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(54) **Washer-dryer apparatus**

(57) In an improved washer-dryer apparatus which performs wash, spin-dry and dry cycles in a sequential order, a microcomputer used therefor controls a motor to repeatedly rotate in forward and backward directions at short time intervals after the spin-dry cycle, thereby performing a loosening cycle once or more times in which laundry stuck to the interior peripheral wall surface of the spin basket is uniformly distributed or dispersed in the basket. This is followed by the dry cycle. Thus, the heated air is conducted all over the laundry in the spin basket, making it possible to uniformly dry the laundry and to prevent it from becoming wrinkled.

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a washer-dryer apparatus which is equipped with a preheat-drying function of performing the final spin-drying cycle while blowing warm air into a fast-driven spin basket at the end of washing and, more particularly, to a washer-dryer apparatus which performs the final spin-drying cycle while loosening the wet clothes stuck centrifugally to the inner wall of the spin basket so as to dry them uniformly and to keep them from becoming wrinkled.

2. Description of the Prior Art

Conventionally, there is known what is called a drum washer-dryer such as shown in Fig. 1. The drum washer-dryer is provided with a washing tub 105 supported by suspension means 103 in a cabinet-like vessel or housing 101, a spin basket 107 rotatably mounted in the washing tub 105 coaxially with its horizontal axis X, a fan 102 for blowing air into the spin basket 107, and a dehumidifier 109 for dehumidifying the air from the fan 102.

The conventional washer-dryer is further provided with a heater 111 for heating the air dehumidified by the dehumidifier 109, a motor 104 for driving the spin basket 107, a pulley 106 mounted on the rotary shaft 104a of the motor 104 at the top end thereof, another pulley 108 mounted on the rotary shaft 107a of the spin basket 107, a belt 110 stretched between the pulleys 106 and 108, a feed valve 112 for feeding water into the washing tub 105, and a drain valve 114 for drainage from the washing tub 105.

In the case of doing the laundry with such a drum washer-dryer, a user opens an access door 115, then puts clothes (and a laundry detergent) into the washing tub 107, and presses a washing start key to the ON position. When the washing start key is thus turned ON, a microcomputer built in the washer-dryer detects it and controls the feed valve 112 to feed water into the washing tub 105. Upon completion of the feeding of water, the motor 104 is driven at a predetermined rotational speed under the control of the microcomputer.

The turning force of the motor 104 thus driven is transmitted by the belt 110 to the spin basket 107 via the pulleys 106 and 108. Consequently, the spin basket 107 is driven in accordance with the rotational speed of the motor 107 and the clothes are washed with running water (containing a detergent) churned up in the spin basket 107.

Thereafter, the microcomputer controls the respective parts of the washer-dryer so that the drain (of washing water), water-feed, rinse, drain, spin-dry and dry cycles take place in this order.

Such a washer-dryer is equipped with a preheat-

dry function of performing the spin-dry cycle while blowing hot air into the spin basket 107.

That is, when the spin-dry cycle is reached, the microcomputer turns ON the fan 102, the dehumidifier 109 and the heater 111 and drives the motor 104 at high speed. The air coming from the fan 102 is dehumidified by the dehumidifier 109 and heated by the heater 111, from which the heated air is fed through ventilating holes 113 into the spin basket 107 being driven at high speed. The hot air thus fed into the rapidly spinning basket 107 is returned to the fan 102 through holes 116 of the spin basket 107 and a hot air outlet 105a, thereafter being dehumidified and heated again as mentioned above and re-fed into the spin basket 107. In this way, the hot air circulates in the drum washer-dryer.

The circulation of the heated air in the washer-dryer raises the temperature of water contained in the wet wash to decrease the viscosity and surface tension of the water so as to enhance the spin-dry effect. This permits reduction of the times for the spin-dry cycle and the subsequent dry cycle.

The conventional washer-dryer has, on the one hand, an advantage that the spin-drying and the subsequent drying time can be shortened by the preheat function as mentioned above but, on the other hand, has a disadvantage that the clothes being treated become nonuniformly dried and wrinkled for the reasons given below.

When the spin basket 107 is driven at high speed during the spin-dry process, the wet clothes are centrifugally forced into the holes 116 of the spin basket 107 and stuck to its interior surface. Since the clothes are exposed to the heated air while being stuck to the interior surface of the spin basket 107 due to centrifugal force by its spinning, they are dried at different rates between those parts exposed directly to the heated air and those parts on the side of the interior surface of the spin basket 107--this results in the laundry becoming wrinkled.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a washer-dryer apparatus which permits uniform drying of laundry.

Another object of the present invention is to provide a washer-dryer apparatus which ensures wrinkle-free washing.

Still another object of the present invention is to provide a washer-dryer apparatus which permits implementation of an excellent or effective preheat-dry function.

To attain the above objective, the washer-dryer apparatus of the present invention is provided with a control means for controlling the rotation of the spin basket so as to loosen therein the laundry at least once in the spin-dry cycle.

The loosening process is one that the control means stops the spin-basket from spinning in the spin-

dry cycle and controls it to repeatedly rotate in normal and reverse directions at short time intervals by which the clothes stuck to the interior surface of the spin basket are dispersed or scattered uniformly in the basket. By performing the spin-dry cycle in combination with such a loosening step, the whole laundry can be exposed thoroughly to the heated air and hence is uniformly dried without becoming badly wrinkled.

According to another aspect of the present invention, the washer-dryer apparatus is provided with a means for controlling the rotation of the spin basket so that the wet laundry stuck to the interior surface of the spin basket by the spin-dry operation comes off or separates therefrom immediately prior to the loosening cycle.

This clothes-separating process is carried out, for instance, by abruptly stopping the rapidly spinning spin basket. When the washer-dryer apparatus according to the present invention is adapted to drive the spin basket in a direction perpendicular to the ground, control is effected so that the spin basket is driven at very low rpm or repeatedly driven and stopped at every predetermined rotational angular position such as 90, 180 or 270 degrees to the ground.

By abruptly braking the rapidly spinning the basket to a halt, the wet clothes stuck to the inside surface of the basket fall or spin off therefrom due to an inertial force. Where the spin basket is controlled to rotate at very low rpm or repeat spinning and stopping at every predetermined rotational angular position as mentioned above, the clothes stuck to the interior surface of the spin basket drop down therefrom by gravity whenever they are raised up to such a rotational angular position of the spin basket.

By performing the clothes-separating process prior to the loosening process, it is possible to shorten the time for the subsequent loosening cycle. Furthermore, the loosening operation, preceded by the clothes-separating step, enables the clothes to be scattered or dispersed more uniformly in the spin basket, and hence it facilitates spin-drying of the laundry.

According to another aspect of the present invention, the washer-dryer apparatus employs, as the above-mentioned control means, a means which, in the case of performing the loosening step a plurality of times, gradually increases the rotational speed of the spin basket toward its steady-state one at each loosening step.

This is based on the fact that the rotational speed of the spin basket at which the laundry is stuck to its interior peripheral surface differs before and after the loosening cycle. That is, the amount of water contained in the laundry is reduced by the rotation of the spin basket prior to the loosening step, and the decrease in the water content serves to prevent the laundry from being readily stuck to the interior peripheral surface of the spin basket after the loosening step.

The same results could be obtained by performing the loosening step at gradually lengthened time inter-

vals in the case of repeating it.

Thus, in the case of performing the loosening cycle a plurality of times, the control means increases the rotational speed of the spin basket on a stepwise basis for each loosening cycle, by which the laundry can be loosened well.

According to still another aspect of the present invention, the washer-dryer apparatus of the present invention employs, as the control means, a means which effects ON-OFF control of a heater for heating air to be fed into the spin basket so that the heater remains OFF until the rotational speed of the spin basket reaches the steady-state speed and turns ON when the steady-state rotational speed is reached.

The switching of the loosening cycle to the spin-dry cycle is done by increasing the rotational speed of the spin basket. To increase the rotational speed of the spin basket for the loosening step up to its steady-state value, it is necessary to use a current of a value larger than in the case of driving the spin basket at the steady-state rpm. Since the current capacity of the power supply for home use is limited to about 15 amperes, it is desirable that the maximum current value in every step of operation of the washer-dryer apparatus be smaller than the above-mentioned current capacity for ordinary households. On the other hand, the limitation on the input specification of the heater (i.e. the use of a heater of low power consumption) is not desirable because the time for drying the laundry will inevitably be extended.

For the reasons given above, the control means holds the heater in the OFF state until the rotational speed of the spin basket reaches the steady-state and put the heater in the ON state when the steady-state rotational speed is reached. This produces a reduction in the time required for drying and enables the maximum current value of the washer-dryer apparatus to be smaller than the power supply current capacity of ordinary households.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a cross-sectional view of a conventional drum washer-dryer;

Fig. 2 is a cross-sectional view of a drum type washer-dryer according to a first embodiment of the present invention;

Fig. 3 is a timing chart for explaining the loosening step in the spin-dry cycle of the washer-dryer of the first embodiment;

Fig. 4 is a schematic diagram for explaining the clothes-separating step which takes place immediately prior to the loosening step in a drum type washer-dryer according to a second embodiment of the present invention;

Fig. 5 is a timing chart for explaining the loosening step in the spin-dry cycle of the washer-dryer of the second embodiment;

Fig. 6 is a graph showing periodic variations in the value of a current flowing through a drive motor of

the washer-dryer according to the present invention;

Fig. 7 is a timing chart for explaining stepwise control of the loosening operation of a drum type washer-dryer according to a third embodiment of the present invention; and

Fig. 8 is a timing chart for explaining stepwise control of the rotation of the spin basket before and after the loosening step in a drum type washer-dryer according to a fourth embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to the accompanying drawings, the preferred embodiment of the present invention will hereinafter be described in detail. The present invention is applicable to what is called a drum type washer-dryer.

The drum type washer-dryer according to a first embodiment of the present invention has, as shown in Fig. 2, a washing tub 3 supported by suspension means 9 in a cabinet-like vessel or housing 1 and a spin basket 3 mounted in the washing tub 3 in such a manner as to be rotatable about the horizontal axis X of the tub 3. Extending outwardly of the backward face of the spin basket 5 is a rotary shaft rotatably supported by a bearing 27 along the horizontal axis X and carrying a pulley 31 at its tip end portion.

The spin basket 5 has, in its rear wall surrounding the rotary shaft 23, many hot air inlet ports 49 for introducing therethrough hot air that is provided during the spin-dry and dry cycles. The spin basket 5 is further provided with a number of perforations 5a in its peripheral wall, through which washing water and heated air flows into and out of the spin basket 5. During the spin-dry cycle the washing water is drained through the perforations 5a.

On the top of the washing tub 3 there is mounted a feed water valve 15, through which water is fed into the washing tub 3. On the bottom of the washing tub 3 there are disposed a heater 11 for heating the washing water and water for rinsing and a water temperature sensor 55 for detecting their temperatures. Mounted on the underside of the washing tub 3 are a drain pipe 19 for the drainage of waste water from the washing tub 3, a motor 17 for driving the drain pump 19 and a drain pipe 21 through which the waste water from the drain pump 19 is discharged to the outside of the washer-dryer.

The drum type washer-dryer has a motor 29 placed at the side of the underside of the washing tub 3, for driving the spin basket 5. The rotary shaft 29a of the motor 29 carries a pulley 33 at its tip end. The turning force of the motor 25 is transmitted to the spin basket 5 by a belt 35 which is driven between the pulley 33 and that 31 affixed to the afore-mentioned rotary shaft 23.

The drum type washer-dryer of this embodiment is further provided with a motor 42 for driving a fan 41 to blow air into the spin basket 5 during the spin-dry and

the dry cycle, a dehumidifier 43 for dehumidifying the air coming from the fan 41, a heater 45 for heating the dehumidified air, an air passage 7 for feeding therethrough the air from the fan 41 to the dehumidifier 43, and a temperature sensor 53 for detecting the temperature of the heated air.

The spin basket 5 has an access door 25 through which laundry is taken in and out thereof. There is defined between the door 25 and the spin basket 5 a heated air outlet port 51 through which the heated air fed into the spin basket 5 through the heated air inlet ports 49 is returned to the side of the fan 41 and is circulated in the washing tub 3.

The drum type washer-dryer of such a construction as described above has a microcomputer 13 which controls the individual sections to perform the operation cycles that are specified by a user's manipulation of control keys 59 of a control panel. More specifically, when the start of washing is designated or instructed by the manipulation of the control keys 59, the microcomputer 13 controls the respective sections to perform laundry load detecting, water feed, washing, draining, short-time spin-dry, water feed, rinsing, draining, short-time spin-dry, water feed, draining, final spin-dry and dry cycles in a sequential order.

That is, when the start of washing is designated, the microcomputer 13 drives the motor 29 prior to water feed, then detects the current expenditure required for the motor 29 to reach a predetermined speed on the basis of the output from a laundry load sensor 57, and detects the laundry load in the spin basket 5 through utilization of the detected current expenditure. The detected laundry load thus detected is used to determine the quantity of water to be fed and the washing, spin-drying and drying times. Incidentally, the amount of water to be fed and the times for the respective operation cycles are determined by referring to a ROM table in which there are prestored the amount of water and the operation times predetermined in accordance with various loads of laundry.

Next, the microcomputer 13 opens the feed water valve 15 to feed therethrough water into the washing tub 3 and, at the same time, turns ON the heater 11. The microcomputer 13 detects the amount of water fed in the washing tub 3 on the basis of the time for which the valve 15 has been opened and the water temperature in the washing tub 3 on the basis of the output from the water temperature sensor 55. When the amount of water fed in the washing tub 3 reaches the value corresponding to the laundry load, the microcomputer 13 closes the feed water valve 15, then turns OFF the heater 11, and drives the motor 29. As a result, the turning force of the motor 29 is transmitted by the belt 35 via the pulleys 33 and 31 to the spin basket 5, enabling the washing cycle to commence.

Upon completion of the washing cycle performed for a predetermined time, the microcomputer 13 stops power supply to the motor 29 so as to perform the drain cycle and drives the motor 17 to actuate the drain pump

19, discharging the washing water from the washing tub 3 through the drain pipe.

Upon completion of draining the washing water from the washing tub 3, the microcomputer 13 keeps driving of the drain pump 19 and drives the motor 29 at high speed to perform the short-time spin-dry cycle. By this, the washing water contained in the laundry is discharged to the drain pump 19 through the perforations 5a of the spin basket 5, permitting reduction of the time necessary for the subsequent rinsing cycle.

Following this, the microcomputer 13 stops power supply to the drain motor 17 and the motor 29 and opens the feed water valve 15 to feed water into the washing tub 3. At this time, the rinsing water may be heated by the heater 11 to promote rinsing.

When a predetermined amount of water is fed in the washing tub 3, the microcomputer 13 closes the feed water valve 15 and drives the motor 29, rinsing the laundry. That is, the laundry in the spin basket 5 is rinsed with water streams produced by the rotation of the basket 5. Since the washer-dryer of this embodiment is designed so that the rinsing cycle is preceded by the short-time spin-dry cycle as referred to above, the rinsing time can be reduced accordingly.

Upon completion of the rinsing cycle, the microcomputer 13 stops power supply to the motor 29 and drives the drain motor 17, thereby discharging the rinsing water in the spin basket 3 through the drain pipe 21.

This is followed by the final spin dry cycle. To perform this, the microcomputer 13 keeps driving the drain pump 19 and drives the motor 29 at high speed and, at the same time, turns ON the motor 42 for driving the fan 41, the dehumidifier 43 and the heater 45.

In consequence, the fan 42 is driven to cause an air stream, which is dehumidified by the dehumidifier 43 and led via the air passage 7 to the heater 45. The air is heated by the heater 45 is fed into the spin basket 5 through its hot air inlet ports 49.

The heated air thus fed into the spin basket 5 is passed over the laundry in the rapidly spinning basket 5 and is then fed back to the fan 41 through the air outlet port 51 and other similar holes. The air thus fed back to the fan 41 is dehumidified and heated, thereafter being refed into the spin basket 3 and circulated in the washer-dryer structure.

By feeding the heated air into the spin basket 5 during the spin-dry cycle as mentioned above, the water temperature in the laundry is increased to thereby decrease the viscosity and surface tension of water, heightening the spin-dry effect. Hence, the laundry can be dried to some extent prior to the subsequent drying cycle, so that the drying time can be shortened accordingly.

The washer-dryer of this embodiment performs the final spin-dry cycle while feeding the heated air into the spin basket 5 but once stops its rotation halfway through the spin-dry operation and performs the loosening cycle for loosening the laundry in the spin basket 5, thereafter resuming the final spin-dry cycle.

To perform this, the microcomputer 13 turns OFF the motor 29 a certain elapsed time, for example, 1 to 5 minutes, after the start of the final spin-dry cycle. This is followed by the loosening cycle during which the motor 29 is controlled to repeat rotation in forward and backward directions at short time intervals. The washer-dryer of this embodiment performs the loosening cycle, for example, three times in the final spin-dry cycle as the low-level periods (loosening periods) in Figs. 3(a) and (b).

The rotational speed of the spin basket 5 in the final spin-dry cycle is usually set in the range of 800 to 1200 rpm, for example, at 1000 rpm so as to enhance the spin-dry effect, but in the loosening cycle the motor 29 is driven at low rpm lower than one-tenth that for the final spin-dry operation. Further, one to three minutes is enough for the loosening cycle. It is effective in drying the laundry to change the direction of rotation of the motor 29 several times during each loosening cycle, but the control operation will be simplified by rotating it in one direction in one loosening cycle and in the opposite direction in the next loosening cycle.

In one preferred embodiment of the invention, the final spin-dry cycle is performed for one minute and the motor 29 is turned OFF. Then the loosening cycle is performed for two minutes with the motor 29 driven to turn the spin basket 5 at 50 to 60 rpm, during which the direction of its rotation is reversed at time intervals of 30 seconds to one minutes. The loosening cycle is repeated three times alternating with a one to four minutes long normal spin-dry cycle. In the normal spin-dry cycle the motor 29 is driven at 1000 rpm in the same direction. Upon completion of the third loosening step, the normal spin-dry cycle is performed for 10 to 20 minutes, followed by a 2 minutes long loosening cycle with the motor 29 driven at 50 to 60 rpm. The last loosening cycle is effective in keeping the laundry from becoming wrinkled.

In the final spin-dry cycle, the spin basket 5 is driven at high speed, so that the laundry is stuck to the inside wall of the basket 5; however, by performing the loosening cycle halfway through the spin-dry cycle, the wet clothes stuck to the interior wall surface of the spin basket 5 can be fallen off therefrom and distributed or dispersed uniformly in the spin basket 5. This permits uniform intermixing of heated air and the wet laundry, and hence ensures the prevention of the undesired uneven drying of the laundry. Thus, it is possible to keep the wet clothes from becoming wrinkled.

Upon completion of the final spin-dry cycle, the microcomputer 13 drives the motor 29 at an intermediate speed and, at the same time, drives the fan 41 to feed heated air into the spin basket 5 to perform the drying cycle. Since the washer-dryer of this embodiment is adapted to spin-dry the laundry while blowing heated air into the spin basket 5 after loosening the clothes in the loosening cycle as described above, the laundry is dried to some extent prior to the drying cycle--this produces a considerable reduction of the time required for drying.

The whole washing process ends with the drying cycle.

Next, a description will be given of the drum type washer-dryer according to a second embodiment of the present invention. The washer-dryer of this embodiment is adapted so that the microcomputer 13 effects control to perform, immediately prior to the loosening cycle, a clothes-separating cycle in which wet clothes stuck to the interior surface of the spin basket 5 in the spin-dry cycle are shaken off.

More specifically, the microcomputer 13 controls the motor 29 to rotate the spin basket 5 at ultra-low speed as shown in Fig. 4 prior to the execution of the loosening cycle. As the spin basket 5 is driven at very low rpm, the laundry stuck to its inside wall surface by the spin-dry operation is periodically brought up to a 90, 180 or 270. rotational angular position of the spin basket 5 with respect to the ground, so that the laundry can be fallen off by its gravity.

Subsequent to the above-described loosening cycle, the microcomputer 13 controls the respective sections to perform the loosening cycle. By this, the wet clothes shaken off the interior surface of the spin basket 5 can be loosened, so that they can be distributed or dispersed more uniformly in the spin basket 5 and can be dried more effectively. Additionally, the loosening time can be reduced.

Turning now to Fig. 5, the spin-dry process of the drum type washer-dryer according to the second embodiment will be described in greater detail. A certain elapsed time, for example, 5 to 10 minutes, after the start of the final spin-dry cycle, the spin basket 5 29 is once stopped from rotating and then it is rotated very slowly. In concrete terms, the rotational speed of the motor 29 and consequently the spin basket 5 is set at a value below 20 rpm, for example, 5 to 15 rpm. In this instance, the current flowing through the motor 29 periodically varies with the angle of the center of gravity of the laundry on the inside peripheral wall of the spin basket 5 about the center thereof with respect to the ground (0°) as shown in Fig. 6. That is, the driving force for turning the spin basket 5 in a direction to raise the laundry needs to be large but need not be so large when turning the spin basket 5 in a direction to lower the laundry. Since in practice the center of gravity of the laundry is not so much off the center of the spin basket 5, the driving force varies at relatively short time intervals.

However, when the laundry stuck to the inner peripheral surface of the spin basket 5 comes off therefrom, the center of gravity of the laundry is greatly displaced from the center of spin basket 5 and the current flowing through the motor 20 increases accordingly. The detection of the increase in the current value will make it possible to detect the timing of the laundry coming off the inside peripheral wall of the spin basket 5. Hence, in the preferred embodiments of the present invention, the spin basket 5 is rotated at ultra-low rpm until the detection of the timing of the laundry falling off the inside peripheral wall surface and the normal loosening cycle is started immediately upon detection of that timing--this

produces further reduction of the washing time.

The clothes-separating cycle can be made more effective as described below. That is, prior to the commencement of the loosening cycle the microcomputer 13 controls the motor 29 to rotate the spin basket 5 at ultra-low rpm as depicted in Fig. 4. In this instance, the motor 29 is controlled to bring the spin basket 5 to a standstill at a position where the center of gravity of the laundry stuck to the inside peripheral wall of the basket 5 is, for example, 90, 180 or 270. off the center of the basket 5 with respect to the ground (0°). The standstill time is usually set in the range of 30 seconds to 1 minute but may be chosen depending on the laundry load. By this, the laundry stuck to the interior peripheral wall of the spin basket 5 is brought up to the position of 90, 180 or 270. to the ground and held at a standstill, and hence it will fall off the wall surface of the spin basket 5 due to gravity.

While in the above the spin basket 5 has been described to be turned to the rotational angular position of 90, 180 or 270° to the ground in the clothes-separating cycle, the angular position need not be limited specifically to the above and may freely be chosen as long as it is an angle at which the laundry clinging to the inside peripheral wall of the spin basket 5 can be fallen off.

In this instance, the angle of the center of gravity of the laundry about the center of the spin basket 5 can be detected by monitoring the periodically varying current of the motor 29 shown in Fig. 6. In practice, however, the angle of the standstill position need not be so accurate, so that simpler control may be effected. The same results as described above could also be obtained by holding the spin basket 5 at a standstill for an appropriate period of time every quarter turn. It is also possible to produce the required effect by stopping the rotation of the spin basket 5 at randomly set points in time independently of the cycle of rotation thereof.

Where the clothes-separating cycle is combined with the loosening cycle, provision may be made for quickly stopping the rapidly spinning spin basket 5 so that the laundry stuck to its interior peripheral surface comes off by the inertial force. Since the laundry thus fallen off can be loosened by the loosening step, the same results as mentioned above can be obtained. That is, in this instance, the spin basket 5 is stopped quickly from rotation when the washing operation proceeds from the normal spin-dry to the loosening cycle.

Next, a description will be given of the drum type washer-dryer according to a third embodiment of the present invention. In view of the fact that the rotational speed of the spin basket 5 at which the laundry is stuck to its inside peripheral surface differs before and after the loosening cycle, the washer-dryer of this embodiment is adapted so that the microcomputer 13 effects control to gradually lengthen the intervals of the normal rotational numbers during individual loosening cycles.

That is, the amount of water contained in the laundry decreases by the spin-dry operation of the spin bas-

ket 5 prior to the loosening cycle, and the decrease in the water content serves to prevent the laundry from being readily stuck to the inner peripheral surface of the spin basket 5 in the spin-dry cycle subsequent to the loosening cycle.

In other words, the microcomputer 13 suspends the power supply to the motor 29 a certain elapsed time, for instance, 1 to 5 minutes, after the commencement of the final spin-dry cycle. Then, the microcomputer 13 supplies power again to the motor 20 to repeatedly turn the spin basket 5 in the forward and backward directions at short time intervals, performing the loosening cycle. In the washer-dryer of this embodiment the intervals between respective loosening steps are gradually lengthened as depicted in Fig. 7.

In one preferred example, the final spin-dry cycle is performed for 10 minutes, followed by changing the rotational speed of the spin basket 5 to 50 to 60 rpm, at which a first loosening cycle is performed for three minutes. During the first loosening cycle the motor 29 is controlled to reverse the direction of rotation of the spin basket 5 every 30 seconds to one minute. Subsequent to the first loosening cycle, the normal spin-dry cycle is performed for three minutes, followed by a 2-minutes second loosening cycle. Then, the normal spin-dry cycle is performed for six minutes, followed by a 1-minutes third loosening cycle. After the third loosening cycle the normal spin-dry cycle is performed for 10 to 20 minutes, followed by a 2-minutes loosening cycle with the spin basket 5 set again at 50 to 60 rpm. The last loosening cycle is effective in keeping the laundry from becoming wrinkled.

Next, a description will be given of the drum type washer-dryer according to a fourth embodiment of the present invention. The embodiment is also based on the fact that the rotational speed of the spin basket at which the laundry is stuck to its interior peripheral surface differs before and after the loosening cycle. In this embodiment, provision is made for the microcomputer to control the motor 29 so that the rotational speed of the spin basket 5 gradually approaches its steady-state value each time the loosening cycle is performed.

That is, the amount of water contained in the laundry decreases by the spin-dry operation of the spin basket 5 prior to the loosening cycle, and the decrease in the water content serves to prevent the laundry from being readily stuck to the inner peripheral surface of the spin basket 5 in the spin-dry cycle subsequent to the loosening cycle.

In view of the above, the microcomputer 13 is designed to control the motor 29 so that, in the case of performing the loosening cycle a plurality of times, the rotational speed of the spin basket 5 increases step by step to first, second, third and steady-state values as the loosening cycle is repeated as shown in Fig. 8. By this, the laundry in the spin basket 5 can be loosened or disentangled well.

In one preferred example, the stepwise elevation of the spin-dry rotational speed between the loosening

cycles is carried out as 400 rpm -> loosening -> 600 rpm -> loosening -> 800 rpm -> loosening -> 1000 rpm.

Next, the drum type washer-dryer according to a fifth embodiment of the present invention will be described. The washer-dryer of this embodiment is adapted so that, in the final spin-dry cycle, the microcomputer 13 effects control such that the heater 45 for heating air to be fed into the spin basket 5 turns ON for the first time when its rotational speed reaches a steady-state value.

When the washing process proceeds from the loosening cycle to the spin-dry cycle, it is necessary to increase the rotational speed of the spin basket 5; to increase the rotational speed to the steady-state value requires a current of a larger value than in the case of driving the spin basket 5 at the steady-state speed. Since the current capacity of the power supply in ordinary households is limited to 15 amperes or so, it is desired that the maximum current value throughout the washing operation of the washer-dryer be smaller than the above-mentioned current capacity (preferably below 1500 W, for instance). In contrast to this, to limit the input specification of the heater 45 (i.e. the use of a heater of low power consumption) is undesirable because much time will be consumed until the drying cycle commences.

From such a perspective as mentioned above, the microcomputer 13 holds the heater 45 OFF until the spin basket 5 comes to rotate at the steady-state value, and turns it ON when the steady-state value is reached. This will avoid the lengthening of the time for the drying cycle and keep the maximum current value of the washer-dryer below the limited current capacity of ordinary households.

As will be appreciated from the above, the washer-dryer apparatus according to the present invention loosens the laundry at least once in the spin-dry cycle in which to spin-dry the wet wash while feeding heated air into the spin basket-this ensures the intermixing of the heated air and the wet laundry, and hence serves to keep clothes from becoming wrinkled.

While in the above the present invention has been described as being applied to the drum type washer-dryer, the invention is also applicable to washer-dryers of the type that the spin basket is rotated horizontally relative to the ground.

It is to be understood that the specific embodiments described and illustrated herein are not to be considered in a limited sense as there may be other forms or modifications of the present invention which should also be construed to come within the scope of the technical concepts of the invention.

Claims

1. A washer-dryer apparatus comprising:

a spin basket for storing washing water and laundry and for performing washing, spin-dry

and drying cycles in a sequential order;
drying means for drying said laundry by spinning said spin basket while feeding thereinto heated air during said spin-dry cycle; and control means for controlling said spin basket and said drying means; and

wherein said control means controls the rotation of said spin basket to perform a loosening cycle for loosening therein said laundry at least once in said spin-dry cycle.

2. A washer-dryer apparatus as claimed in claim 1, wherein said control means controls the rotation of said spin basket so that said laundry stuck to an interior peripheral surface of said spin basket falls off thereinto immediately prior to said loosening cycle. 15
3. A washer-dryer apparatus as claimed in claim 2, wherein the rotational speed of said spin basket is lowered to 20 rpm or below to fall off said laundry from said interior peripheral surface of said spin basket. 20
4. A washer-dryer apparatus as claimed in claim 4, wherein the rotational speed of said spin basket is lowered to 5 through 15 rpm to fall off said laundry from said interior peripheral surface of said spin basket. 25
5. A washer-dryer apparatus as claimed in claim 3, wherein the rotational speed of said spin basket is lowered to 20 rpm or below and the timing of said laundry coming off said interior peripheral surface of said spin basket is detected, immediately followed by returning the rotational speed of said spin basket to its initial value. 30
6. A washer-dryer apparatus as claimed in claim 2, wherein said spin basket is stopped at a rotational angular position where the center of gravity of said laundry stuck to said interior peripheral surface of said spin basket is at an angle of 90, 180 or 270 degrees about the center thereof with respect to the ground (0 degree) to fall said laundry off said interior peripheral surface of said spin basket. 40
7. A washer-dryer apparatus as claimed in claim 1, wherein the rotational speed of said spin basket for said loosening cycle is 1/10 the speed for said spin-dry cycle. 50
8. A washer-dryer apparatus as claimed in claim 7, wherein the rotational speed of said spin basket for said loosening cycle is 50 through 60 rpm. 55
9. A washer-dryer apparatus as claimed in claim 1, wherein said loosening cycle is performed alternating with 1- to-4-minutes normal spin-dry cycles.

10. A washer-dryer apparatus as claimed in claim 9, wherein said loosening cycle is performed a plurality of times and a normal spin-dry cycle is performed for 10 to 20 minutes, followed by driving said spin basket at 50 to 60 rpm.

11. A washer-dryer apparatus as claimed in claim 1, wherein when said loosening cycle is performed a plurality of times, said control means controls the spin-dry rotation of said spin basket so that its rotational speed gradually approaches a steady-state value upon each completion of said loosening cycle.

12. A washer-dryer apparatus as claimed in claim 1, wherein when said loosening cycle is performed a plurality of times, said control means effects control to gradually lengthen the intervals of the normal rotational numbers during individual loosening cycles.

13. A washer-dryer apparatus as claimed in claim 1, wherein said control means controls a heater for heating air to be fed into said spin basket so that said heater turns ON when the rotational speed of said spin basket reaches a steady-state value.

FIG.1
PRIOR ART

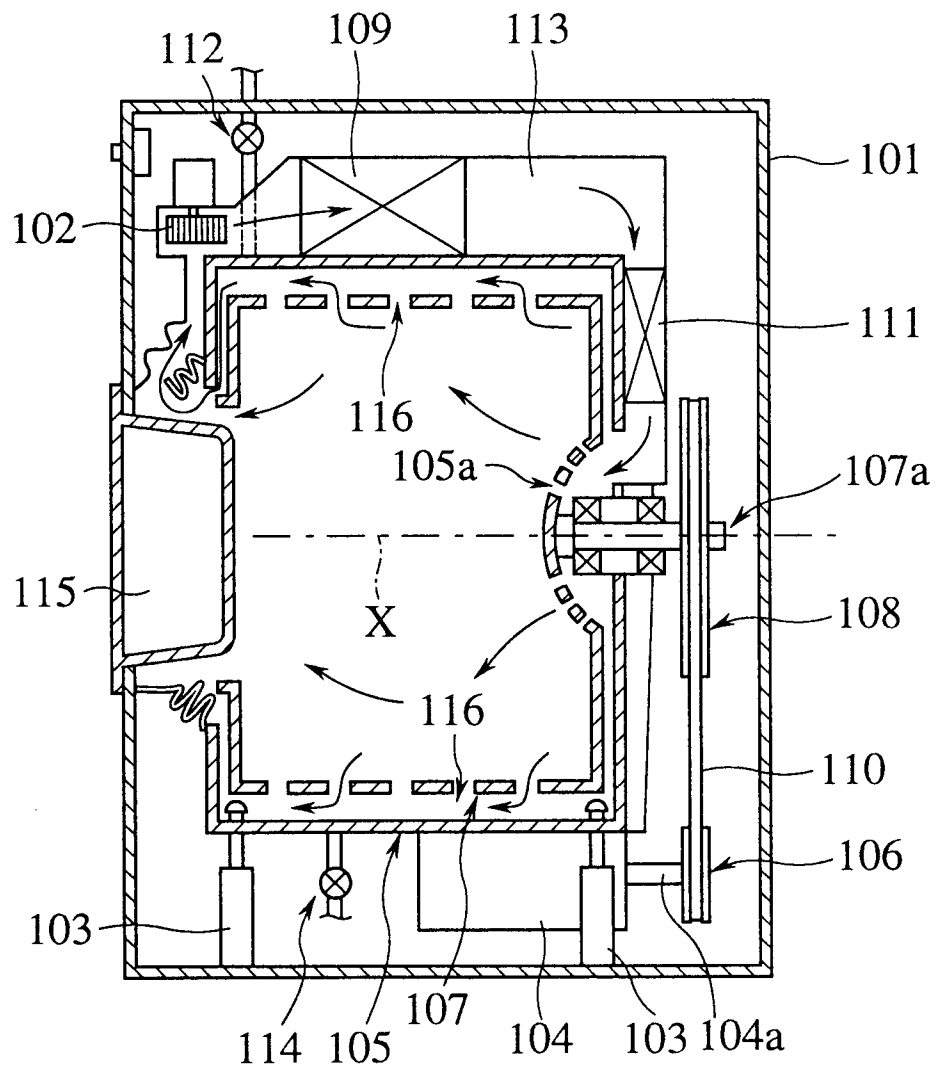
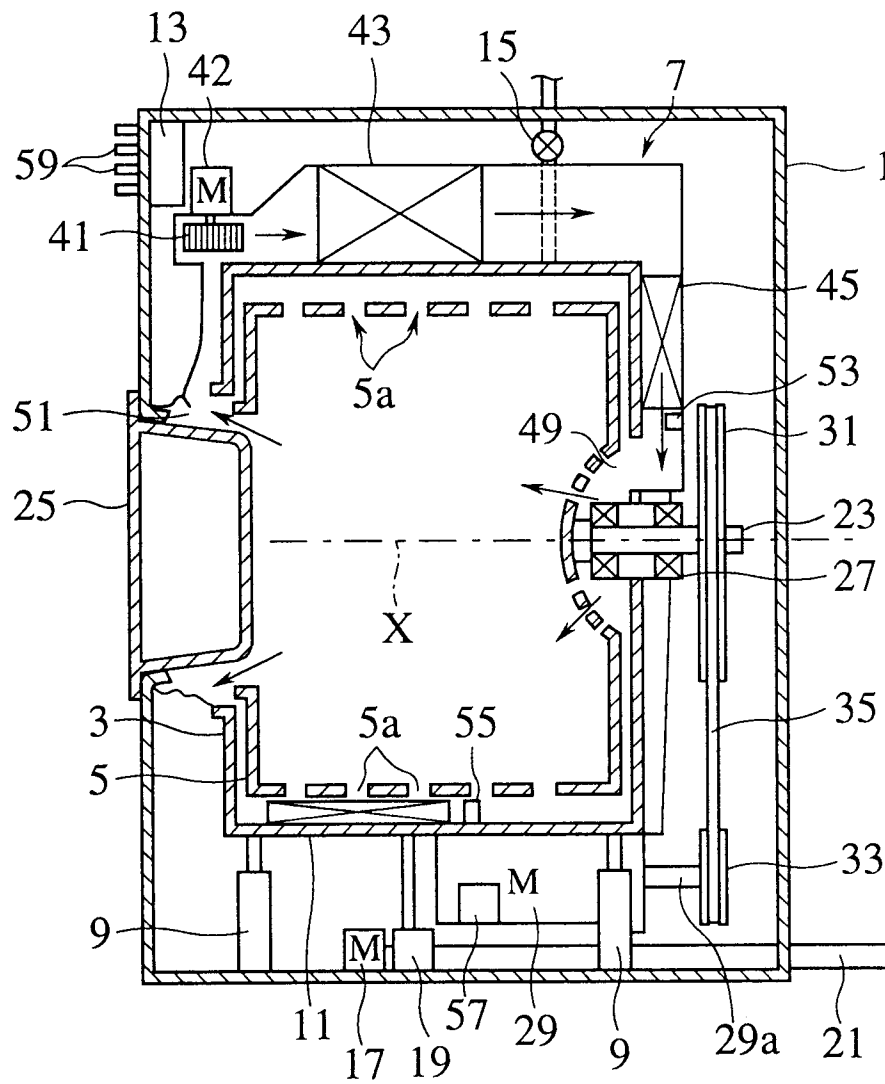


FIG.2



NORMAL
ROTATION NUMBER

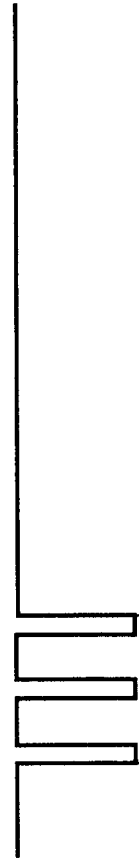
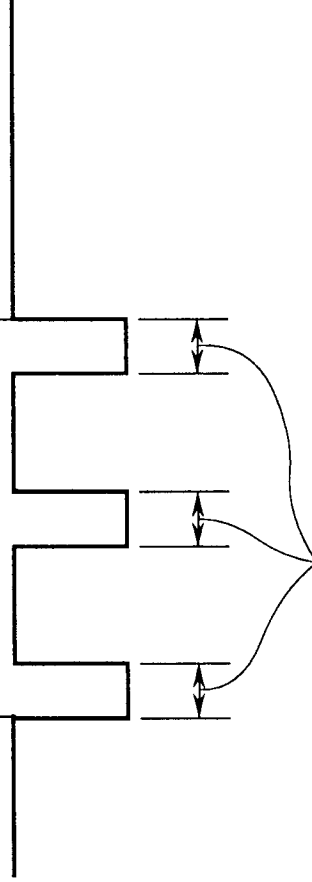


FIG.3A

NORMAL
ROTATION NUMBER



LOOSENING STEP PERIOD

FIG.3B

FIG.4

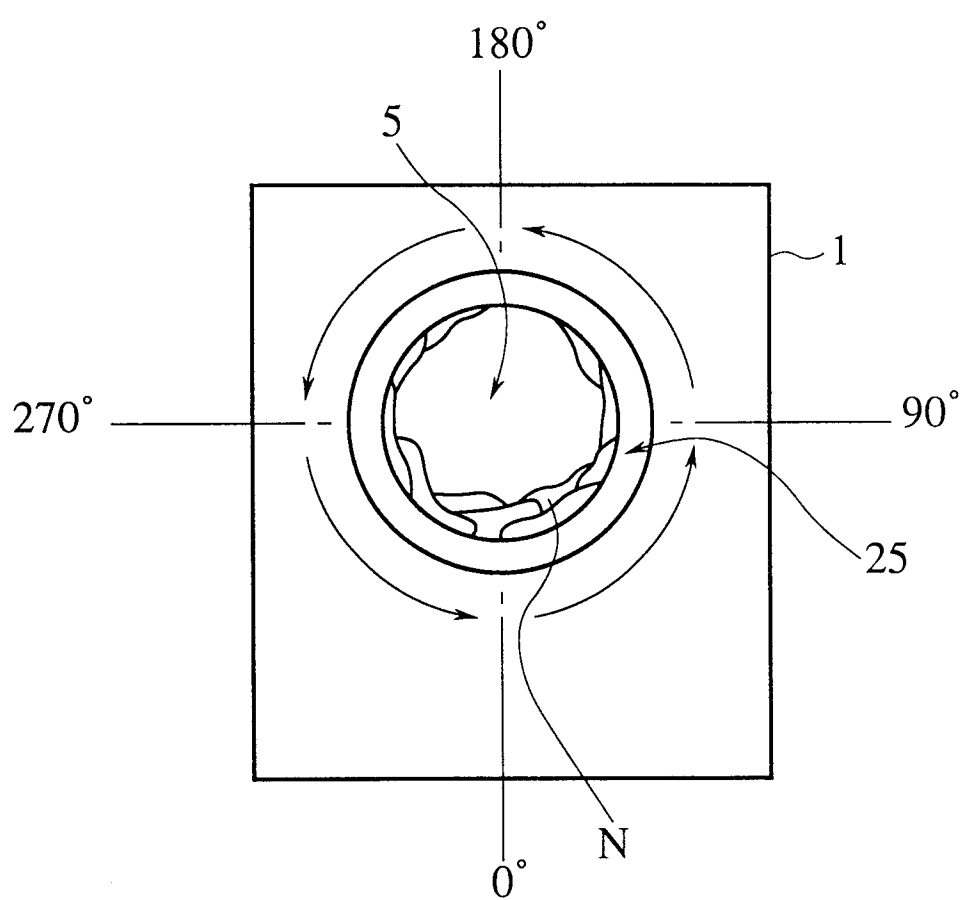


FIG.5

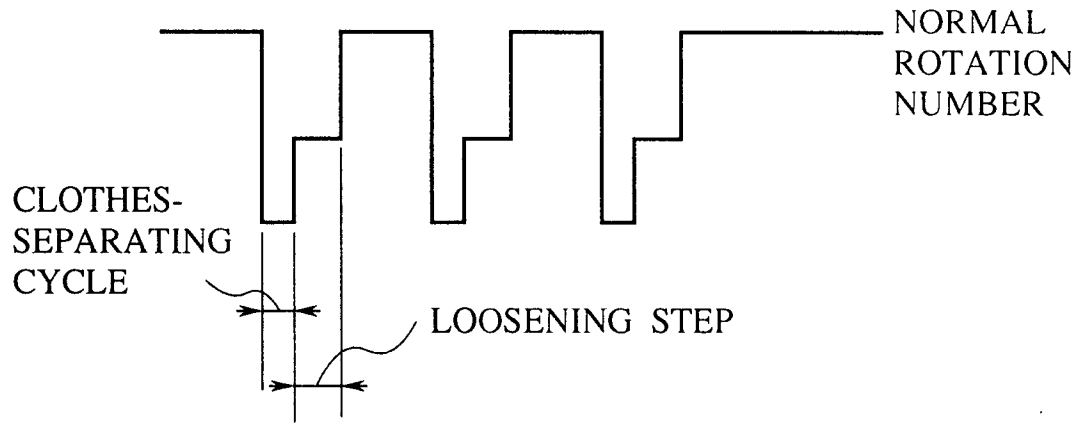


FIG.6

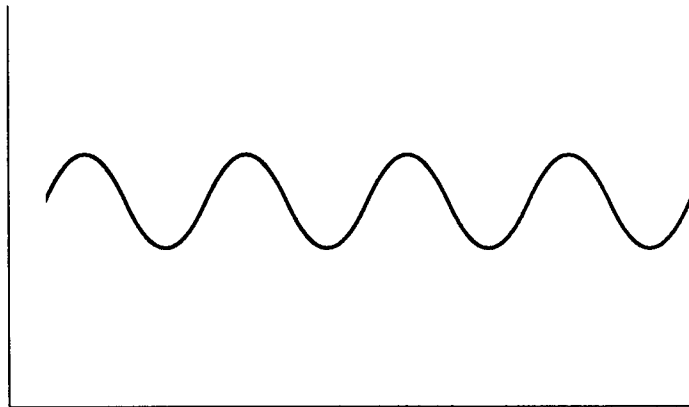


FIG.7

