

## DESCRIPTION

### DRUM-TYPE LAUNDRY MACHINE

#### 5 TECHNICAL FIELD

[0001]

The present disclosure relates to a drum-type laundry machine that detects an unbalanced state of clothes in a rotary drum.

#### 10 BACKGROUND ART

[0002]

Conventionally, as a drum-type laundry machine, there is known a drum-type laundry machine that detects whether clothes in a rotary drum provided inside or within a water tub are unevenly distributed at a front side of  
15 or a rear side of the rotating drum.

[0003]

When there is an unbalanced load at a front side of the rotary drum, there are problems as follows.

[0004]

20 The first problem is that there is a high possibility that vibration of a front part of the water tub may cause abnormal vibration of a washing machine body. A seal member or the like for suppressing leakage of washing water is provided between a loading port of the washing machine body and an opening of the water tub. Thus, the vibration of the front part of the water tub is easily  
25 transmitted to the washing machine body.

[0005]

The second problem is that the unbalanced load at the front side is

heavily applied to the shaft. The shaft is connected to the rear side of the rotary drum. Thus, when there is an unbalanced load at the rear side of the rotary drum, the shaft is not heavily loaded. On the other hand, when there is an unbalanced load at the front side of the rotary drum, the shaft is heavily  
5 loaded because a distance from the shaft to the front side of the rotary drum is long. This can possibly damage the shaft.

[0006]

PTL 1 discloses a drum-type laundry machine that determines a position of an unbalanced load and determines the unbalanced state of clothes  
10 from the vibration of the front part of the water tub and a correlation obtained in an experiment.

[0007]

The washing machine in PTL 1 includes a water tub supported inside or within a laundry housing, a rotary drum rotatably provided inside or within the  
15 water tub, and a vibration detecting means that is provided at a front part of an upper surface of the water tub and detects a vibration component in a three-dimensional direction. The washing machine identifies the unbalanced load in the water tub in a spin-drying operation, using a two-way vibration component detected at the front part of the water tub, and the correlation of the  
20 vibration component of the rear part of the water tub with the vibration component of the front part of the water tub obtained by the experiment.

Citation List

Patent Literature

[0008]

25 PTL 1: Unexamined Japanese Patent Publication No. 2010-136903

SUMMARY OF THE INVENTION

[0009]

However, in the conventional configuration, the position of the unbalanced load is estimated based on the correlation obtained in the experiment, and therefore the accuracy of identifying the position of the unbalanced load is low. It may be therefore erroneously determined whether  
5 the unbalanced state exists at the front side or the rear side.

[0010]

The present disclosure provides the drum-type laundry machine that detects vibration of the water tub and determines, based on a detected value,  
10 whether the unbalanced load of laundry in the rotary drum is at the front side or the rear side.

[0011]

The drum-type laundry machine of the present disclosure includes a housing, an outer tub swingably supported inside or within (in) the housing, an  
15 inner tub rotatably disposed inside or within the outer tub and provided such that an axis of rotation is horizontal or is inclined from a horizontal direction, a motor disposed inside or within the housing and configured to rotate the inner tub around the axis of rotation, a vibration detector disposed in the outer tub and configured to detect motion information of the outer tub along a first axis  
20 and a second axis intersecting each other in a side view, and a controller configured to control the motor based on the motion information of the outer tub detected by the vibration detector and control a washing operation, a rinsing operation, and a spin-drying operation.

[0012]

25 In a spin-drying operation, the controller is configured to compare motion information of the outer tub along another axis different from one axis when the motion information of the outer tub along one of a first axis or a

second axis is a maximum value, with the motion information of the outer tub along the other axis when the motion information of the outer tub along the one axis is a minimum value, and the controller is thereby configured to determine a position of an unbalanced load in the inner tub, and control the motor based  
5 on a position of the unbalanced load in the inner tub that has been determined.  
[0013]

The drum-type laundry machine of the present disclosure can detect an unbalanced load of the laundry in the rotary drum and determine whether the unbalanced load of the laundry in the rotary drum is at the front side or the  
10 rear side.

## BRIEF DESCRIPTION OF DRAWINGS

[0014]

FIG. 1 is a sectional view of a drum-type laundry machine according to  
15 a first exemplary embodiment of the present disclosure as viewed from a side surface.

FIG. 2A is a schematic diagram when an unbalanced load occurs at a front side of a rotary drum of the drum-type laundry machine according to the first exemplary embodiment of the present disclosure.

20 FIG. 2B is a schematic diagram when an unbalanced load occurs at a rear side of the rotary drum of the drum-type laundry machine according to the first exemplary embodiment of the present disclosure.

FIG. 3A is a schematic diagram in which vibration amplitude values detected by a vibration detector are plotted when an unbalanced load is present  
25 at a front side of the drum-type laundry machine according to the first exemplary embodiment of the present disclosure.

FIG. 3B is a schematic diagram in which vibration amplitude values

detected by the vibration detector are plotted when an unbalanced load is present at a rear side of the drum-type laundry machine according to the first exemplary embodiment of the present disclosure.

FIG. 4 is a flowchart for determining a position of an unbalanced load in the spin-drying operation of the drum-type laundry machine according to the first exemplary embodiment of the present disclosure.

## DESCRIPTION OF EMBODIMENTS

[0015]

Hereinafter, exemplary embodiments will be described in detail with reference to the drawings as appropriate. However, the exemplary embodiments may not be described unnecessarily in detail. For example, a detailed description of a well-known item and a redundant description of substantially the same configuration may be omitted. Consequently, the following description is not unnecessarily wordy, and thus is easily understood by a person skilled in the art.

[0016]

Note that the attached drawings and the following description are provided for those skilled in the art to fully understand the present disclosure, and are not intended to limit the subject matter as described in the appended claims.

[0017]

Further, each drawing is a schematic diagram and is not necessarily precisely illustrated. In each drawing, substantially the same constituent elements are denoted by the same reference marks, and description thereof may be omitted or simplified.

[0018]

(First exemplary embodiment)

Hereinafter, a first exemplary embodiment will be described with reference to FIGS. 1 to 3B.

[0019]

5           FIG. 1 is a sectional view of a drum-type laundry machine according to the first exemplary embodiment as viewed from a side surface. In FIG. 1, a front-rear direction of the washing machine body is referred to as an X-axis, a vertical direction of the washing machine body is referred to as a Y-axis, and a lateral direction of the washing machine body is referred to as a Z-axis. Note  
10   that these axes are merely shown for convenience, and do not limit the present disclosure in any way.

[0020]

In FIG. 1, water tub 19 has a bottomed cylindrical shape, and is disposed inside or within (in) housing 6. Water tub 19 is elastically supported  
15   by a plurality of suspensions 31 and a plurality of anti-vibration dampers 26 such that a central axis of water tub 19 lowers from a front side toward a rear side. A front side of water tub 19 is covered with water tub cover 27 including resin. Seal member 23 including a resin material is provided between a front side of water tub cover 27 and a front side of housing 6. Water tub cover 27  
20   and water tub 19 configures water tub unit 37. The resin material forming seal member 23 includes a synthetic rubber material.

[0021]

Lid 10 is openably and closably provided to cover an opening of housing 6. A user can put the laundry (clothes) in and out of rotary drum 17 by  
25   opening lid 10.

[0022]

Rotary drum 17 is rotatably disposed inside or within water tub 19.

Rotary drum 17 is in a bottomed cylindrical shape. That is, rotary drum 17 has a bottomed cylindrical shape. Multiple water passage holes 18 are provided on a side surface of rotary drum 17. Further, a plurality of protruding plates 22 for agitating clothes is provided on an inner wall surface of rotary drum 17. Inside or within rotary drum 17, each of the plurality of protruding plates 22 lifts the clothes to a predetermined height as rotary drum 17 rotates, and then drops the lifted clothes downward.

[0023]

One end of shaft 24 is fixed to a bottom of rotary drum 17. Shaft 24 is provided to pass through the central axis of rotary drum 17 and extend to a rear surface of rotary drum 17. Shaft 24 is supported by bearing 25 to penetrate a bottom of water tub 19. Bearing case 15 is disposed at the bottom of water tub 19. Bearing case 15 houses bearing 25. The other end of shaft 24 penetrates bearing case 15 and is fixed to drum pulley 28 disposed below bearing case 15.

[0024]

Drum drive motor 21 is disposed below water tub 19. Belt 29 is stretched between drum pulley 28 and drum drive motor 21. Rotational driving force of drum drive motor 21 is transmitted to rotary drum 17 via belt 29, drum pulley 28, and shaft 24. As a result, rotary drum 17 rotates.

[0025]

Vibration detection device 40 is disposed on a front part of a top surface of the water tub cover. Vibration detection device 40 is configured by a triaxial acceleration sensor. Vibration detection device 40 detects motion information of water tub unit 37 along the X-axis and the Y-axis. Specifically, vibration detection device 40 obtains an acceleration value of water tub unit 37 along the X-axis and the Y-axis, and detects a vibration amplitude value from the

obtained acceleration value.

[0026]

Controller 20 is provided at a rear side of housing 6. Controller 20 controls a series of operations including a washing operation, a rinsing  
5 operation, a spin-drying operation, and a drying operation based on the user's instruction input and operation state monitoring of each component.

[0027]

Next, the operations of the drum-type laundry machine will be described with reference to FIGS. 2A and 2B.

10 [0028]

First, a basic operation of the laundry operation according to the present exemplary embodiment will be described.

[0029]

The laundry operation is configured by the washing operation of  
15 rotating clothes immersed in detergent water in rotary drum 17, the rinsing operation of rinsing clothes containing detergent water with water, and the spin-drying operation of spin-drying clothes containing water in water tub unit 37.

[0030]

20 First, the washing operation will be described. The user puts clothes in rotary drum 17. Then, the user operates the operation display unit (not shown) of the washing machine to start the washing operation. When the washing operation starts, a predetermined amount of tap water is supplied (water supply) into water tub 19. Also, water is supplied to a detergent case  
25 (not shown) in which the detergent is stored, and detergent water in which the detergent is dissolved is poured into water tub 19. After the water supply ends, rotary drum 17 is rotated by drum drive motor 21 to start the washing

operation. In the washing operation, the clothes are agitated for predetermined washing time to remove attached dirt and the like.

[0031]

Next, the rinsing operation will be described. When the washing  
5 operation ends, the dirty washing water is drained from water tub 19, and the operation is shifted to the rinsing operation. The rinsing operation is performed by repeating the rinsing operation and the spin-drying operation. In the rinsing operation, a predetermined amount of tap water is supplied into water tub 19, rotary drum 17 rotates, and the dirt and washing water removed  
10 from the clothes during the washing operation are drained from water tub 19. The spin-drying operation will be described later. When the rinsing operation ends, the spin-drying operation in the spin-drying operation starts.

[0032]

Next, the spin-drying operation will be described. In the spin-drying  
15 operation, drum drive motor 21 rapidly rotates to spin-dry the washing water contained in the laundry. When the spin-drying operation starts, controller 20 starts the rotation of rotary drum 17 and gradually increases a rotation speed of rotary drum 17 until the rotation speed reaches about 800 r/min. The laundry stored in rotary drum 17 adheres to the inner wall of rotary drum 17 by  
20 centrifugal force as the rotation speed increases.

[0033]

When rotary drum 17 rapidly rotates, the laundry is not evenly attached to an inner peripheral wall of rotary drum 17, and a position of the laundry inside or within rotary drum 17 is in an unbalanced state (ununiform  
25 state). As a result, an unbalanced load may occur on rotary drum 17. When an unbalanced load occurs, water tub unit 37 driven by drum drive motor 21 does not perform a predetermined circular motion but a rotational motion that

draws an ellipse. In the present exemplary embodiment, in order to detect this unbalanced state, unbalance determination is performed.

[0034]

The unbalance determination is started when the rotation speed of rotary drum 17 reaches about 800 r/min. In the unbalance determination, the unbalanced state is detected from a locus of vibration of rotary drum 17 and water tub unit 37.

[0035]

FIG. 2A is a schematic diagram when an unbalanced load occurs at a front side of the rotary drum of the drum-type laundry machine according to the first exemplary embodiment. FIG. 2B is a schematic diagram when an unbalanced load occurs at a rear side of the rotary drum of the drum-type laundry machine according to the first exemplary embodiment. In FIGS. 2A and 2B, a front-rear direction of the washing machine body is referred to as the X-axis, a vertical direction of the washing machine body is referred to as the Y-axis, and a lateral direction is referred to as the Z-axis, as in FIG. 1. Note that these axes are merely shown for convenience, and do not limit the present disclosure in any way.

[0036]

When laundry 50 is unevenly distributed at the front side of rotary drum 17, rotary drum 17 swings so as to draw an ellipse centered on rotation center A behind rotary drum 17. Rotation center A takes different positions depending on positions and amounts of laundry 50. As rotary drum 17 swings, water tub unit 37 and vibration detection device 40 also vibrate so as to draw an ellipse centered on rotation center A behind rotary drum 17.

[0037]

Thus, when water tub unit 37 is viewed from a side, a front side of

water tub unit 37 vibrates so as to make a large vertical movement as shown in FIG. 2A.

[0038]

Similarly, when laundry 60 is unevenly distributed at the rear side of rotary drum 17, rotary drum 17 swings so as to draw an ellipse centered on rotation center B in front of rotary drum 17.

[0039]

Thus, when water tub unit 37 is viewed from the side, the rear side of water tub unit 37 vibrates so as to make a large vertical movement as shown in FIG. 2B.

[0040]

Next, the vibration amplitude values detected by vibration detection device 40 when an unbalanced load occurs will be described with reference to FIGS. 3A and 3B.

[0041]

FIG. 3A is a schematic diagram in which the vibration amplitude values detected by the vibration detector are plotted when the unbalanced load is present at the front side of the drum-type laundry machine according to the first exemplary embodiment. FIG. 3B is a schematic diagram in which the vibration amplitude values detected by the vibration detector are plotted when the unbalanced load is present at the rear side of the drum-type laundry machine according to the first exemplary embodiment. In FIGS. 3A and 3B, the front-rear direction of the washing machine body is defined as the X-axis and the vertical direction of the washing machine body is defined as the Y-axis, as in FIG. 1. In FIGS. 3A and 3B, the vibration amplitude value in an X-axis direction is defined as X, and the vibration amplitude value in a Y-axis direction is defined as Y.

[0042]

The locus of the vibration amplitude value in FIG. 3A is an ellipse that rises to the right. A maximum value of X is defined as Xmax and a minimum value of X is defined as Xmin. The value of Y when X = Xmax is defined as Y1,  
5 and the value of Y when X = Xmin is defined as Y2. When there is an unbalanced load at the front side of the washing machine, Y1 is larger than Y2.

[0043]

On the other hand, the locus of the vibration amplitude value in FIG. 3B is an ellipse that rises to the left. Similarly, when there is an unbalanced  
10 load at the rear side of the washing machine, Y1 is smaller than Y2.

[0044]

It is therefore possible to easily determine whether the unbalanced load is at the front side or at the rear side of the washing machine by comparing Y1 with Y2.

15 [0045]

Next, a determination process of the unbalance determination will be described with reference to FIG. 4.

[0046]

When a predetermined period of time elapses after the rotation speed of  
20 rotary drum 17 reaches about 800 r/min, the determination process is started (S100).

[0047]

First, controller 20 sets Xmax to “0” and Xmin to “0” as initial values. Similarly, controller 20 sets Y1 to “0” and Y2 to “0” (S200).

25 [0048]

Next, controller 20 obtains the vibration amplitude value detected by vibration detection device 40 (S300).

[0049]

Next, controller 20 determines whether the obtained value of X is larger than Xmax (S310). In S310, upon determination that the obtained value of X is larger than Xmax (Yes in S310), controller 20 substitutes the value of X into  
5 Xmax and the value of Y into Y1 (S320), and the process proceeds to S400. In S310, upon determination that the obtained value of X is not larger than (smaller than or equal to) Xmax (No in S310), the process proceeds to S330.

[0050]

Next, controller 20 determines whether the obtained value of X is  
10 smaller than Xmin (S330). In S330, upon determination that the obtained value of X is smaller than Xmin (Yes in S330), controller 20 substitutes the value of X into Xmin and the value of Y into Y2 (S340), and the process proceeds to S400. In S330, upon determination that the obtained value of X is not smaller than (larger than or equal to) Xmin (No in S330), the process  
15 proceeds to S400.

[0051]

Next, controller 20 determines whether the elapsed time for the repeated process has reached a predetermined period of time (S400). When controller 20 determines that the elapsed time for the repeated process has not  
20 reached the predetermined period of time (No in S400), then, the vibration amplitude value detected by vibration detection device 40 is obtained again (S300), and the value of X is determined (S310 and S330).

[0052]

Upon determination that the elapsed time for the repeated process has  
25 reached the predetermined period of time (the predetermined period of time has elapsed) (Yes in S400), controller 20 compares the value of Y1 with the value of Y2 (S500). Upon determination that the value of Y1 is larger than the

value of Y2 or the value of Y1 is equal to the value of Y2 (No in S500), controller  
20 determines that the unbalanced load is at the front side (S510).  
Subsequently, controller 20 sets an allowable value of the vibration amplitude  
value to a decreased allowable value that is a value relatively lower than a  
5 predetermined allowable value (S520), and ends the determination process.  
[0053]

Similarly, upon determination that the value of Y1 is smaller than the  
value of Y2 (Yes in S500), controller 20 determines that the unbalanced load is  
at the rear side (S530). Further, controller 20 sets the allowable value of the  
10 vibration amplitude value to an increased allowable value that is a value  
relatively higher than a predetermined allowable value (S540), and ends the  
determination process.  
[0054]

Update time (S300 to S400) for the X value and the Y value is  
15 preferably set to less than or equal to 1/8 of a rotation cycle of rotary drum 17.  
This ensures accuracy of the determination.  
[0055]

Further, the predetermined period of time in the repeated process is  
preferably set to be longer than the rotation cycle of rotary drum 17. From the  
20 repeated process from S300 to S400, Xmax, Xmin, Y1, and Y2 can be obtained.  
[0056]

After the end of the determination process, controller 20 detects the  
vibration amplitude value by vibration detection device 40 and compares the  
vibration amplitude value with the allowable value. At this time, as the  
25 vibration amplitude values, the maximum value and the minimum value along  
each of the X-axis, the Y-axis, and the Z-axis are used. Similarly, as the  
allowable value, the value along each of the X-axis, the Y-axis, and the Z-axis is

set.

[0057]

In the present exemplary embodiment, when the detected vibration amplitude value exceeds the allowable value in any of the X-axis, the Y-axis, and the Z-axis, controller 20 determines that the vibration amplitude value is larger than the allowable value. However, controller 20 may determine that the vibration amplitude value is larger than the allowable value only when the vibration amplitude value exceeds the allowable value in all the X-axis, the Y-axis, and the Z-axis.

10 [0058]

Upon determination that the detected vibration amplitude value is smaller than the allowable value or the detected vibration amplitude value is equal to the allowable value, controller 20 continues the spin-drying operation. Upon determination that the detected vibration amplitude value is larger than the allowable value, controller 20 stops the rotation of rotary drum 17 and shifts the spin-drying operation to a corrective rinsing operation as a corrective operation.

[0059]

First, rotary drum 17 is filled with water, and the corrective rinsing operation for loosening entanglement of the laundry is performed. After the corrective rinsing operation ends, the spin-drying operation starts again.

[0060]

If the unbalanced state is not resolved after repeating the corrective rinsing operation and the spin-drying operation a predetermined number of times, controller 20 notifies abnormality indicating that the unbalanced state is present. When the abnormality is notified, the user needs to open lid 10, take out the laundry in rotary drum 17, and loosen the entanglement. After

removing the entanglement, the user puts the laundry in rotary drum 17, closes lid 10, and restarts the operation via the operation display unit. When the user restarts the operation, controller 20 restarts the spin-drying operation.

[0061]

5           An operation of the determination process configured as above will be described.

[0062]

When the detected vibration amplitude value is larger than the increased allowable value, controller 20 stops the spin-drying operation and  
10       performs the corrective operation regardless of whether the unbalanced load is at the front side or the rear side.

[0063]

When the detected vibration amplitude value is smaller than the increased allowable value and larger than the decreased allowable value,  
15       controller 20 performs different processes when the unbalanced load is at the front side and when the unbalanced load is at the rear side. That is, when the unbalanced load is at the front side, controller 20 stops the spin-drying operation and performs the corrective operation. On the other hand, when the unbalanced load is at the rear side, controller 20 continues the spin-drying  
20       operation.

[0064]

When the unbalanced load is in at the front side, abnormal noise may occur and shaft 24 may be damaged. Thus, the unbalanced state is desirably corrected when the unbalanced load is at the front side. On the other hand,  
25       when the unbalanced load is at the rear side, the possibility of occurrence of abnormality is relatively low. Thus, there are problems such as prolonged laundry operation time and excessive water use (increased water bill) due to

the corrective rinsing. Therefore, setting the allowable value to the increased allowable value that is relatively high will save an unnecessary corrective operation.

[0065]

5           As described above, controller 20 switches the allowable value of the vibration amplitude value based on the position of the unbalanced load, and the unbalanced state can be appropriately dealt with.

[0066]

10           As described above, the drum-type laundry machine according to the present disclosure includes housing 6, water tub unit 37 including water tub 19 swingably supported inside or within (in) housing 6, rotary drum 17 rotatably disposed inside or within water tub unit 37 and provided such that an axis of rotation is horizontal or is inclined from a horizontal direction, drum drive motor 21 disposed inside or within housing 6 and configured to rotate rotary  
15   drum 17 around the axis of rotation, vibration detection device 40 disposed in water tub unit 37 and configured to detect the motion information of water tub unit 37 along a first axis and a second axis intersecting each other in a side view, and controller 20 configured to control drum drive motor 21 based on the motion information of water tub unit 37 detected by vibration detection device  
20   40 and control the washing operation, the rinsing operation, and the spin-drying operation. In the spin-drying operation, controller 20 is configured to compare the motion information of water tub unit 37 along the other axis different from one axis when the motion information of water tub unit 37 along one of the first axis or the second axis is a maximum value, with  
25   the motion information of water tub unit 37 along the other axis when the motion information of water tub unit 37 along the one axis is a minimum value, and the controller is thereby configured to determine the position of the

unbalanced load in rotary drum 17 based on a result of the comparing, and control drum drive motor 21 based on the position of the unbalanced load in rotary drum 17 that has been determined.

[0067]

5           Accordingly, controller 20 can directly determine the unbalanced state from an actual measurement value by vibration detection device 40. Thus, controller 20 can accurately determine whether the unbalanced load is at the front side or at the rear side. This accurately suppresses the occurrence of abnormality due to the unbalanced load in rotary drum 17.

10       [0068]

Further, controller 20 may be configured to determine whether the position of the unbalanced load in rotary drum 17 is at the front side or at the rear side of rotary drum 17 in the spin-drying operation.

[0069]

15           This is expected to be particularly effective in the spin-drying operation with a high rotation speed.

[0070]

Further, controller 20 may be configured to continue the spin-drying operation when the motion information of water tub unit 37 detected by vibration detection device 40 is smaller than or equal to a predetermined allowable value in the spin-drying operation. Controller 20 may be configured to stop the rotation of rotary drum 17 when the motion information of water tub unit 37 detected by vibration detection device 40 is larger than the predetermined allowable value.

25       [0071]

This allows different processing to be performed in accordance with the detected motion information.

[0072]

Further, controller 20 may be configured to continue the spin-drying operation when the motion information of water tub unit 37 detected by vibration detection device 40 is smaller than or equal to a predetermined allowable value in the spin-drying operation. Controller 20 may be configured to stop the rotation of rotary drum 17 when the motion information of water tub unit 37 detected by vibration detection device 40 is larger than the predetermined allowable value. Further, upon determination that the position of the unbalanced load in rotary drum 17 is at the front side of rotary drum 17, controller 20 may be configured to set the predetermined allowable value to be relatively smaller than the predetermined allowable value. Upon determination that the position of the unbalanced load of rotary drum 17 is at the rear side of rotary drum 17, controller 20 may be configured to set the predetermined allowable value to be relatively larger than the predetermined allowable value.

[0073]

This makes it possible to set the allowable value not to apply a load to shaft 24 depending on the position of the unbalanced load.

[0074]

Further, when the motion information of water tub unit 37 detected by vibration detection device 40 is larger than the predetermined allowable value in the spin-drying operation, controller 20 may be configured to stop the rotation of rotary drum 17, perform the corrective operation different from the spin-drying operation, and restart the spin-drying operation after an end of the corrective operation.

[0075]

Accordingly, when the motion information of water tub unit 37 is larger

than the predetermined allowable value, the corrective operation can be performed.

[0076]

Further, the first axis may be an axis parallel to the axis of rotation,  
5 and the second axis may be an axis horizontal or parallel to a virtual line connecting a highest position and a lowest position on a front surface of rotary drum 17.

[0077]

This allows controller 20 to more accurately determine whether the  
10 unbalanced load is at the front side or at the rear side.

[0078]

Further, clothes may be stored inside or within rotary drum 17.  
Controller 20 may be configured to determine the uneven distribution inside or  
within rotary drum 17 of the clothes stored inside or within rotary drum 17 as  
15 the position of the unbalanced load in rotary drum 17.

[0079]

This accurately suppresses the occurrence of abnormality due to an  
unbalanced load of the clothes in rotary drum 17.

[0080]

20 Further, controller 20 may determine the position of the unbalanced load in rotary drum 17 after a passage of a predetermined period of time since the rotation speed of rotary drum 17 reaches a predetermined rotation speed.

[0081]

This makes it possible to determine the position of the unbalanced load  
25 in rotary drum 17 after the rotation speed of rotary drum 17 reaches the predetermined rotation speed.

[0082]

Further, vibration detection device 40 may be an acceleration sensor. Vibration detection device 40 may be configured to detect the acceleration of water tub unit 37 or the vibration amplitude value of water tub unit 37 as the motion information.

5 [0083]

Thus, the position of the unbalanced load in rotary drum 17 can be determined based on the acceleration or the vibration amplitude value.

[0084]

(Other exemplary embodiments)

10 The first exemplary embodiment has been described above to exemplify techniques disclosed in the present application. However, the techniques of the present disclosure are not limited thereto, but may be applicable to exemplary embodiments with changes, additions, omissions, or the like.

[0085]

15 Therefore, other exemplary embodiments will be exemplified below.

[0086]

In the first exemplary embodiment, an attachment position of vibration detection device 40 in the lateral direction is not limited. That is, vibration detection device 40 may be attached to an upper part of water tub unit 37 above the axis of rotation. Further, vibration detection device 40 may be attached to either a left end or a right end of an upside of water tub unit 37. When vibration detection device 40 is attached to either the left end or the right end of water tub unit 37, the vibration amplitude values in all three axes in the front-rear direction, the lateral direction, and the vertical direction can be measured.

25

[0087]

In the first exemplary embodiment, the upper part of the front side of

water tub unit 37 has been described as an example of the attachment position of vibration detection device 40. However, vibration detection device 40 only has to be attached to water tub unit 37, and the attachment position is not limited to the upper part of the front side of water tub unit 37. For example,  
5 the attachment position of vibration detection device 40 may be the upper part of the rear side of water tub unit 37, or a side part and a lower part of water tub unit 37.

[0088]

In the first exemplary embodiment, as an example in which vibration  
10 detection device 40 detects the motion information of water tub unit 37, an example has been described in which vibration detection device 40 detects the motion information of water tub unit 37 along the X-axis and the Y-axis. However, the axes on which vibration detection device 40 detects the motion information of water tub unit 37 are not limited to the X-axis and the Y-axis.  
15 For example, vibration detection device 40 may be configured to detect the motion information of water tub unit 37 along the first axis and the second axis that intersect each other in the side view.

[0089]

In the first exemplary embodiment, an example in which controller 20  
20 performs the determination process using the vibration amplitude value detected by vibration detection device 40. However, the value used by controller 20 is not limited to the vibration amplitude value. For example, controller 20 may perform the determination process using the acceleration value detected by vibration detection device 40.

25 [0090]

In the first exemplary embodiment, vibration detection device 40 is a triaxial acceleration sensor, and the vibration amplitude value is described as

an example of the value detected by vibration detection device 40. However, the value detected by vibration detection device 40 is not limited to the vibration amplitude value or the acceleration, and may be a value indicating the movement of water tub unit 37, that is, a value having a correlation with the motion information of water tub unit 37. For example, vibration detection device 40 may be a speed sensor, and vibration detection device 40 may detect a speed value. In this case, controller 20 may perform the determination process using the speed value detected by vibration detection device 40.

## 10 INDUSTRIAL APPLICABILITY

[0091]

The present disclosure is applicable to a drum-type laundry machine in which uneven distribution of clothes can occur during spin-drying.

## 15 REFERENCE MARKS IN THE DRAWINGS

[0092]

- 6: housing
- 10: lid
- 15: bearing case
- 20 17: rotary drum (inner tub)
- 18: water passage hole
- 19: water tub (outer tub)
- 20: controller
- 21: drum drive motor (motor)
- 25 22: protruding plate
- 23: seal member
- 24: shaft (axis of rotation)

- 26: anti-vibration damper
- 27: water tub cover (outer tub)
- 28: drum pulley
- 29: belt
- 5 31: suspension
- 37: water tub unit (outer tub)
- 40: vibration detection device (vibration detector)
- 50, 60: laundry

## CLAIMS

1. A drum-type laundry machine comprising:
  - a housing;
  - 5 an outer tub swingably disposed in the housing;
  - an inner tub rotatably disposed in the outer tub and having an axis of rotation that is horizontal or is inclined from a horizontal direction;
  - a motor disposed in the housing and configured to rotate the inner tub around the axis of rotation;
  - 10 a vibration detector disposed in the outer tub and configured to detect motion information of the outer tub along a first axis and a second axis that intersect each other in a side view; and
  - a controller configured to control the motor based on the motion information of the outer tub detected by the vibration detector, and to control a washing operation, a rinsing operation, and a spin-drying operation,
  - 15 wherein in the spin-drying operation, the controller is configured to compare (i) the motion information of the outer tub along another axis different from one axis among the first axis and the second axis when the motion information of the outer tub along the one axis is a maximum value with (ii) the motion information of the outer tub along the other axis when the motion information of the outer tub along the one axis is a minimum value, and
  - 20 the controller is configured to determine a position of an unbalanced load in the inner tub based on a result of the comparing, and to control the motor based on the position of the unbalanced load in the inner tub that has
  - 25 been determined.

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

controller is configured to determine whether the position of the unbalanced load in the inner tub is at a front side or a rear side of the inner tub in the spin-drying operation.

5           3. The drum-type laundry machine according to claim 1 or 2, wherein,  
in the spin-drying operation, the controller is configured to continue the  
spin-drying operation when the motion information of the outer tub detected by  
the vibration detector is smaller than or equal to a predetermined allowable  
value, and the controller is configured to stop a rotation of the inner tub when  
10 the motion information of the outer tub detected by the vibration detector is  
larger than the predetermined allowable value.

          4. The drum-type laundry machine according to claim 2, wherein  
in the spin-drying operation, the controller is configured to continue the  
15 spin-drying operation when the motion information of the outer tub detected by  
the vibration detector is smaller than or equal to a predetermined allowable  
value, and the controller is configured to stop a rotation of the inner tub when  
the motion information of the outer tub detected by the vibration detector is  
larger than the predetermined allowable value,

20           the controller is configured to set the predetermined allowable value to  
be relatively smaller than the predetermined allowable value upon  
determination that the position of the unbalanced load in the inner tub is at the  
front side of the inner tub, and

          the controller is configured to set the predetermined allowable value to  
25 be relatively larger than the predetermined allowable value upon  
determination that the position of the unbalanced load in the inner tub is at the  
rear side of the inner tub.

5. The drum-type laundry machine according to claim 3 or 4, wherein,  
in the spin-drying operation, when the motion information of the outer tub  
detected by the vibration detector is larger than the predetermined allowable  
5 value, the controller is configured to stop the rotation of the inner tub, perform  
a corrective operation different from the spin-drying operation, and restart the  
spin-drying operation after an end of the corrective operation.

6. The drum-type laundry machine according to any one of claims 1 to  
10 5, wherein

the first axis is an axis parallel to the axis of rotation, and

the second axis is an axis horizontal or parallel to a virtual line  
connecting a highest position and a lowest position of a front surface of the  
inner tub.

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7. The drum-type laundry machine according to any one of claims 1 to  
6, wherein

clothes are stored in the inner tub, and

the controller is configured to determine an uneven distribution in the  
20 inner tub of the clothes stored in the inner tub as the position of the unbalanced  
load in the inner tub.

8. The drum-type laundry machine according to any one of claims 1 to  
7, wherein the controller is configured to determine the position of the  
25 unbalanced load in the inner tub after a passage of a predetermined period of  
time since a rotation speed of the inner tub reaches a predetermined rotation  
speed.

9. The drum-type laundry machine according to any one of claims 1 to 8, wherein

the vibration detector is an acceleration sensor, and

5 the vibration detector is configured to detect acceleration of the outer tub or a vibration amplitude value of the outer tub as the motion information.