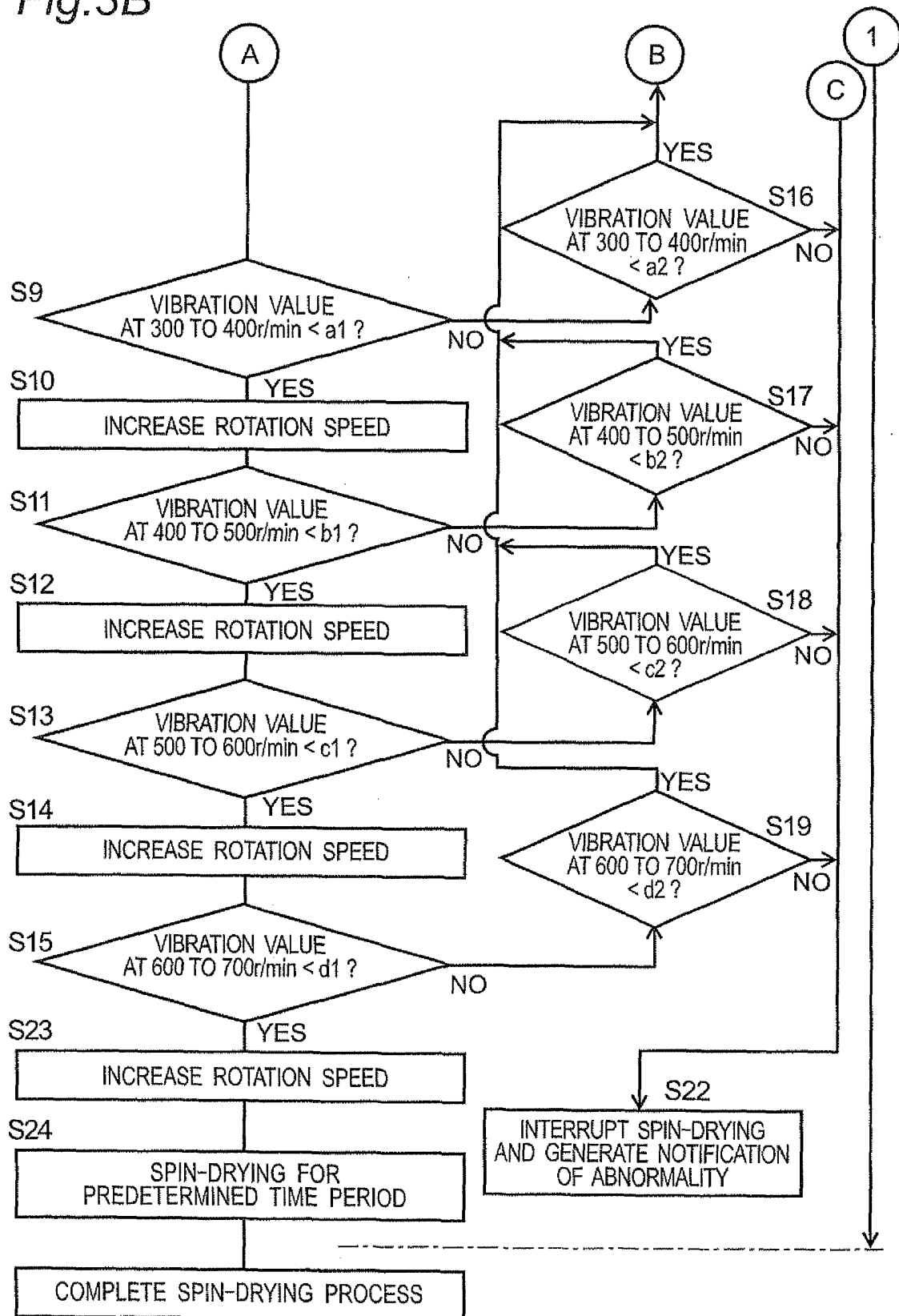


Fig. 4

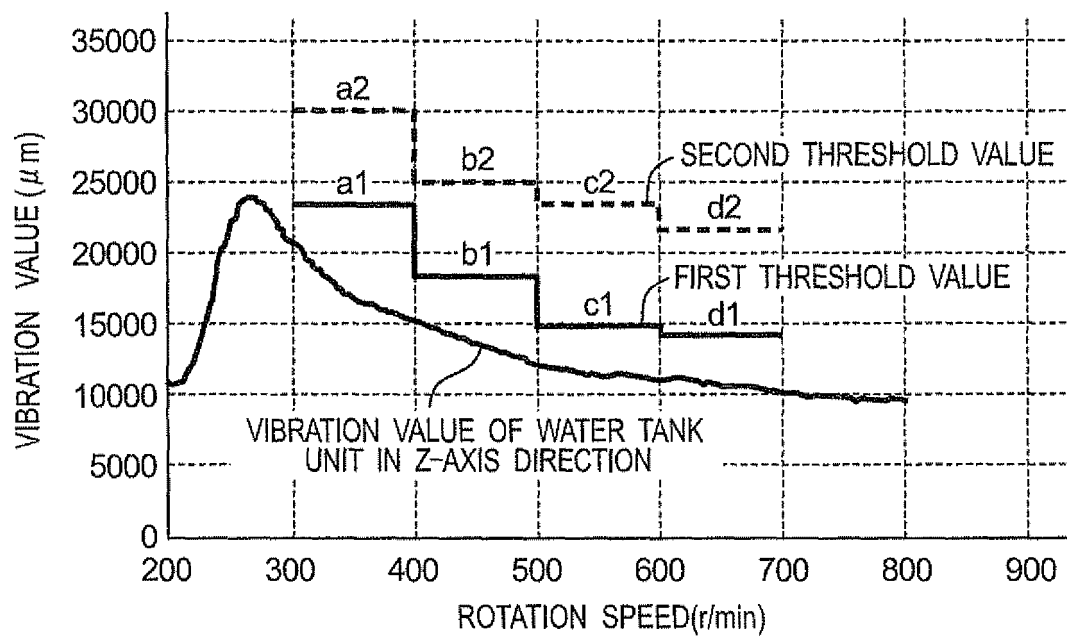
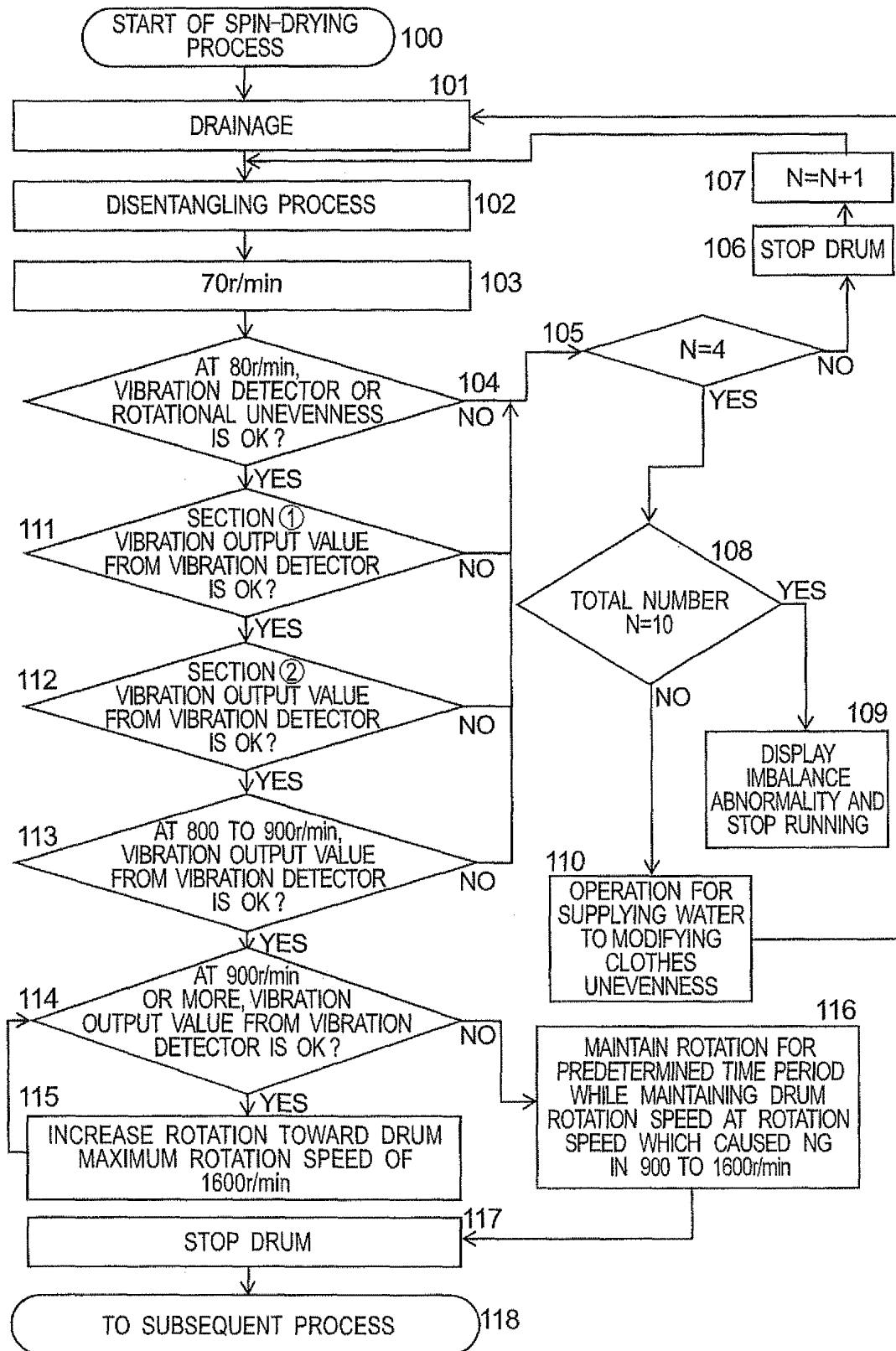


Fig. 5



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/001116

A. CLASSIFICATION OF SUBJECT MATTER

D06F33/02 (2006.01) i, D06F23/02 (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)

D06F33/02, D06F23/02

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2012

Kokai Jitsuyo Shinan Koho 1971-2012 Toroku Jitsuyo Shinan Koho 1994-2012

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2007-236585 A (Matsushita Electric Industrial Co., Ltd.), 20 September 2007 (20.09.2007), paragraphs [0047], [0101] (Family: none)	1, 3 2
Y	JP 2010-279410 A (Panasonic Corp.), 16 December 2010 (16.12.2010), paragraphs [0028] to [0030] (Family: none)	1, 3
Y	JP 2010-75669 A (Panasonic Corp.), 08 April 2010 (08.04.2010), paragraph [0025] & EP 2319971 A1 & WO 2010/023912 A1 & CN 102137966 A	3



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

24 April, 2012 (24.04.12)

Date of mailing of the international search report

15 May, 2012 (15.05.12)

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/001116

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 2006-149423 A (Matsushita Electric Industrial Co., Ltd.), 15 June 2006 (15.06.2006), paragraph [0017] (Family: none)	2

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2009213803 A [0014]
- JP 2011036743 A [0069]