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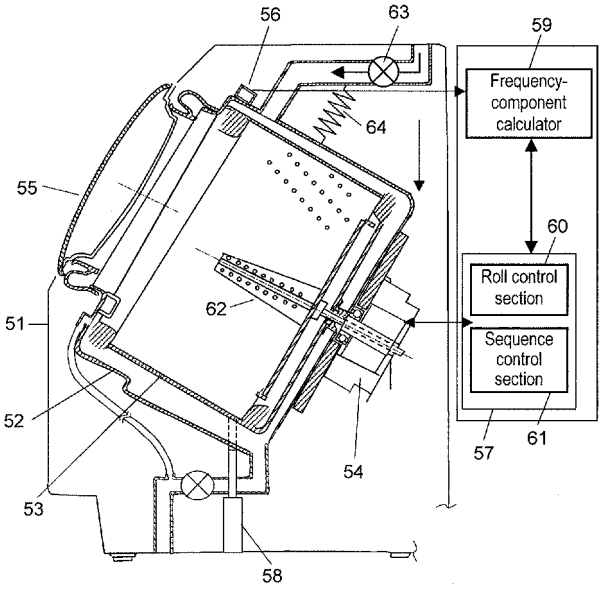
(54) Drum-type washing machine

(57) A drum-type washing machine is disclosed, and during a step of peeling the laundry off rotary drum (53), controller (57) of the washing machine compares a magnitude of vibrations sensed by acceleration sensor (56) and corresponding to a rotary cycle of rotary drum (53) with another magnitude of vibrations sensed by acceleration sensor (56) and corresponding to another rotary cycle of drum (53), so that the controller (57) determines whether or not the laundry is peeled off the inner wall of drum (53). This structure allows sensing accurately the vibration of water tub (52) and also sensing more properly the status whether or not the laundry in drum (53) is peeled off.

FIG. 1



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Description

FIELD OD THE INVENTION

[0001] The present invention relates to a drum-type washing machine in which a cylindrical rotary drum having a bottom is installed in a water tub, and the laundry accommodated in the drum can be washed by rotating the drum.

BACKGROUND OF THE INVENTION

[0002] A conventional drum-type washing machine with a drying function (hereinafter referred to as a drum-type washing machine with dryer) has dehydrated the laundry by spinning the rotary drum at a high speed for using centrifugal force, which spin-dries the laundry. Some of the laundry is thus obliged to stick to the inner wall of the drum after the dehydration. The drying step following this dehydrating step thus ends its process with the laundry half-dried because the laundry stuck to the drum limits the contact area between the drying air and the laundry.

[0003] To overcome this problem, i.e. the laundry suck to the inner wall of the drum, a peeling-off step is introduced in order to peel the laundry off the drum and loosen the laundry. The peeling-off step rotates the drum forward and backward at a fine angle. This driving method of the rotary drum is disclosed in, e.g. Unexamined Japanese Patent Application Publication No. 2000 - 254385 (patent document 1).

[0004] Fig. 6 shows a vertical sectional view illustrating a structure of the conventional drum-type washing machine with dryer disclosed in patent document 1. As shown in Fig. 6, rotary drum 26 is placed in water tub 20 supported by suspension mechanism 22, and driven by motor 24.

[0005] Fig. 7A shows a flowchart illustrating the processes from the final rinsing step to the final dehydrating step of the conventional drum-type washing machine with dryer. Fig. 7B shows a flowchart illustrating the drying operation of the same drum-type washing machine with dryer, and this drying operation follows the steps shown in Fig. 7A. In Fig. 7A, final rinsing operation 70 includes the following steps:

dehydrating step 71 for dehydrating the laundry in drum 26; then
supply-water step 72 for supplying the water into drum 26; and rinsing step 73 for rinsing the laundry in drum 26.

[0006] Final dehydrating operation 74 includes the following steps:

final dehydrating step 75 for dehydrating the laundry in the end; and
peeling-off step 76 for peeling the laundry off the inner wall of drum 26.

[0007] In Fig. 7B, drying operation 77 following the steps shown in Fig. 7A includes the steps of:

drying step 78 for drying the dehydrated laundry; and
cooling step 79 for cooling the dried laundry.

In the last step of the final dehydrating operation 74, i.e. peeling-off step 76, motor 24 is driven at 50 rpm and rotated forward and backward with a fine angle. This low rpm allows loosening the laundry.

[0008] In other words, drum 26 is spun by motor 24 at a high speed, so that the laundry is stuck to the inner wall of drum 26 due to centrifugal force, and then drum 26 is rotated forward and backward at a fine angle, whereby the laundry stuck to the inner wall is peeled off and loosened. The laundry is then moved to drying operation 77.

[0009] The conventional structure discussed above; however, is obliged to take a longer time for the peeling-off step in order to result in the better peeling-off and the better loosening of the laundry obstinately suck to the inner wall of the drum. On the other hand, the washing machine is required to work more conveniently to the user, e.g. improvement in dehydration performance by spin-dry at a higher speed for shortening the washing time, or introduction of powerful drying for shortening the drying time. The peeling-off step has no way other than extending the time in order to result in the better performance, which, however, is opposed to the requirement of shortening the total washing time, and yet, a longer peeling-off time will not ensure reliable peel-off for the laundry.

SUMMARY OF THE INVENTION

[0010] The present invention addresses the problems discussed above, and aims to provide a drum-type washing machine having the following features:

determining whether or not the laundry is peeled off in the rotary drum; and
performing an optimum peeling-off step based on the determination within a reasonable time for reliably peeling off the laundry;

[0011] The drum-type washing machine of the present invention comprises the following elements:

a rotary drum to which the laundry is input:
a water tub accommodating the rotary drum and supported by a resilient supporting mechanism installed to a housing:
a motor for driving the rotary drum;
an agitating projection for agitating the laundry in the rotary drum;
a supply-water section for supplying the water into the water tub;
a vibration sensor for sensing vibrations of the water

tub; and

a controller formed of a roll control section for controlling the rotation of the motor and a sequence control section for controlling the steps of washing the laundry.

[0012] The step of washing includes the peeling-off step for peeling the laundry off the inner wall of the rotary drum. The vibration sensor senses vibrations of the water tub in which the drum is rotated during the peeling-off step. The controller compares an output supplied from the vibration sensor in response to the rotary cycle of the rotary drum during the peeling-off step with another output from the vibration sensor in response to a rotary cycle different from that of the rotary drum, and the controller determines whether or not the laundry is peeled off the drum based on the comparison.

[0013] The foregoing structure allows determining properly the peeled-off status of the laundry, and a reliable peeling-off of the laundry within a reasonable time can be expected. As a result, an improvement in the drying performance following the peeling-off step can be expected.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014]

Fig. 1 shows a schematic diagram illustrating a drum-type washing machine with dryer in accordance with an embodiment of the present invention.

Fig. 2A shows an output supplied from an acceleration sensor and varied with time during a peeling-off step of the drum-type washing machine.

Fig. 2B shows an output supplied from an acceleration sensor and varied with time during the peeling-off step of the drum-type washing machine.

Fig. 3A shows a frequency component of the output from the acceleration sensor during the peeling-off step of the drum-type washing machine.

Fig. 3B shows a frequency component of the output from the acceleration sensor during the peeling-off step of the drum-type washing machine.

Fig. 4 shows a flowchart of a first peeling-off step of the drum-type washing machine with dryer.

Fig. 5 shows a flowchart of a second peeling-off step of the drum-type washing machine with dryer.

Fig. 6 shows a vertical sectional view of a conventional drum-type washing machine with dryer.

Fig. 7A shows a first flowchart of a peeling-off step of the conventional drum-type washing machine with dryer.

Fig. 7B shows a second flowchart of the peeling-off step of the conventional drum-type washing machine with dryer.

DESCRIPTION OF EXEMPLARY EMBODIMENT

[0015] An exemplary embodiment of the present invention is demonstrated hereinafter with reference to the accompanying drawings. The present invention is not limited to this embodiment. Exemplary Embodiment

[0016] Fig. 1 shows a schematic diagram illustrating a drum-type washing machine with dryer in accordance with this embodiment of the present invention. In Fig. 1, rotary drum 53 working as a washing tub and accommodating the laundry such as clothing is placed rotatably in water tub 52 which is placed inside housing 51, i.e. the body of the washing machine. Water tub 52 is supported resiliently in a vibration-less manner by a resilient supporting mechanism including spring 64 and dumper 58.

[0017] Rotary drum 53 is driven by motor 54 mounted on the right side outer wall of water tub 52. Multiple agitating protrusions 62 formed on the inner wall of rotary drum 53 pick up and then drop the laundry, thereby performing beat-wash, and the laundry is agitated for washing. Motor 54 is formed of a brushless motor with a variable rpm, and repeats forward rotation and backward rotation during the step of washing. Supply-water section 63 is placed at an upper-rear part of housing 51 for supplying the water to drum 53 and tub 52.

[0018] Acceleration sensor 56, working as a vibration sensor for sensing the vibrations of water tub 52, is formed of semiconductor and mounted to an upper section of tub 52, and senses multi-axial vibrations (acceleration) vibrating along a back and forth direction, a right and left direction, and an up and down direction. The reason why this multi-axial sensor is employed is this: Water tub 52 actually vibrates not always in one direction, so that triaxial acceleration sensor 56 is used for sensing the triaxial acceleration components, and these components are added for detecting the movement of water tub 52 more accurately and effectively. This embodiment makes full use of the data obtained with this multi-axial acceleration sensor 56.

[0019] Controller 57 is accommodated in housing 51; however, it is shown outside (right side) of housing 51 in Fig. 1 for describing its function more explicitly. Controller 57 includes frequency-component calculator 59, roll control section 60, and sequence control section 61. Frequency-component calculator 59 calculates a frequency component of vibration sensed by the vibration sensor, and roll control section 60 controls an rpm and a rotation time of motor 54, and sequence control section 61 controls the step of washing the laundry, which step is formed of a series of steps such as washing, rinsing, dehydrating, and drying steps, and also includes a step of peeling-off the cloth, and an extension step of the peeling-off.

[0020] Frequency-component calculator 59 is formed of a microprocessor, and performs the discrete Fourier transform (DFT) or fast Fourier transform (FFT) of a signal obtained by acceleration sensor 56, thereby calculating a magnitude of a frequency component (frequency spectrum).

[0021] Controller 57 determines a peeled-off status of the laundry in drum 53 depending on the magnitude of the frequency component, calculated with calculator 59, of the vibration, or depending on an output change due to a time-varying amplitude of the signal obtained by sensor 56. In response to the peeled-off status of the laundry, controller 57 also controls the rpm and the rotation time of motor 54, and performs a sequence control over the steps of washing, such as an extension step of peeling-off, moving on to the step of rinsing, and moving on to the step of drying.

[0022] The foregoing drum-type washing machine with dryer in accordance with the embodiment operates generally in the following manner: A power-on by a user prompts supply-water section 63 to supply the water to rotary drum 53 via water tub 52, then sequence control section 61 and roll control section 60 of controller 57 control over the respective steps such that washing, rinsing, dehydrating, peeling-off, an extension of the peeling-off, and drying can be done automatically in this order. The step of peeling-off is demonstrated hereinafter.

[0023] Detection of a peeled off status of the cloth based on a magnitude of a signal obtained with acceleration sensor 56 is firstly demonstrated with reference to Figs. 2A and 2B, which show the output supplied from sensor 56 varied with time in the peeling-off step. Fig. 2A shows the status of the laundry stuck to rotary drum 53, and Fig. 2B shows the status of the laundry peeled off drum 53. In Figs. 2A and 2B, the Y-axis represents an output from sensor 56 which senses water tub 52 vibrating, and X-axis represents elapsed time of drum 53 spinning. In other words, the output based on the result sensed by the vibration sensor is a magnitude of the output from acceleration sensor 56.

[0024] The drum-type washing machine with dryer described in Figs. 2A and 2B works at a low angular velocity such as 15 rpm, or 0.25 Hz, namely it has a cycle of 4 seconds during the peeling-off step.

[0025] In Fig. 2A, points a1 and a2, where the laundry is stuck to drum 53, indicate an elapsed time of the peak-to-peak outputs, at which a change occurs in the outputs from acceleration sensor 56, and the interval between the peak-to-peak is approx. 4 seconds. In other words, when the laundry is not peeled off, sensor 56 outputs a signal by sensing water tub 52 vibrating, and the output shows the interval at approx. 0.25Hz the same as the rpm of drum 53, so that sensor 56 senses a vibration at the cycle of 4 seconds which is the same cycle of drum 53.

[0026] In Fig. 2B, point b1 - point b7, where the laundry is peeled off drum 53, indicate elapsed times of peaks at which a change occurs in the outputs from sensor 56, and every elapsed time is less than approx. 4 seconds. For instance, approx. 1 second is needed between points b1 and b2, and approx. 2.5 seconds is needed between points b2 and b3, approx. 1. 5 seconds is needed between points b4 and b5. To be more specific, when the laundry is peeled off, the signal obtained with acceleration sensor 56, which senses water tub 52 vibrating, expresses a sharp change at a shorter frequency than 0.25 Hz which is the frequency of the rpm of drum 53 and at a lower cycle than 4 seconds which is the cycle of the rpm of drum 53. This is caused by a higher vibration frequency of water tub 52 because agitating protrusions 62 pick up the laundry, which then falls by itself and hits drum 53, thereby increasing the vibration frequency of water tub 52.

[0027] The difference between the output signals from sensor 56 teaches whether or not the laundry is peeled off drum 53. In other words, during the peeling-off step, when a magnitude of a vibration output (an output based on a sensing result sensed by the vibration sensor) obtained with sensor 56 changes sharply at a cycle shorter than the cycle of the rpm of rotary drum 53, the vibration output does not derive from the vibration of drum 53 due to eccentricity of rotary center of drum 53, where the eccentricity is caused by the laundry stuck onto the inner wall of drum 53. The vibration output actually derives from the vibration of drum 53 due to the shock produced by the laundry hitting on drum 53 because the laundry is picked up by agitating protrusions 62 and then falls by itself and hits the inside of drum 53. The vibration then travels to water tub 52 to be sensed. Sensing this vibration will teach that the laundry is peeled off drum 53, so that the peel-off can be determined properly without taking a time, and the peel-off of the cloth can be sensed in a reliable manner, and the drying performance thereafter can be improved.

[0028] As discussed above, during the peeling-off step, the output (a magnitude of vibration output) based on the sensing result done by the vibration sensor (acceleration sensor 56) and corresponding to the rpm cycle of rotary drum 53 is compared with another output (a magnitude of vibration output) based on another sensing result done by the vibration sensor and corresponding to another cycle different from the rpm cycle of drum 53. When the output corresponding to the cycle smaller than the rpm cycle of drum 53 is greater than the other one, controller 57 determines that the cloth is peeled off drum 53.

[0029] Next, sensing the peel-off status based on a magnitude of the frequency component of the vibration caused by the rotation of rotary drum 53 is demonstrated hereinafter with reference to Figs. 3A and 3B. These drawings show a frequency spectrum value (a magnitude of frequency component) as a result of calculation in which frequency component calculator 59 calculates the output from acceleration sensor 56 in the peeling-off step. Fig. 3A shows the status of the laundry stuck to rotary drum 53, and Fig. 3B shows the status of the laundry peeled off drum 53. In Figs. 3A and 3B, the Y-axis represents a frequency spectrum of the vibration of water tub 52, the vibration having undergone the Fourier transformation, and X-axis represents the frequency of the vibration of rotary drum 53. In other words, the output based on the result sensed by the vibration sensor is a frequency spectrum value (a magnitude of the frequency

component) obtained through a calculation in which frequency component calculator 59 calculates the output from sensor 56.

[0030] In Figs. 3A and 3B, frequency component calculator 59 extracts a frequency component corresponding to an rpm which is a result of multiplying the rpm of drum 53 by the number of agitating protrusions 62, and another frequency component corresponding to the rpm of drum 53, and then controller 57 determines whether or not the cloth is peeled off the inner wall of drum 53 based on the magnitudes of the frequency components.

[0031] The drum-type washing machine with dryer shown in Figs. 3A and 3B spins its rotary drum 53 at as low as 15 rpm in the peeling-off step similar to the washing machine shown in Figs. 2A and 2B. This rpm is a frequency of 0.25 Hz and a cycle of 4 seconds. The number of agitating protrusions 62 are 3 (three), so that 15 rpm x 3 = 45 rpm, which means a frequency of 0.75 Hz and a cycle of 4/3 seconds.

[0032] In Fig. 3A, point A1, where the laundry sticks to drum 53, indicates a peak value of the frequency spectrum of the rotation of drum 53, and the frequency is 0.25 Hz and the cycle is 4 seconds, identical to those of the rpm of rotary drum 53.

[0033] In Fig. 3B, point B1, where the laundry is peeled off drum 53, indicates a peak frequency of the frequency spectrum of the rotation of drum 53, and the peak frequency is 0.75 Hz, and the cycle is 4/3 seconds. The peak frequency corresponds to the rpm (45 rpm), i.e. the product of multiplying the rpm of drum 53 by the number of agitating protrusions 62.

[0034] In other words, frequency component calculator 59 extracts a frequency component corresponding to an rpm which is a result of multiplying the rpm of drum 53 by the number of agitating protrusions 62, and another frequency component corresponding to the rpm of drum 53, and then determines whether or not the cloth is peeled off the inner wall of drum 53 based on the magnitudes of the frequency components (frequency spectrum values).

[0035] As discussed above, a difference in the results of calculating the frequency components of signals based on the output from the vibration sensor such as acceleration sensor 56 teaches whether or not the laundry is peeled off the inner wall of drum 53. To be more specific, when the frequency component in the frequency band corresponding to the rpm of rotary drum 53 is greater than the other one, it can be determined that the laundry still sticks to the inner wall of drum 53. On the other hand, when the frequency component in the frequency band corresponding to the multiplication of the rpm of drum 53 by the number of agitating protrusions 62 is greater than the other one, it can be determined that the laundry is peeled off the inner wall of drum 53. A detection of the vibration component in this case will teach the user that the laundry is peeled off the inner wall of drum 53. This mechanism allows determining rightly the peel-off of the laundry without taking a time, and improving the drying performance thereafter.

[0036] In this embodiment, an output (a magnitude of frequency component) based on a result sensed with the vibration sensor (acceleration sensor 56) during the peeling-off step and corresponding to the cycle (frequency) of the rpm of rotary drum 53 is compared with another output (a magnitude of frequency component) based on a result sensed with the vibration sensor (acceleration sensor 56) during the peeling-off step and corresponding to another cycle (frequency) than the cycle (frequency) of the rpm of drum 53. When the output based on the sensing result supplied from the vibration sensor and corresponding to the cycle smaller than the rpm cycle of drum 53 (a greater frequency than the frequency of the rpm of drum 53) is greater than the other one, controller 57 determines that the cloth is peeled off drum 53.

[0037] An operational control which detects whether or not the laundry is peeled off the inner wall of drum 53 is demonstrated hereinafter with reference to the flowcharts shown in Figs. 4 and 5. Fig. 4 shows a flowchart of a first peeling-off step of the drum-type washing machine with dryer in accordance with this embodiment. In Fig. 4, rinsing step (S100) ends, and then peeling-off step (S102) starts following dehydrating step (S101). During peeling-off step (S102), firstly a peel-off sensing step (S103) is done for determining whether or not the laundry is peeled off the inner wall of drum 53 as described in Figs. 2A and 2B or Figs. 3A and 3B. The determination of peel-off prompts the step to move on to drying step (S106) as indicated by the line marked with "Y".

[0038] On the other hand, when the detection in step S103 determines that the laundry still sticks to drum 53 as indicated by the line marked with "X", the step moves on to an extension step (S104) of peeling-off, and drum 53 is rotated again at as low as 15 rpm for peeling off and loosening the laundry. After a given time, the step moves on to peel-off sensing step (S105) where the detection is done whether or not the laundry is peeled off the inner wall of drum 53 as indicated by the lines marked with "N" (not yet peeled off) and "Y"(yes, peeled off).

[0039] In the peel-off sensing step (S105), a detection of peel-off prompts the step to move on to drying step (S106) as indicated by the line marked with "Y", while a detection of not peel-off prompts the step to return to rinsing step (S100) as indicated by the line marked with "N".

[0040] Fig. 5 shows a flowchart of a second peeling-off step of the drum-type washing machine with dryer in accordance with this embodiment. This flowchart teaches that the control over the peeling-off step or the extension step thereof can peel off the laundry with more ease.

[0041] In Fig. 5, rinsing step (S200) ends, and then peeling-off step (S202) starts following dehydrating step (S201). During peeling-off step (S202), firstly a peel-off sensing step (S203) is carried out for determining whether or not the laundry is peeled off the inner wall of drum 53. The determination of peel-off in the peel-off sensing step (S203) prompts the step to move on to drying step (S208) as indicated by the line marked with "Y".

[0042] On the other hand, when the peel-off detection step (S203) determines that the laundry still sticks to drum 53 as indicated by the line marked with "X", the step moves on to an extension step (S205) of peeling-off, and supply-water section 63 supplies the water into drum 53 in advance (S206). Then drum 53 is rotated at as low as approx. 15 rpm for peeling off and loosening the laundry (S205). The water can be supplied during the peel-off and loosening operation at the same rpm, i.e. approx. 15 rpm of drum 53.

[0043] After a given time, the step moves on to peel-off sensing step (S207) where the detection is done whether or not the laundry is peeled off the inner wall of drum 53 as indicated by the lines marked with "N" (not yet peeled off) and "Y"(yes, peeled off). A detection of peel-off prompts the step to move on to dehydrating step (S201) as indicated by the line marked with "Y", while a detection of not peel-off prompts the step to return to rinsing step (S200) as shown by the line marked with "N".

[0044] As shown in Fig. 4, sequence control section 57 moves the step on to the extension step depending on the peel-off status, or returns the step to rinsing step (S200) when the detection determines that the laundry is not peeled off yet. This control can peel off the laundry reliably and optimize the drying performance.

[0045] As shown in Fig. 5, the supply of water by supply-water section 63 in the peeling-off step or the extension step thereof allows wetting the laundry in drum 53 so that the laundry can begin to peel off. This mechanism ensures that the laundry in the water tub can be peeled off in the peeling-off step, and optimizes the drying performance.

[0046] As discussed above, the drum-type washing machine with dryer of the present invention comprises the following elements:

a rotary drum to which the laundry is input:
a water tub accommodating the rotary drum and supported by a resilient supporting mechanism installed to a housing:
a driving section for driving the rotary drum;
agitating protrusions for agitating the laundry in the rotary drum;
a supply-water section for supplying the water into the water tub;
a vibration sensor for sensing vibrations of the water tub; and
a controller formed of a roll control section for controlling the rotation of the driving section and a sequence control section for controlling the step of washing the laundry.

[0047] The step of washing the laundry includes the peeling-off step. The vibration sensor senses vibrations of the water tub in which the drum is rotated during the peeling-off step. The controller compares an output supplied from the vibration sensor in response to the rotary cycle of the rotary drum during the peeling-off step with another output from the vibration sensor in response to another rotary cycle than that of the rotary drum, and the controller determines whether or not the laundry in the drum is peeled off based on the comparison.

[0048] The foregoing structure allows detecting the laundry peeled off the inner wall of drum 53 when a sensing with the vibration sensor shows a sharp output change at the cycle different from the cycle of the rpm of rotary drum 53. In other words, a sharp change in the sensing result at the cycle different from the cycle of the rpm of drum 53 is not derived from the vibration of drum 53 due to the increment in eccentricity of drum 53 caused by the laundry sticking to the inner wall of drum 53. The vibration of drum 53 is rather derived from the laundry hitting to the inside of drum 53 because the laundry is picked up by the agitating protrusions and falls by itself, and the vibration travels to water tub 52 to be sensed. This mechanism allows determining properly that the laundry is peeled off the inner wall of drum 53 without taking a time, and improving the drying performance thereafter.

[0049] The vibration sensor of the drum-type washing machine of the present invention includes at least one acceleration sensor that detects the vibration along at least one direction of the water tub, and the controller determines a peel-off status of the laundry based on the result of sensing the vibration of the water tub along at least one direction.

[0050] The foregoing structure allows sensing vibrations of the water tub along at least one direction out of the up and down, right and left, and back and forth directions, and determines the peel-off status of the laundry based on the output based on the vibrations along the respective directions. As a result, the vibration of water tub 52 can be sensed accurately, and the peel-off status of the laundry in drum 53 can be properly detected.

[0051] Here is another structure of the present invention; the vibration sensor of the drum-type washing machine of the present invention includes multiple acceleration sensors which can sense vibrations along different directions, and the controller can determine the peel-off status of the laundry based on the sum of the results of sensing the vibrations along different directions. The foregoing structure allows sensing the vibrations of the water tub along multiple directions out of the up and down, right and left, and back and forth directions, and determines the peel-off status of the laundry based on the output based on the sum of the vibrations along the respective directions. As a result, the vibration of the water tub can be sensed accurately, and the peel-off status of the laundry in the rotary drum can be more properly detected.

[0052] The present invention proves that the output based on the sensing result by the vibration sensor equals to a magnitude of the vibration sensed by the vibration sensor. The controller compares the magnitude of the vibration corresponding to a rotary cycle of the rotary drum with another magnitude of the vibration cor-

responding to a rotary cycle shorter than the foregoing rotary cycle of the rotary drum. When the magnitude of the vibration corresponding to the shorter rotary cycle is greater than the magnitude of the vibration corresponding to the rotary cycle of the drum, the controller determines that the laundry is peeled off. This structure allows determining properly the peel-off status.

[0053] The drum-type washing machine with dryer of the present invention further includes a frequency-component calculator for calculating a frequency component of the vibration of the water tub sensed with the vibration sensor. The output based on the result sensed with the vibration sensor is a magnitude of the frequency component calculated by the frequency-component calculator. The controller compares a magnitude of a frequency component at the frequency band corresponding to the cycle in response to the rpm of the rotary drum with another magnitude of a frequency component at the frequency band corresponding to a multiplied rpm that is a product of multiplying an rpm of the rotary drum by the number of the agitating protrusions. When the latter magnitude is greater than the former one, the controller determines that the laundry is peeled off the inner wall of the rotary drum. This structure thus allows determining properly that the laundry is peeled off.

[0054] The drum-type washing machine with dryer of the present invention further includes a sequence control section in the controller, and if the controller determines that the laundry still sticks to the inner wall of the rotary drum at the end of the peeling-off step, then the sequence control section prompts the step to move on to an extension step of the peeling-off step. This structure thus prevents the laundry not yet peeled off from moving on to the drying step, so that a half-dried finish of the laundry can be prevented.

[0055] The present invention allows the sequence control section of the controller to return the step to the rinsing step if the controller determines that the laundry still sticks to the inner wall of the drum at the end of the peeling-off step. This structure allows carrying out the rinsing step again for cancelling the status where the laundry obstinately sticks to the drum, and then carrying out the peeling-off step again for positively peeling off the laundry.

[0056] The present invention allows the controller to prompt the supply-water section to supply the water to the laundry for a given time after the peeling-off step, and then allows the controller to move the step on to the extension step of peeling-off. When the controller determines that the laundry is peeled off after the extension step, the sequence control section of the controller prompts the step to go back to the dehydrating step. This structure allows the laundry to absorb the water, so that the laundry tends to leave the inner wall of the drum because of its increased weight. The laundry can be thus expected to positively peel off the inner wall of the drum. The step immediately returns to the dehydrating step, so that the peeling-off step takes a shorter time.

[0057] The present invention allows the controller to prompt the supply-water section to supply the water to the laundry at the end of the peeling-off step while the peeling-off performance is extended, and then when the controller determines that the laundry is peeled off after the extension, the sequence control section prompts the step to go back to the dehydrating step. This structure allows the laundry to absorb the water, so that the laundry tends to leave the inner wall of the drum because of its increased weight. The laundry can be thus expected to positively peel off the inner wall of the drum. The step immediately returns to the dehydrating step, so that the peeling-off step takes a shorter time.

Claims

1. A drum-type washing machine comprising:

(a) a rotary drum into which a laundry is put;
(b) a water tub supported by a resilient supporting mechanism mounted to a housing of the washing machine for accommodating the rotary drum;
(c) a driving section for driving the rotary drum;
(d) an agitating protrusion for agitating the laundry in the rotary drum;
(e) a supply-water section for supplying water into the water tub;
(f) a vibration sensor for sensing vibrations of the water tub; and
(g) a controller formed of a roll control section for controlling a rotation of the driving section and a sequence control section for controlling a step of washing the laundry,

wherein the step of washing the laundry includes a step of peeling the laundry off the rotary drum, and the vibration sensor senses vibrations of the water tub in which the rotary drum is rotating,
wherein the controller compares an output based on a sensing result supplied from the vibration sensor and corresponding to a rotary cycle of the rotary drum with another output based on a sensing result supplied from the vibration sensor and corresponding to another rotary cycle of the rotary drum for determining a status whether or not the laundry is peeled off the rotary drum.

2. The drum-type washing machine of claim 1, wherein the vibration sensor includes at least one acceleration sensor which senses vibrations of the water tub along at least one direction, and the controller determines the status whether or not the laundry is peeled off the drum based on a result of sensing the vibrations along at least the one direction.

3. The drum-type washing machine of claim 1, wherein the vibration sensor includes a plurality of accelera-

tion sensors for sensing vibrations of the water tub along different directions, and the controller determines the status whether or not the laundry is peeled off the rotary drum based on a sum of results of sensing the vibrations along the different directions.

4. The drum-type washing machine of claim 1, wherein an output based on a sensing result supplied from the vibration sensor is a magnitude of the vibrations sensed by the vibration sensor, and the controller compares a magnitude of the vibrations corresponding to a rotary cycle of the rotary drum with another magnitude of the vibrations corresponding to a rotary cycle shorter than the foregoing rotary cycle, and when the latter magnitude is greater than the former magnitude, the controller determines that the laundry is peeled off the rotary drum.

5. The drum-type washing machine of claim 1 further comprising a frequency-component calculator, wherein an output based on a sensing result supplied from the vibration sensor is a magnitude of the frequency component calculated by the frequency-component calculator, and the controller compares a magnitude of the frequency component in a frequency band corresponding to a cycle in response to an rpm of the rotary drum with another magnitude of the frequency component in a frequency band corresponding to a cycle in response to a multiplied rpm which is a product of multiplying an rpm of the rotary drum by a number of the agitating protrusions, and when the latter magnitude is greater than the former magnitude, the controller determines that the laundry is peeled off the rotary drum.

6. The drum-type washing machine of claim 1, wherein the controller prompts the sequence control section to move a step from the peeling-off step on to an extension step of the peeling-off step when the controller determines at an end of the peeling-off step that the laundry is not yet peeled off the rotary drum.

7. The drum-type washing machine of claim 6, wherein the controller prompts the sequence control section to move a step from the peeling-off step on to a rinsing step when the controller determines at an end of the extension step that the laundry is not yet peeled off the rotary drum.

8. The drum-type washing machine of claim 6, wherein the controller prompts the supply-water section to supply the water to the laundry for a predetermined time at the end of the peeling-off step, and then carry out the extension step, and when the controller determines after the extension step that the laundry is peeled off the rotary drum, the controller prompts the sequence control section to move a step from the extension step to a dehydrating step.

9. The drum-type washing machine of claim 6, wherein the controller prompts the supply-water section to supply the water to the laundry for a predetermined time when a step moves on to the extension step while the extension step is carried out, and when the controller determines that the laundry is peeled off after the extension step, the controller prompts the sequence control section to move the step from the extension step to a dehydrating step.

FIG. 1

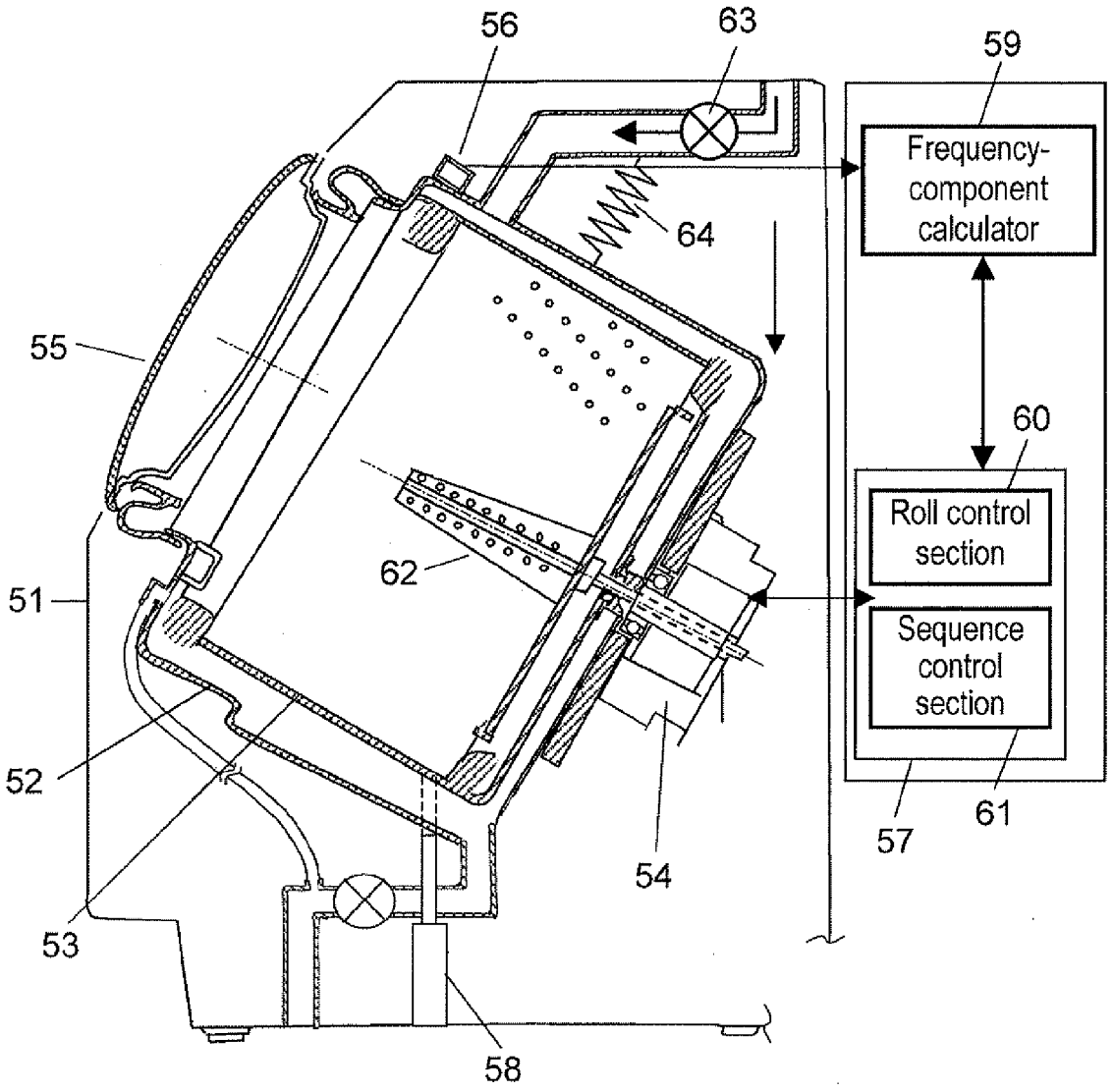

56
63
59
Frequency-component calculator
64
55
60
Roll control section
62
51
Sequence control section
52
54
61
57
53
58

FIG. 2A

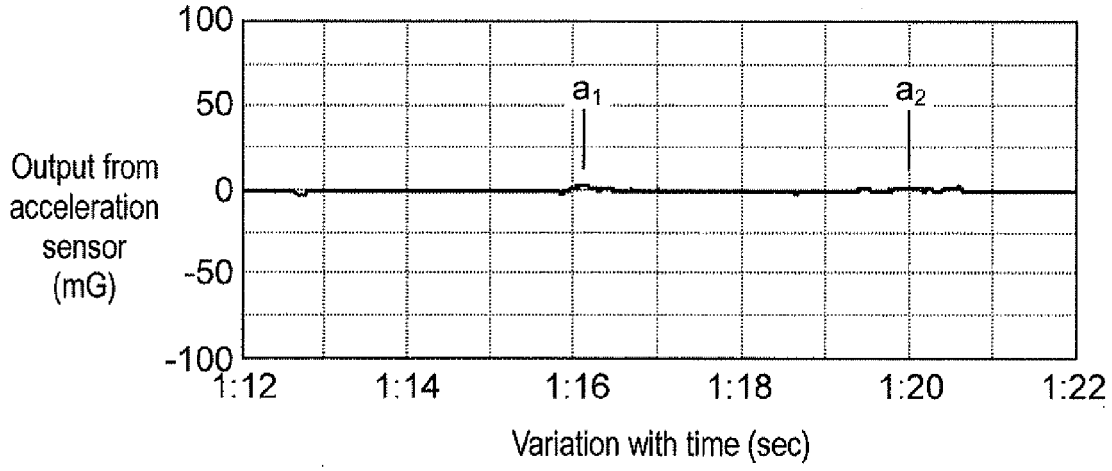

100
50
0
-50
-100
Output from acceleration sensor (mG)
a1
a2
1:12
1:14
1:16
1:18
1:20
1:22
Variation with time (sec)

FIG. 2B

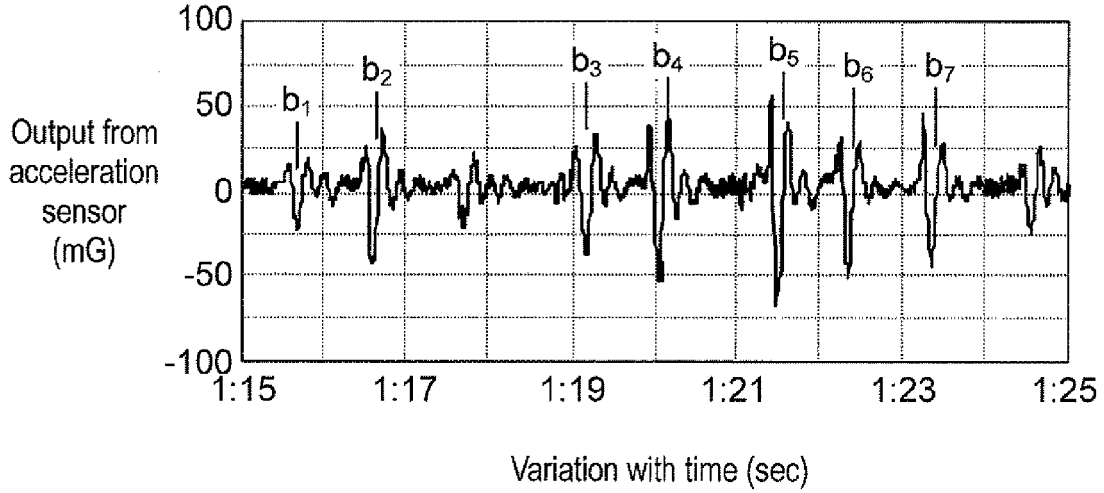

100
50
0
-50
-100
Output from acceleration sensor (mG)
b1
b2
b3
b4
b5
b6
b7
1:15
1:17
1:19
1:21
1:23
1:25
Variation with time (sec)

FIG. 3A

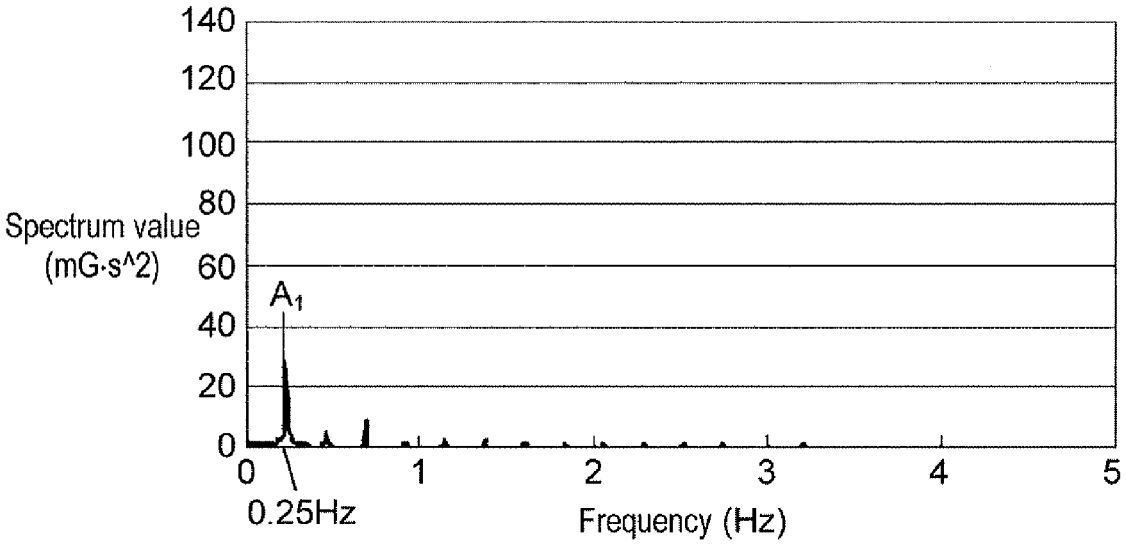

140
120
100
80
60
40
20
0
Spectrum value
(mG·s^2)
A1
0
1
2
3
4
5
0.25Hz
Frequency (Hz)

FIG. 3B

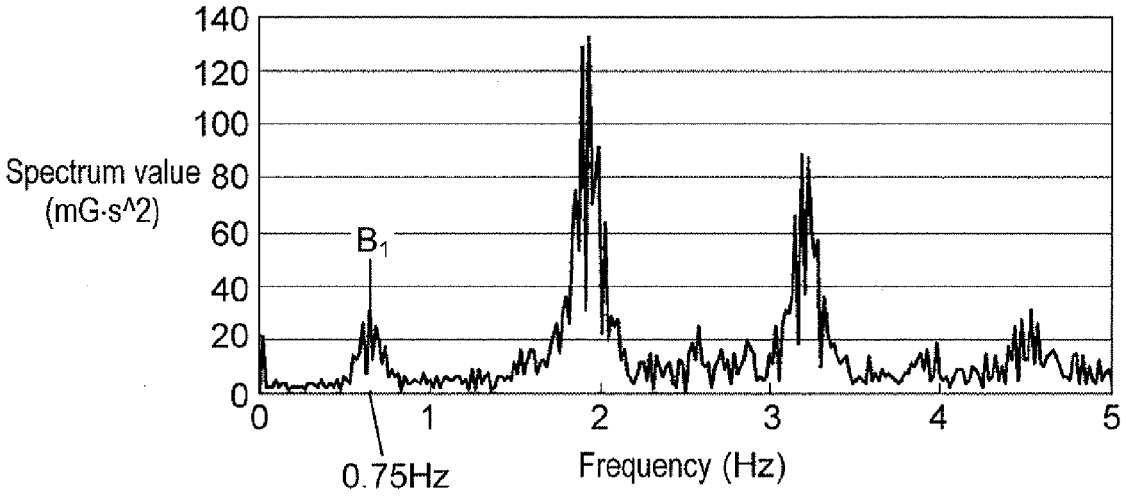

140
120
100
80
60
40
20
0
Spectrum value
(mG·s^2)
B1
0
1
2
3
4
5
0.75Hz
Frequency (Hz)

FIG. 4

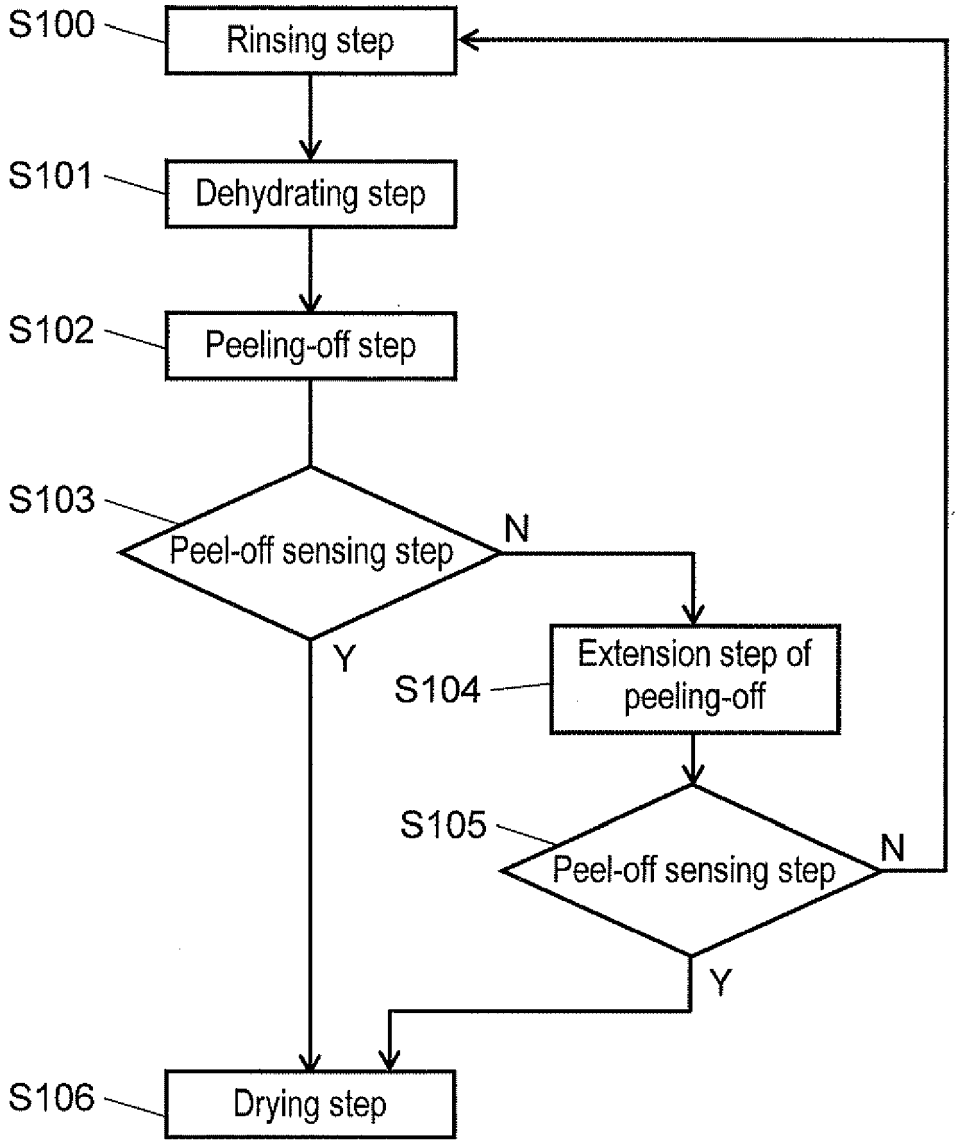

S100
Rinsing step
S101
Dehydrating step
S102
Peeling-off step
S103
Peel-off sensing step
N
Y
S104
Extension step of peeling-off
S105
Peel-off sensing step
N
Y
S106
Drying step

FIG. 5

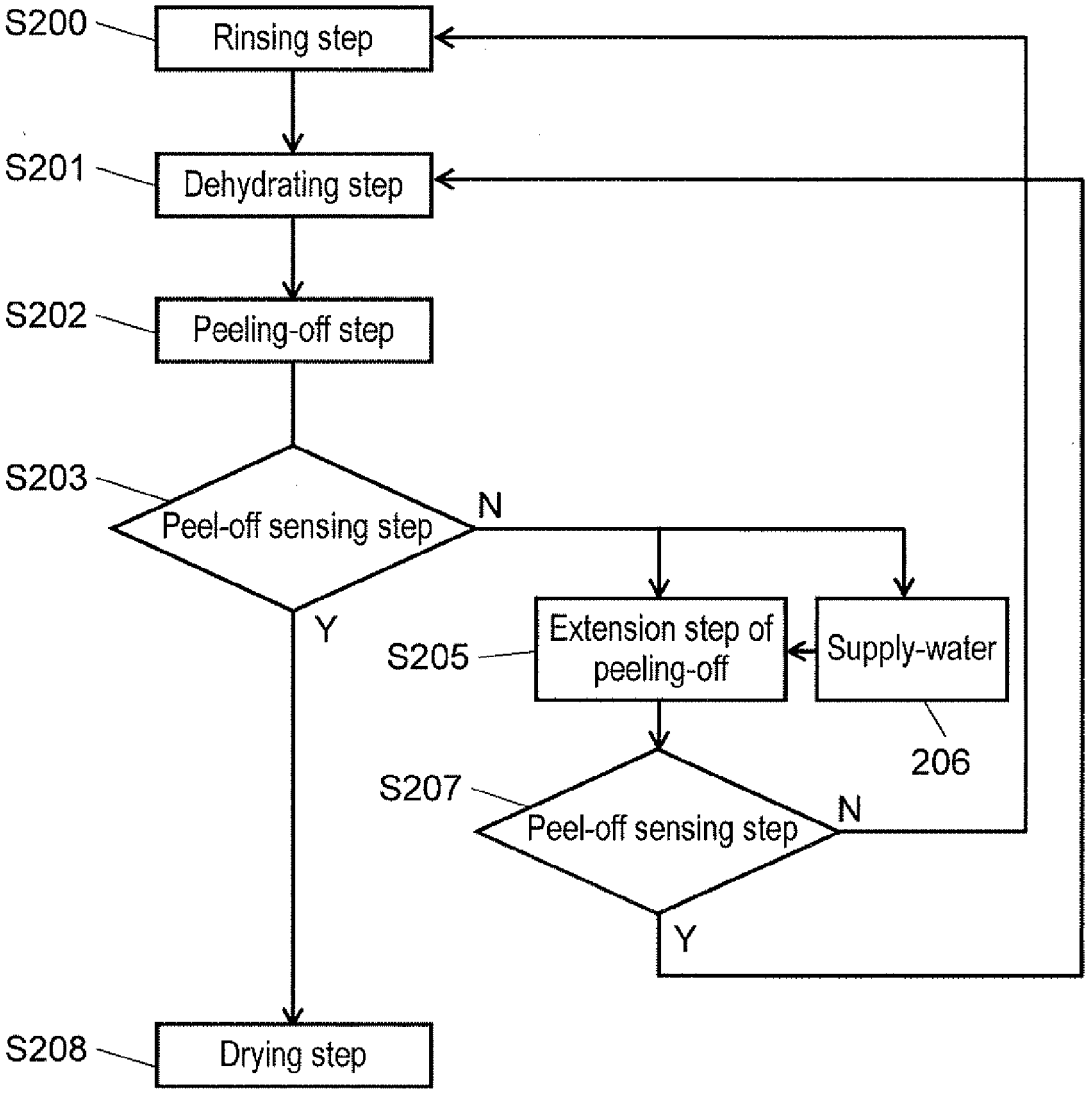

S200
Rinsing step
S201
Dehydrating step
S202
Peeling-off step
S203
Peel-off sensing step
N
Y
S205
Extension step of peeling-off
Supply-water
206
S207
Peel-off sensing step
N
Y
S208
Drying step

FIG. 6

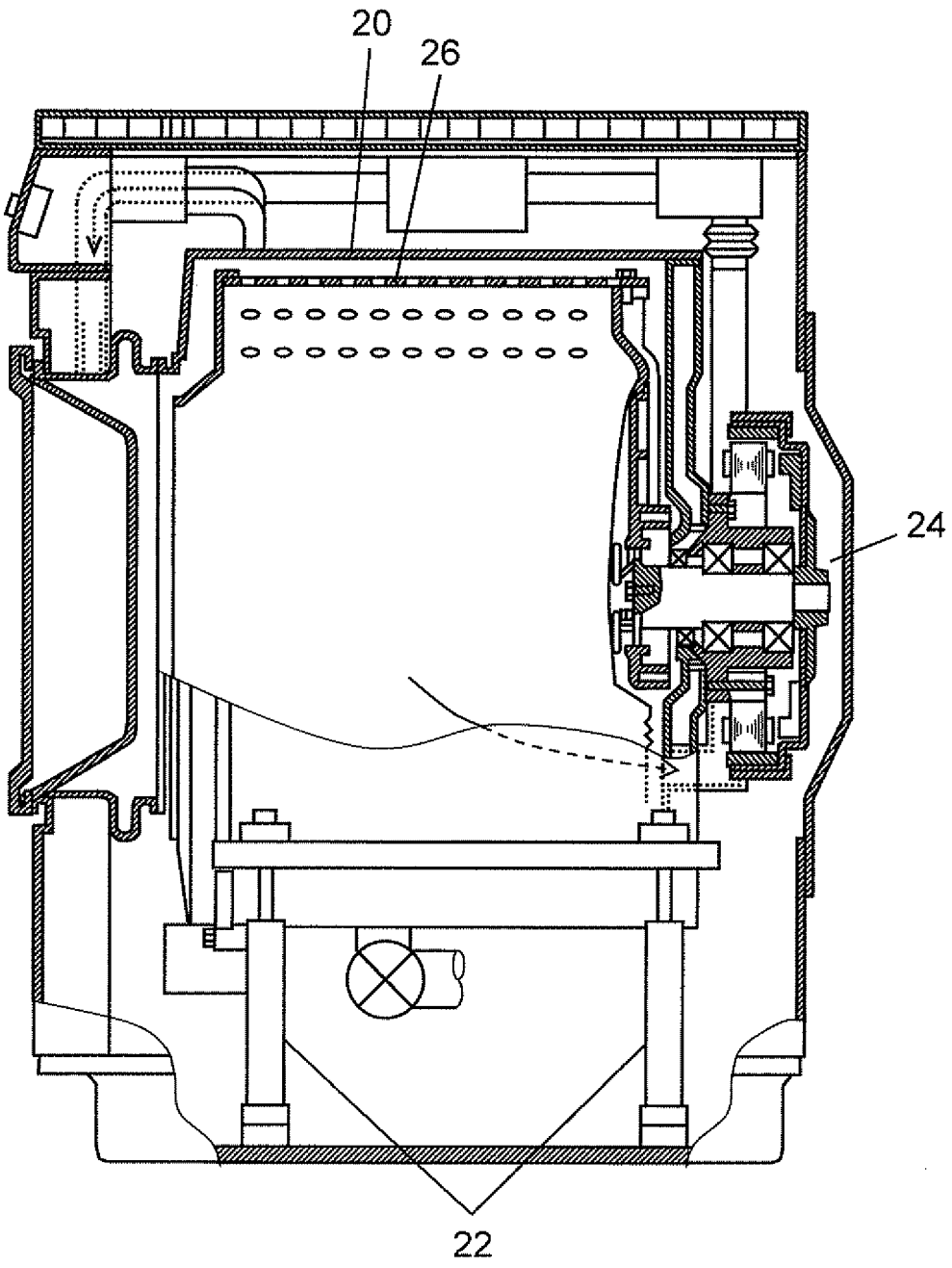


FIG. 7A

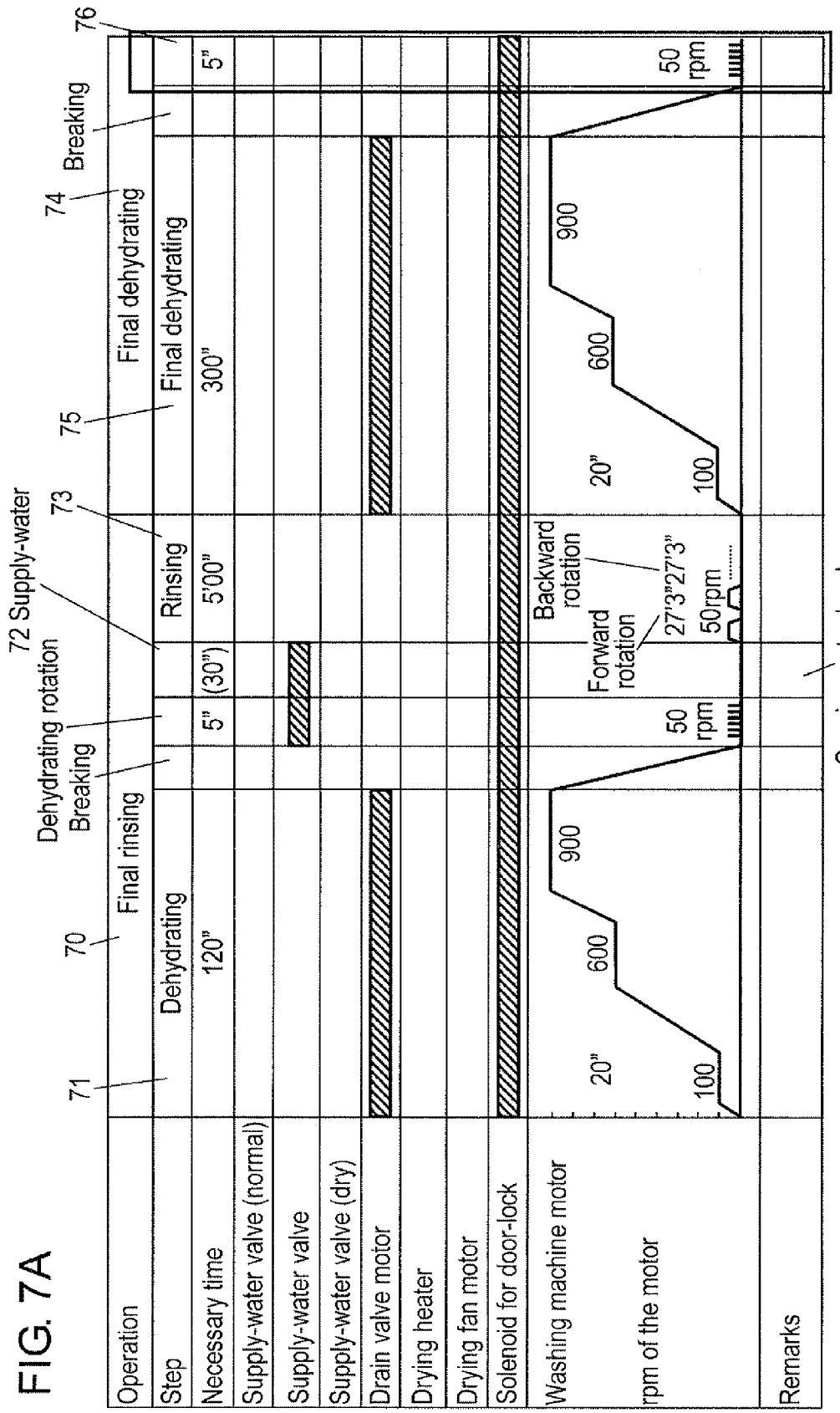
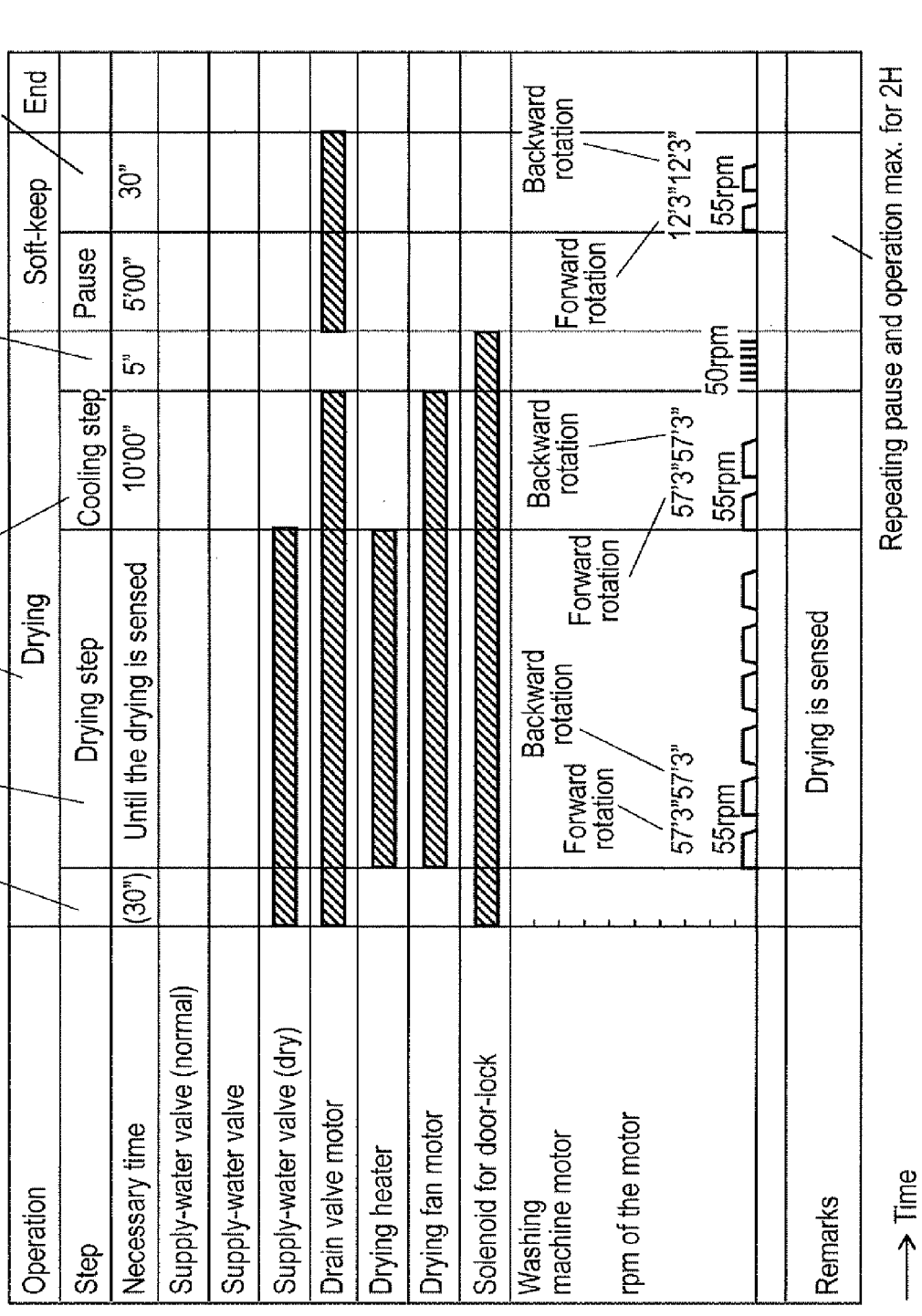

71
70
72 Supply-water
Dehydrating rotation
Breaking
73
75
74
Breaking
76
Operation
Final rinsing
Final dehydrating
Step
Dehydrating
Rinsing
Final dehydrating
Necessary time
120"
5" (30")
5'00"
300"
5"
Supply-water valve (normal)
Supply-water valve
Supply-water valve (dry)
Drain valve motor
Drying heater
Drying fan motor
Solenoid for door-lock
Washing machine motor
rpm of the motor
900
600
20"
100
50 rpm
Forward rotation
Backward rotation
27"3"27"3"
50rpm
Sensing water level
Remarks
Time

FIG. 7B


Pause
78
77
Drying
79
Peeling-off the laundry
Soft operation
Operation
Step
Drying step
Cooling step
Pause
Soft-keep
End
Necessary time
(30")
Until the drying is sensed
10'00"
5"
5'00"
30"
Supply-water valve (normal)
Supply-water valve
Supply-water valve (dry)
Drain valve motor
Drying heater
Drying fan motor
Solenoid for door-lock
Washing machine motor
rpm of the motor
Backward rotation
Forward rotation
57'3"57'3"
55rpm
Backward rotation
Forward rotation
57'3"57'3"
55rpm
50rpm
Forward rotation
Backward rotation
12'3"12'3"
55rpm
Remarks
Drying is sensed
Repeating pause and operation max. for 2H
Time

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EUROPEAN SEARCH REPORT

Application Number
EP 09 15 5272

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	JP 2008 054960 A (HITACHI APPLIANCES INC) 13 March 2008 (2008-03-13) * abstract *	1,2,6,7 3	INV. D06F33/02 D06F35/00 D06F58/28
Y	JP 2006 346270 A (TOKYO SHIBAURA ELECTRIC CO; TOSHIBA CONSUMER MARKETING; TOSHIBA KADEN) 28 December 2006 (2006-12-28) * abstract *	3	
A	EP 1 602 770 A (SAMSUNG ELECTRONICS CO LTD [KR]) 7 December 2005 (2005-12-07) * paragraphs [0029] - [0034] *	1	
A	JP 2006 311886 A (SHARP KK) 16 November 2006 (2006-11-16) * abstract *	1,5	

TECHNICAL FIELDS SEARCHED (IPC)

D06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	28 July 2009	Kising, Axel

CATEGORY OF CITED DOCUMENTS

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28-07-2009

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		KR 20050115342 A	07-12-2005
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JP 2006311886 A	16-11-2006	NONE	

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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