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(71) Applicant: **LG Electronics Inc.**
Seoul 07336 (KR)

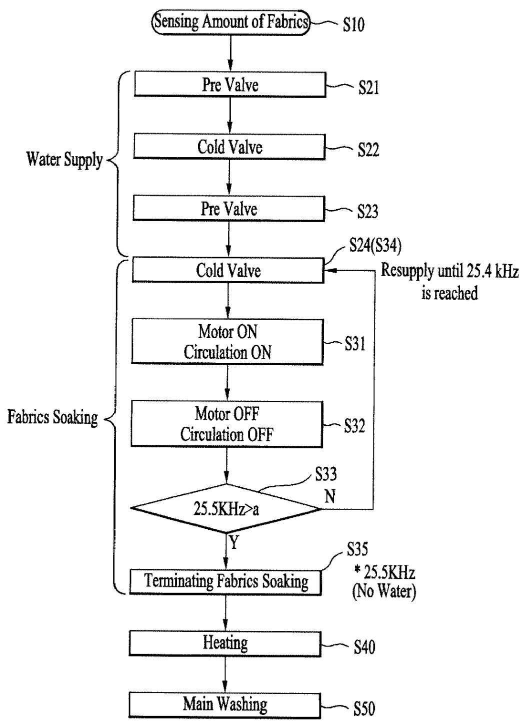
(72) Inventors:
- **KIM, Changoh**
  Seoul 08592 (KR)
- **HONG, Sangwook**
  Seoul 08592 (KR)

(74) Representative: **Vossius & Partner**
Patentanwälte Rechtsanwälte mbB
Siebertstrasse 3
81675 München (DE)

(54) LAUNDRY APPARATUS AND CONTROL METHOD THEREOF

(57) Disclosed herein are a laundry apparatus for heating a drum by an induction heater and a control method thereof. According to an embodiment, the method of controlling a laundry apparatus including a tub (10), a drum and an induction heating module (27) mounted on the tub (10) to heat the drum through induction heating includes a water supply step of supplying wash water into the tub (10) through a water supply valve; and a heating step (S40) of performing heating by driving the induction heating module (27) after termination of the water supply step, wherein, in the heating step (S40), driving of the drum and driving of the induction heating module (27) are controlled to be operatively connected to each other, wherein a period for driving the drum comprises a period for driving the induction heating module (27), and the driving of the induction heating module (27) is excluded outside the period for driving the drum.

FIG. 4



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a laundry apparatus, and more particularly, to a laundry apparatus for heating a drum by an induction heater and a control method thereof.

Discussion of the Related Art

[0002] The laundry apparatus includes a tub (an outer tub) configured to store wash water and a drum (an inner tub) rotatably provided in the tub. Laundry (fabrics) is provided inside the drum, and the fabrics are washed with a detergent and wash water while the drum rotates.

[0003] In order to enhance the washing effect by promoting the activation of the detergent and decomposition of contaminants, hot wash water is supplied into the tub or heated inside the tub. To this end, the bottom of the inside of the tub is generally recessed downward to form a heater mounting portion, a heater is provided in the heater mounting portion. Such heaters are generally sheath heaters.

[0004] When washing is performed with cold water, the heater is not driven. However, for normal washing, the temperature of the wash water is set to 40 degrees Celsius or a higher temperature. Thus, in many cases, the heater is driven during washing.

[0005] The amount of wash water needed for washing may be determined by the amount of wash water needed for a heater protection water level and the amount of wash water needed for fabrics soaking.

[0006] First, approximately 6 liters of wash water should be supplied to ensure the heater protection water level for the heater at which the heater is completely submerged. In the absence of fabrics, approximately 6 liters of wash water is supplied to the tub such that the heater is completely submerged in the wash water and a part of the lower portion of the drum is also submerged in the wash water.

[0007] Second, more wash water is needed for fabrics soaking as well as heater protection. In general, the amount of water that the fabrics keep therein when water is supplied is about 200% of the amount of fabrics. Therefore, as the amount of water increases, the amount of wash for fabrics soaking increases. Approximately 6 liters of wash water will be needed for soaking of approximately 3 kg of fabrics.

[0008] As water starts to be supplied for washing, soaking of fabrics is performed. After water supply is finished, fabrics soaking is performed in earnest and then finished. Even during fabrics soaking, water may continue to be supplied to meet the heater protection water level. Water supply during the fabrics soaking may be additional water supply so as to be distinguished from the water supply before the fabrics soaking. The amount of wash water needed to reach the heater protection water level with the fabrics completely soaked is approximately 6 liters.

[0009] Thus, to wash 3 kg of fabrics, approximately 12 liters of wash water is needed. Of course, this amount of wash water is the amount needed for one washing cycle. The amount of wash water required for rinsing when water is drained after washing correspond to separate water.

[0010] In order to enhance the washing effect, a laundry apparatus having a wash water circulation system is provided. The circulating system is a system configured to drain wash water from the tub through a circulation pump and then spraying the same back into the drum. Thus, the circulation system may include a flow channel and a spray nozzle, which constitute a circulation path, as well as the circulation pump. Detergent-dissolved wash water may be sprayed onto the fabrics in the drum through the circulation system, thereby further enhancing the washing effect.

[0011] However, for a laundry apparatus adopting the circulation system, more wash water may be needed for circulation of the wash water. This is because there is wash water present on the circulation path running from a point at which wash water is supplied from the outside of the tub to a point at which the wash water is sprayed into the drum. Therefore, wash water as much as the wash water on the circulation path needs to be further supplied to meet the heater protection water level.

[0012] Approximately 1.5 liters of additional wash water are needed for circulation of the wash water. Therefore, to wash 3 kg of fabrics, 12 to 13.5 liters of wash water or more is needed. When the water level of the wash water is sensed using a frequency, the water level frequency at the heater protection water level is lower than or equal to approximately 24.7 KHz. As the water level frequency increases, the water level is lowered.

[0013] FIG. 1 shows the relationship between a washing step and an actual operating rate of the drum in a laundry apparatus having a wash water heater and a circulation pump. In the laundry apparatus, driving of the drum and driving of the circulation pump may be synchronized. Therefore, the actual operating rate of the motor may be equal to the actual operating rate of the circulation pump.

[0014] At the initial stage of washing, water supply and fabrics soaking may be performed. In this operation, the drum may be tumbled. Tumbling may be performed through forward and reverse rotation, and the RPM of the drum during tumbling is approximately 40 RPM. When more than 1.5 liters of wash water is supplied after the initial water supply, soaking of fabrics is carried out and water continues to be supplied as the tumbling begins.

[0015] Since the drum is driven to tumble, the fabrics are stirred by being repeatedly lifted up and then falling inside the drum. Thereby, soaking of fabrics is facilitated. In addition, circulation of the wash water may be carried out in the operation of fabrics soaking to further promote fabrics soaking. Then, water supply and fabrics soaking are performed until the water level of the wash water is no longer changed at the heater protection water level. That is, the fabrics soaking may be performed until the fabrics are completely wet as not to absorb wash water anymore.

[0016] When the water supply and fabrics soaking are completed, the wash water heater is driven to heat the supplied wash water. The motor actual operating rate is designed to be the minimum when the wash water is heated. The motor is designed to have an actual operating rate of approximately 13%. That is, the time for which the motor is driven may be designed to be approximately 13% of the entire heating period. Minimum tumbling is needed to evenly heat the fabrics and the wash water.

[0017] As the drum rotates, a portion of the wash water rotates along with the drum. That is, scattering of the wash water may occur, and the heater may be exposed to the air due to slopping water. The heater protection water level is not kept due to exposure of the heater to the air. For this reason, tumbling is needed during heating, but the actual operating rate is set to a minimum to maintain the heater protection water level. As a result, the actual operating rate during the heating period is very low compared to that in the period of fabrics soaking or the main washing period.

[0018] Since the time required to perform tumbling in the heating period is minimized, the washing effect in the heating period is not remarkable. That is, the washing time is increased by the time required for heating, and the heating time cannot be used in securing washing performance.

[0019] In addition, driving the circulation pump is stopped in the heating period. That is, driving of the circulation pump is not synchronized with driving of the drum and the actual operating rate of the circulation pump in the heating period may be 0%. This is because when the circulation pump is driven, about 1.5 liters or more of wash water should be additionally supplied as described above. In addition, the heater protection water level may be destroyed by the driving of the circulation pump and the tumbling driving.

[0020] It is not desirable to supply additional water to drive the circulation pump or increase the actual operating rate in the heating period. This is because the detergent concentration is lowered when the amount of supplied wash water is increased compared to a predetermined amount of detergent. That is, the washing performance may be slightly increased through circulation and a high actual operating rate in a relatively short period called the heating period. However, since the concentration of the detergent is low, the washing performance may be significantly reduced in the main washing period.

[0021] Once the wash water is heated up to a target temperature, the drum is driven at an actual operating rate of approximately 70%, and washing is performed in earnest. In the main washing, the circulation pump may be driven.

[0022] Accordingly, for typical laundry apparatuses, a relatively large amount of wash water is needed to meet the heater protection water level. Therefore, it is difficult to perform washing through high-concentration detergent water (wash water in which detergent is dissolved), or a large amount of detergent is needed. In addition, in order to meet the heater protection water level, the degree of freedom of the actual operating rate of the drum or the circulation pump in the heating period is inevitably limited . Therefore, the washing time is relatively increased.

[0023] Therefore, there are large requirements for saving wash water, reducing detergent, performing washing by high-concentration detergent water, reducing the heating time, saving energy by improving the degree of freedom of the motor and circulation pump, and reducing the washing time.

SUMMARY OF THE INVENTION

[0024] The present invention basically aims to address the issues of the conventional laundry apparatus.

[0025] In one embodiment of the present invention, a laundry apparatus capable of increasing efficiency of fabrics soaking by driving a circulation pump in a period of fabrics soaking even when the amount of supplied wash water is small, and a control method thereof are provided.

[0026] In one embodiment of the present invention, a laundry apparatus capable of shortening the time required for fabrics soaking while effectively performing fabrics soaking, and a control method thereof are provided.

[0027] In one embodiment of the present invention, a laundry apparatus capable of improving washing performance and reducing energy consumption by increasing the actual operating rate of a drum and the actual operating rate of a circulation pump in a wash water heating period by destroying a heater protection water level, and a control method thereof are provided.

[0028] In one embodiment of the present invention, a laundry apparatus capable of enhancing washing performance by driving a circulation pump in a wash water heating period, and a control method thereof are provided.

[0029] In one embodiment of the present invention, a laundry apparatus capable of securing washing performance and saving energy by reducing energy needed to heat wash water, and a control method thereof are provided.

[0030] In one embodiment of the present invention, a laundry apparatus capable of performing washing using a small amount of wash water and high-concentration detergent water, and a control method thereof are provided.

[0031] In one embodiment of the present invention, a laundry apparatus capable of safely heating wash water despite the destruction of a heater protection water level, and a control method thereof are provided.

[0032] In one embodiment of the present invention, a laundry apparatus capable of heating a drum through an induction heating module and heating wash water through the heated drum, and a control method thereof are provided.

[0033] In one embodiment of the present invention, a safe laundry apparatus that prevents overheating through an induction heating module and a control method thereof are provided. In addition, a laundry apparatus capable of enhancing the heating efficiency and washing efficiency by increasing a time for which the induction heating module is driven (i.e., an actual operating rate of the induction heating module) in a heating period, and a control method thereof are provided.

[0034] In one embodiment of the present invention, a laundry apparatus capable of preventing an induction heating module from overheating a drum by controlling driving of the drum and the circulation pump to operatively connected to each other, in particular by operatively connecting the driving of the drum with the driving of the circulation pump, and a control method thereof are provided.

[0035] In one embodiment of the present invention, a safe laundry apparatus capable of forcibly stopping driving an induction heating module when overheating of the drum is sensed through a drying temperature sensor for detecting overheating of the drum, and a control method thereof are provided. In particular, a laundry apparatus capable of quickly addressing overheat of the drum by maintaining scheduled driving of the drum and/or the circulation pump when the induction heating module is forcibly stopped, and a control method thereof are provided.

[0036] In one embodiment of the present invention, a safe laundry apparatus capable of preventing overheating by the induction heating module through a drying temperature sensor and a wash water temperature sensor for detecting the temperature of wash water, which are installed at different positions, targeting different objects, and operate at different sensing times, and a control method thereof are provided.

[0037] Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objectives and other advantages of the invention may be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[0038] To achieve these objects and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, a method of controlling a laundry apparatus including a tub, a drum and an induction heating module mounted on the tub to heat the drum through induction heating includes a water supply step of supplying wash water into the tub through a water supply valve, and a heating step of performing heating by driving the induction heating module after termination of the water supply step, wherein, in the heating step, driving of the drum and driving of the induction heating module are controlled to be operatively connected to each other, wherein a period for driving the drum includes a period for driving the induction heating module, and the driving of the induction heating module is excluded outside the period for driving the drum. Thus, the induction heating module may be driven along with rotation of the drum to prevent the drum from overheating.

[0039] The driving of the drum may include tumbling driving. In addition, the driving of the drum may include filtration driving.

[0040] ON/OFF times of the motor for the driving of the drum may be the same as ON/OFF times of the induction heating module.

[0041] In the heating step, an ON time of the induction heating module may be later than an ON time of the motor.

[0042] The induction heating module may be turned on when the motor is accelerated after the ON time of the motor and rotations per minute (RPM) of the drum is greater than or equal to predetermined RPM, the predetermined RPM being lower than RPM of tumbling (target RPM). This is because heat may not be sufficiently transferred from the heated drum to the wash water or fabrics if the rotational speed is excessively low.

[0043] An OFF time of the motor may be the same as an OFF time of the induction heating module. After the motor is turned off, the drum is decelerated by inertia to stop.

[0044] An OFF time of the induction heating module may be later than an OFF time of the motor and earlier than a stop time of the drum.

[0045] The induction heating module may be turned off when the drum is decelerated after the OFF time of the motor, and rotations per minute (RPM) of the drum is less than or equal to predetermined RPM, the predetermined RPM being lower than RPM of tumbling (target RPM). Accordingly, the induction module may be driven even after the OFF time of the motor. Thus, the heating time may be increased.

[0046] The laundry apparatus further may include a drying temperature sensor configured to sense a temperature of the drum.

[0047] When a temperature higher than or equal to a set temperature is sensed by the drying temperature sensor before the induction heating module is turned off in operative connection with the driving of the drum, the driving of the induction heating module may be forcibly turned off. That is, the conditions for OFF during operation of the induction module may be a condition for operative connection with the drum and a temperature condition by the drying temperature sensor. If either condition is met, the induction heating module will be turned off.

[0048] The driving of the drum may be repeated a plurality of times in the heating step.

[0049] The laundry apparatus may further include a wash water temperature sensor configured to sense a temperature of the wash water in the tub, wherein the wash water temperature sensor may be configured to sense the temperature of the wash water when the drum is stopped.

[0050] Therefore, the temperature of the wash water is sensed a plurality of times in the heating step. In addition, the temperature of the drum is sensed a plurality of times during the driving of the drum.

[0051] The heating step may be terminated when the wash water temperature sensor senses a preset temperature.

[0052] The laundry apparatus may include a circulation pump configured to pump the wash water inside the tub and supply the pumped wash water to an upper portion of the drum.

[0053] The driving of the drum and driving of the circulation pump may be operatively connected to each other in the heating step. The wash water may also be heated by driving the circulation pump. In particular, even when the wash water level is lower than the lowest end of the drum, the wash water may be heated.

[0054] ON/OFF times of the motor for the driving of the drum may be the same as ON/OFF times of the circulation pump.

[0055] The heating step may be performed while a water level of the wash water is lower than a lowest end of the drum.

[0056] The water level of the wash water in the heating step may be lower than or equal to a circulation water level formed by an amount of wash water smaller than or equal to an amount of wash water filling a circulation path for the driving of the circulation pump.

[0057] The amount of wash water stored in the tub in the heating step to form a circulation water level may be less than or equal to 1 liter.

[0058] In the heating step, the driving of the drum may include tumbling driving and filtration driving.

[0059] In the heating step, the driving of the drum may include circulation driving of performing the tumbling driving and the filtration driving in succession.

[0060] In the heating step, the tumbling driving, stop and circulation driving of the drum may be repeatedly performed.

[0061] In another aspect of the present invention, provided herein is a laundry apparatus including a tub configured to accommodate wash water, a drum rotatably provided in the tub, the drum accommodating fabrics therein, a motor configured to drive the drum, an induction heating module mounted on the tub to heat the drum through induction heating, a water supply valve configured to supply wash water into the tub, a water level sensor configured to sense a water level of the wash water in the tub, and a controller configured to control driving of the motor, the induction heating module and the water supply valve, wherein the controller is configured to control ON/OFF of the motor and ON/OFF of the induction heating module to be operatively connected to each other, and to control the induction heating module to be driven when rotations per minute (RPM) of the drum after the motor is turned on is greater than or equal to predetermined RPM before reaching target RPM.

[0062] The controller may control the induction heating module to be turned off when the RMP is lower than or equal to than predetermined RMP before the drum is stopped at or after an OFF time of the motor.

[0063] The laundry apparatus may further include a drying temperature sensor configured to sense a temperature of the drum, wherein, when a temperature sensed by the drying temperature sensor is higher than or equal to a predetermined temperature, the controller may exclude control of the motor and the induction heating module in operative connection therebetween, and forcibly turn off the induction heating module.

[0064] When a time required from a start of the ON of the motor to the OFF of the motor is preset, and the induction heating module is forcibly turned off before the preset required time elapses, the controller may control the motor to be turned off after the preset required time elapses.

[0065] The laundry apparatus may further include a circulation pump configured to pump the wash water inside the tub and supply the pumped wash water into the drum, wherein the controller may control operation of the motor and operation of the circulation pump to be operatively connected to each other.

[0066] Features of the above-described embodiments may be implemented in combination in other embodiments unless they are contradictory or exclusive of each other.

[0067] It is to be understood that both the foregoing general description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0068] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention and together with the description serve to explain the principle of the invention. In the drawings:

FIG. 1 illustrates driving of a drum and a circulation pump in a washing operation of a conventional laundry apparatus;

FIG. 2 illustrates control elements of a laundry apparatus according to an embodiment of the present invention;

FIG. 3 illustrates operation of the control elements in a water supply step and a fabrics soaking step in the laundry apparatus according to the embodiment of the present invention;

FIG. 4 illustrates a control flow of the laundry apparatus according to the embodiment of the present invention;

FIG. 5 illustrates operation of the control elements in a heating step in the laundry apparatus according to the embodiment of the present invention;

FIG. 6 illustrates a drum which is stopped;

FIG. 7 illustrates tumbling operation of the drum;

FIG. 8 illustrates filtration operation of the drum;

FIG. 9 illustrates a relationship between driving of the drum and driving of an induction heating module for safe driving of the induction heating module;

FIG. 10 illustrates a correlation between washing performance, the amount of water, a washing temperature, wash water circulation, and drum driving in a conventional laundry apparatus; and

FIG. 11 illustrates a correlation between washing performance, the amount of water, a washing temperature, wash water circulation, and drum driving in the laundry apparatus according to the embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0069] Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

[0070] Hereinafter, a laundry apparatus and a control method thereof according to an embodiment of the present invention will be described in detail with reference to the accompanying drawings.

[0071] The applicant has filed a patent application (Korean Patent Application No. 10-2017-0101332, hereinafter referred to as "prior art patent document") for a laundry apparatus having an induction heating module as a laundry apparatus applicable to one embodiment of the present invention.

[0072] Accordingly, elements not described herein may be the same as or similar to those disclosed in the prior art patent document, unless they contradict the prior art patent document.

[0073] Therefore, a detailed description of a cabinet defining the exterior of the laundry apparatus, a tub provided in the cabinet, a drum rotatably provided in the tub, and a door rotatably provided to the cabinet are omitted. In addition, a detailed description of the heating principle and structural features of the induction heating module will be omitted.

[0074] First, control elements of the laundry apparatus according to an embodiment of the present invention will be described in detail with reference to FIG. 2.

[0075] A controller 20 is provided as a main processor to control operation of the laundry apparatus. Operation of various control elements which will described later may be controlled by the controller.

[0076] A motor 21 is provided to drive the drum. That is, the motor 21 is provided to rotate the drum. The rotational force of the motor 21 may be transmitted directly or indirectly to the drum. Recently, a direct drive motor whose rotational force is directly transmitted to the drum is commonly used as the motor 21.

[0077] The driving pattern of the drum may vary according to the driving pattern of the motor 21. Therefore, the controller 20 controls driving of the motor 21 to generate various kinds of driving including tumbling driving, filtration driving, and spin driving of the drum. The driving of the drum may be referred to as motion of the drum.

[0078] The time for which the motor is actually driven within a certain period may correspond to an actual operating rate. That is, if the motor is actually driven for only 50 seconds within the period of 100 seconds, the actual operating rate of the motor may be 50%. Since the motor drives the drum, the actual operating rate of the motor may be approximately equal to the actual operating rate of the drum. In this embodiment, the actual operating rate of the motor and the actual operating rate of the drum may be understood to be the same unless otherwise described.

[0079] The tumbling driving of the drum causes the fabrics inside the drum to be lifted and then fall as the drum rotates at approximately 40 to 46 RPM. In the tumbling driving, washing or fabrics soaking may be performed by mechanical force according to fall of the fabrics and friction against the drum. Since the fabrics are agitated in the drum through the tumbling driving, the tumbling driving may be commonly used.

[0080] In the filtration driving of the drum, the drum and the fabrics may integrally rotate with the fabrics making close contact with the inner circumferential surface of the drum as the drum rotates at approximately 100 RPM. In this driving, the laundry fabrics are spread on the inner circumferential surface of the drum and wash water is separated from the fabrics.

[0081] In the spin driving of the drum, wash water may be removed from the fabrics by centrifugal force as the drum rotates at about 800 or higher RPM. The spin driving may be performed by very large centrifugal force in the final process of washing, and then washing may be finished.

[0082] Therefore, the RPM of the drum increases from the spin driving to the filtration driving to the tumbling driving. In the spin driving, the drum may be continuously rotated in one direction. In the tumbling driving and the spin driving, forward and reverse rotation and stopping may be repeated.

[0083] For washing, the wash water should be supplied from the outside of the laundry apparatus into the tub. To this end, the laundry apparatus is provided with a water supply valve 23. The water supply valve is connected to an external water supply, and wash water is supplied into the laundry apparatus when the water supply valve is operated.

[0084] If necessary, a plurality of water supply valves 23 may be provided. A cold water valve 25, which is configured to supply cold water from an external water supply source, and a pre-valve 24 connected to a boiler to supply water other than cold water, such as hot water, may be provided.

[0085] When the wash water temperature is set to room temperature (cool or cold water), heating of the wash water is not required during washing. Therefore, in this case, water may be supplied only by the cold water valve 25. However, when the wash water temperature is set to a constant temperature (25 °C, 40 °C, etc.), not the room temperature, wash water may be supplied through the pre-valve 24 and the cold water valve 25. Of course, in the latter case, wash water may be supplied only through the cold water valve 25.

[0086] The pre-valve 24 and the cold water valve 25 may be used to supply the same cold water. Supplying water through the pre-valve 24 may correspond to a case where water is supplied to the tub through the drum, and supplying water through the cold water valve 25 may correspond to a case where water is supplied to the tub without passing through the drum. Of course, supplying water through the valves may refer to the opposite cases.

[0087] In addition, the pre-valve 24 may be a water supply valve for supplying wash water to the tub through the detergent box, and the cold water valve 25 may be a water supply valve for supplying wash water directly into the tub without passing through the detergent box. Of course, the valves may be used in the opposite way.

[0088] Therefore, a plurality of water supply valves may be provided according to the temperature of the wash water and the water supply path of the wash water.

[0089] A water level sensor 26 may be provided to sense the level of wash water supplied into the tub. That is, it may be a sensor configured to control the water level such that an appropriate amount of wash water is supplied.

[0090] In general, a frequency sensor configured to sense the water level through the frequency is commonly used as the water level sensor 26. The water level is sensed based on the difference between frequencies sensed according to the water levels. In the washing operation, the water level sensor 26 senses a water level for water supply, which is between a zero water level and the maximum water level. As described above, the maximum water level is a level for protecting the heater, at which a part of the lower portion of the drum is submerged in the wash water. It is common to supply water until the water level of the wash water reaches the heater protection water level after the fabrics fully absorbs wash water.

[0091] In this embodiment, the heater protection water level may be destroyed. That is, the heater protection water level may be ignored. Accordingly, the maximum water level at which water is supplied may be a water supply water level, not the heater protection water level. In this embodiment, the water supply water level may be a water level at which a part of the lower portion of the drum is submerged in the wash water.

[0092] In the frequency sensor, the zero water level may correspond to approximately 25.5 kHz and the heater protection water level may correspond to approximately 24.7 kHz. Of course, the value of a specific frequency may depend on the size of the laundry apparatus, the model of the frequency sensor, and the external environment. In any case, a higher frequency may mean a lower water level in the frequency sensor.

[0093] The controller 20 controls operation of the water supply valve 23 based on the water level value sensed by the water level sensor 26.

[0094] The induction heating (IH) module 27 may be a heater configured to heat the drum through induction heating. Since the IH module is described in detail in the prior art patent document, a redundant description thereof will be omitted.

[0095] Wash water is heated when the drum is heated by the IH module. Of course, the fabrics in contact with the drum as well as the wash water are directly heated. This heating method may increase the heating effect as the fabrics having absorbed the wash water are directly heated. In addition, since heat is less diffused to the surroundings, the heating efficiency may be enhanced.

[0096] In washing, heating through the IH module may be performed through the wash water temperature sensor 28. That is, heating may be terminated when the temperature of the wash water reaches a set temperature.

[0097] By the IH module, the drum may be heated to about 160 °C in a short time. In one example, the temperature of the outer circumferential surface of the drum may rise to 160 °C in about three seconds. Therefore, the heat of the drum should be transferred to the wash water and the fabrics to prevent the drum or the IH module from overheating.

[0098] In order to prevent the drum from overheating, a drying temperature sensor 29 may be provided. The drying temperature sensor 29 may be provided to directly or indirectly sense the temperature of the outer circumferential surface of the drum. When it is determined by the drying temperature sensor 29 that the drum is overheated, the controller 20 stops the operation of the IH module.

[0099] The wash water temperature sensor 28 may be mounted under the tub to sense the temperature of the wash water. The drying temperature sensor may be mounted on the top of the tub to sense the temperature of the outer circumferential surface of the drum. Accordingly, both sensors may be arranged at different positions and have different sensing targets.

[0100] The wash water temperature sensor 28 may directly sense the temperature of the wash water. The drying temperature sensor 29 may indirectly sense the temperature of the rotating drum in a non-contact manner. Accordingly, both sensors may employ different sensing mechanisms or methods.

[0101] The wash water temperature sensor 28 may be configured to sense the temperature of the wash water when the drum is stopped. The IH module may be controlled not to operate when the target temperature is reached. The drying temperature sensor 29 may be configured to sense the temperature of the drum when the drum rotates. In particular, it may be configured to sense the temperature during rotation of the drum and operation of the IH module. Accordingly, both sensors may operate at different sensing times.

[0102] Through such a dual sensor configuration, a safe laundry apparatus and a control method thereof may be provided.

[0103] One embodiment of the present invention may provide a laundry apparatus capable of stably driving the IH module and a control method thereof. In particular, driving of the drum may be operatively connected to driving of the IH module. Details of this embodiment will be described later.

[0104] With the laundry apparatus and the control method according to this embodiment, effective washing may be performed with wash water whose amount is significantly smaller than the amount of wash water needed for washing in conventional cases. That is, effective washing may be performed only by the amount of wash water up to a level much lower than the heater protection water level.

[0105] In order for washing to be effective, the fabrics should be supplied with sufficient detergent water (wash water in which detergent is dissolved). That is, washing may be performed when the fabrics cam absorb and discharge the detergent water at the same time. It will be clear that a portion of the fabrics that is not wet will not be washed. This may be reason why washing is performed at the heater protection water level in the conventional cases.

[0106] However, the heater protection water level is not required in this embodiment, and washing may be performed at a level much lower than the heater protection water level. That is, washing may be performed without the fabrics submerged in the wash water.

[0107] In this case, as the drum is driven, the detergent water absorbed by the fabrics is inevitably discharged to the tub, which may reduce the washing effect. For this reason, in this embodiment, a circulation pump 22 configured to supply or resupply the detergent water to the fabrics may be provided.

[0108] The circulation pump 22 may be an element configured to drain and pump a part of wash water from the lower portion of the tub to spray the wash water onto the fabrics from the top of the drum. The washing effect may be enhanced by the spray pressure of the wash water, and the wash water (detergent water) may be resupplied to the fabrics to ensure that the fabrics always remain sufficiently wet. Thus, effective washing may be performed even when the fabrics are not submerged in the wash water.

[0109] Washing through the laundry apparatus may be performed through the initial water supply, fabrics soaking, heating, and main washing steps or periods. After the main washing, rinsing and spin-drying may be performed to finish washing. The entire washing process or washing course is automatically performed in the order of washing operation, rinsing operation, and spin-drying operation and then terminated.

[0110] Additional water may be supplied in the fabrics soaking step. This embodiment may achieve the above object when heating is performed in the washing operation. Features in the washing operation according to an embodiment of the present invention described below may be equally applicable to the rinsing operation unless contradictory or exclusive.

[0111] Hereinafter, a control method according to an embodiment of the present invention will be described in detail with reference to FIGS. 3 and 4. FIG. 4 illustrates the overall flow of the washing operation, and FIG. 3 illustrates operation of the control elements (the water supply valve, the motor to drive the drum, the circulation pump, and the water level sensor) in the washing operation, in particular, in the water supply and fabrics soaking periods (step).

[0112] The water supply and fabrics soaking periods will be described first.

[0113] When washing is started, sensing the amount of fabrics (S10) may be performed first while the drum is driven. As the sensed amount of fabrics increases, the amount of wash water needed may increase, and the time required for washing may also increase. Once the amount of fabrics is sensed, an expected end time of washing may be displayed according to the sensed amount of fabrics.

[0114] When the amount of fabrics is sensed, the water supply step S20 may be performed. The water supply step S20 may be initial water supply. In the water supply step S20, the drum may be subjected to tumbling driving. The RPM at this time may be approximately 46 RPM. When the motor is turned on, the RPM gradually increases, and the motor drives the drum while maintaining the set RPM, which is 46 RPM. When the motor is turned off, the RPM gradually decreases from 46 RPM to stop the drum. Thus, the drum rotates for a short time after the motor is turned off. When a predetermined time elapses after the drum stops rotating as the motor is turned off, the motor is turned on again. At this time, the drum may be rotated in the opposite direction.

[0115] In the water supply step S20, intermittent water supply may be performed by repeatedly turning on and off the water supply valve 23, or water may be supplied while keeping the valve turned on for a certain time. In the water supply step S20, water supply may be performed a plurality of times. A different on/off pattern or different On-state duration of the water supply valve 23 may be given each time water supply is performed. FIG. 2 illustrates an exemplary case where tumbling driving is performed for times and water supply is performed four times. The number of times of tumbling driving and the number of times of water supply may depend on the amount of fabrics.

[0116] In the water supply step S20, the water supply (S21) by the pre-valve 24 and the water supply (S22) by the cold water valve 25 may be sequentially performed. That is, pre-water supply (S21), cold water supply (S22), pre-water water supply (S23) and cold water supply (S24) may be performed. The final water supply in the water supply step (S20) may be cold water supply (S24).

[0117] As the water supply step S20 proceeds, the water level is increased. That is, the sensed water level frequency is reduced. In FIG. 2, 25.5 kHz is an example of the zero water level, 25.4 kHz is an example of a water level which is higher than the zero water level and is the minimum water level required in this embodiment (which is, for example, a level corresponding to about 1 liter, and is called a circulation water level in this embodiment). 24.7 kHz is an example of a conventional heater protection water level or a water level at which the low end of the drum is partially submerged in wash water.

[0118] In the water supply step S20, the initial water supply may be performed such that a large portion of the tumbling driving period overlaps with the water supply period. In other words, detergent water may be directly supplied to the fabrics to reduce the time for fabrics soaking later.

[0119] Dry fabrics take a certain amount of time to absorb the wash water. Therefore, a relatively small amount of the wash water supplied in the water supply step S20 is absorbed by the fabrics at the initial stage. Accordingly, when a target water level is reached the water supply step S20 is terminated. Here, the target water level may be a level similar to or lower than the conventional heater protection water level. Of course, the target water level may be a water level higher than the circulation water level. However, since it is expected that the water level will be lowered later through soaking of fabrics, the target water level may be set equal to the heater protection water level. Although not shown in FIG. 3, the water level may be sensed in the water supply process, which may be intended to determine the end time of the water supply process.

[0120] When the water supply step S20 ends at the target water level (approximately 24.7 kHz), the fabrics soaking step S30 is performed. The fabrics soaking step may be a step of allowing the fabrics to sufficiently absorb the wash water.

[0121] In this embodiment, the water level at the end of the water supply step S20 may be a water level at which the fabrics are not substantially submerged in the wash water. At this water level, only a part of the fabrics which is in contact with the lower portion of the drum may be submerged in the wash water. The fabrics soaking step S30 may be started while the drum is driven without additional water supply. Therefore, the circulation pump may be driven together with the drum for fabrics soaking.

[0122] That is, when the water supply step S20 finally ends with the water supply S24, the fabrics soaking step S30 may be started by turning on the motor and the circulation pump to drive the drum.

[0123] The water level at the end of the water supply step S20 may be higher than the circulation water level. Thus, the amount of wash water stored in the tub may be sufficient for circulation.

[0124] Driving of the drum may include tumbling driving. The driving of the drum may include filtration driving.

[0125] The tumbling driving may be performed for a predetermined time from the time at which the motor is turned on, and be followed by the filtration driving in succession. That is, rotation of the drum operating at 46 RPM for the tumbling driving may be increased and maintained at about 100 RPM for the filtration driving. The motor may be turned off when a predetermined time elapses. The driving of the drum in which the tumbling driving is followed by the filtration driving in succession may be referred to as circulation driving or circulation motion of the drum for convenience. That is, in the circulation driving of the drum, the tumbling driving and the filtration driving may be continuously performed in series.

[0126] Since the circulation pump is driven in the tumbling driving, which is the initial operation of the circulation driving, the water level gradually decreases. This is because the fabrics absorb wash water sprayed onto the fabrics as the circulation pump is driven. As the water level gradually decreases, the amount of wash water needed to drive the circulation pump may not be stored in the tub. Accordingly, in the filtration driving, which is the later operation of the circulating driving, a part of wash water sucked around the drum or excessively absorbed by the fabrics is removed. Wash water for the circulation pump driving may be secured by the filtration driving.

[0127] Most of the wash water is absorbed by the fabrics by the first time of the circulation driving of the drum and the circulation pump driving (S31), and thus the fabrics become wet. The wash water absorbed by the fabrics to a proper degree is not removed by centrifugal force because the RPM of the filtration driving is relatively low.

[0128] Thus, driving of the drum and the circulation pump is performed for the first time (S31), and driving of the drum and the circulation pump is terminated (S32) by turning off the motor and the circulation pump. The motor and the circulation pump may be synchronized. However, when the motor is turned off, the drum rotates for a short time and stops. This may take place due to inertia. When the drum is completely stopped after the motor is turned off, the water level is measured (S33). That is, this is intended to accurately measure the water level on the calm water surface. The water level after the first time of driving of the drum and circulation pump may be approximately the zero water level.

[0129] If the sensed water level is the zero water level or a water level lower than the circulating water level, for example, 25.5 kHz or higher than 25.4 kHz, additional water supply may be performed for the first time. The additional water supply may be water supply through the water supply valve 23 described above. That is, the water supply step S24 may be performed again through the valve that was turned on at the end of the water supply step S20, for example, the cold water valve S25. Thus, the additional water supply may be represented by S34 so as to distinguished from the water supply step S24 in fabrics soaking. The additional water supply S34 may be performed up to the circulation water level. That is, water supply may be performed until the water level sensor 26 senses, for example, 25.4 kHz.

[0130] After the additional water supply S33 is performed, driving of the drum and the circulation pump is performed for the second time (S31). Here, it may be seen that the water level at which driving of the circulation pump starts is the target water level of the additional water supply in the fabrics soaking step S30.

[0131] Driving of the drum and the circulation pump may be performed in the same manner as in the first time of the driving. The additional water supply S33 may be performed again when water level sensing is needed. Of course, the driving of the drum and the circulation pump may be restarted.

[0132] In the fabrics soaking step S30, driving the drum and circulation pump (S31), turning off the motor and circulation pump (S32), sensing the water level (S33), and the additional water supply (S34) may be continuously repeated. This repetition may be performed until the circulating water level is sensed in the water level sensing (S33) and additional water supply is not needed anymore. That is, the additional water supply is repeatedly performed until the circulation water level is reached. And when the water level is not reduced but is maintained at the circulation level, the fabrics soaking step is terminated.

[0133] In other words, when the water level sensed after the circulation driving is the circulation water level, the fabrics soaking step S30 is terminated (S35). That is, the fabrics soaking step S30 may be performed by the time at which the fabrics does not absorb wash water anymore despite spraying of wash water onto the fabrics through the circulation pump, the step of filling (S30) is carried out until the point at which (i.e., the time when absorption and discharge of the wash water is balanced in the fabrics).

[0134] When the lowest end of the drum touches the wash water, the amount of wash water supplied to the tub is approximately 2 liters, which correspond to, for example, 24.9 kHz. When a part of the lower portion of the drum is submerged in the wash water and a part of the fabrics inside the drum is submerged in the wash water, the amount of wash water supplied to the tub is approximately 3 to 4 liters, which correspond to, for example, 24.7 kHz. On the other hand, the circulation level is about 1 liter of wash water supplied to the tub. In other words, the amount of wash water corresponding to the circulation water level (e.g., 25.4 kHz) may be between the zero water level (e.g., 25.5 kHz) and 1 liter.

[0135] As described above, approximately 1.5 liters of wash water is needed to smoothly drive the circulation pump. However, 1.5 liters of wash water may be the amount of wash water present when the circulation pump is driven during the normal tumbling driving.

[0136] In this embodiment, the drum may be subjected to circulation driving when the circulation pump is driven. Since the filtration driving is implemented in the circulation driving, the washing water may be driven to gather in the lower portion of the tub, and therefore the circulation pump may be smoothly driven even with a relatively small amount of the wash water.

[0137] The circulation water level refers to wash water whose amount is smaller than the amount corresponding to the water level at which the lowest end of the drum touches the wash water by about 1 liter and is smaller than the amount corresponding to the heater protection water level by about 2 to 3 liters. In addition, the circulation water level may be a water level reached when approximately 1 liter of wash water is added at the zero water level.

[0138] Therefore, it may be seen that after completion of fabrics soaking, a relatively very small amount of wash water is stored in the tub. In other words, even if only a relatively small amount of wash water is supplied, fabrics soaking may be effectively performed, and heating or main washing subsequent thereto may also be performed.

[0139] In the conventional laundry apparatus, the amount of wash water reaching the heater protection water level is inevitably required after fabrics soaking. In this embodiment, only the amount of the wash water reaching the circulation level may be required after fabrics soaking. That is, it can be seen that the amount of residual wash water in the tub after fabrics soaking is remarkably small in this embodiment. It can be seen that the subsequent operations of wash water heating and main washing may be effectively performed even if wash water whose amount (less than 1 liter) smaller than the amount of wash water filling the circulation pump and the circulation channel (approximately 1.5 liters) remains after fabrics soaking.

[0140] In the circulation pump driving and the tumbling driving of the drum, approximately 1.5 liters may be left. By performing the filtration driving, approximately 1 liter may be left. In particular, by performing circulation driving through about 1 liter of residual wash water, the fabrics soaking effect may be enhanced and the circulation pump may be effectively driven.

[0141] Here, it can be seen that the amount of wash water required for washing is very effective for the washing effect and energy saving.

[0142] First, washing may be performed through high-concentration detergent water. When a large amount of wash water is needed, the amount of detergent is inevitably increased for the optimum-concentration detergent water. In many cases, washing will be performed at a concentration lower than the required concentration. However, in this embodiment, the amount of wash water may be reduced by approximately 2 to 3 liters, and therefore washing may be performed through detergent water of a very high concentration. Thereby, washing performance may be enhanced. When it is assumed that the laundry apparatus is used approximately 3 to 4 times a week, a considerable amount of water may be saved.

[0143] Next, the heating efficiency, which will be described later, may be improved. When wash water or the fabrics are heated, a lot of thermal energy is consumed to heat the wash water. This is because the thermal capacity of water is relatively large. Therefore, as the amount of wash water to be heated decreases, energy saving may be performed more effectively. That is, the amount of energy needed to heat water to the same temperature may be reduced, and a higher temperature may be reached by heating using the same amount of energy.

[0144] For example, 52°C may be reached by heating, using the energy conventionally consumed to reach 40°C by heating. Therefore, when the same energy is consumed, washing performance may be enhanced by a higher temperature.

[0145] For this reason, according to this embodiment, i the chemical washing effect may be enhanced by the detergent and a high temperature. In addition, the effect according to reduction of the washing time and the effect of enhancing washing by mechanical force may be more prominent in the heating step described below.

[0146] As shown in FIG. 4, the heating step S40 and the main washing step S50 may be performed after the fabrics soaking step S30.

[0147] Hereinafter, the heating step S40 that is performed after the fabrics soaking step S30 will be described in detail with reference to FIGS. 5 to 8.

[0148] FIG. 5 illustrates operation of the motor and the IH module of the circulation pump and change in water level in the heating step. FIGS. 6 to 8 illustrate stopping of the drum, the tumbling driving and the filtration driving, respectively.

[0149] In this embodiment, unlike the example in FIGS. 6 to 8, the heater mounting portion 11 of the tub 10 may not be formed, and the heater 12 may not be mounted. However, the conventional tub may be used without changing the design, and the heater 12 is shown because the heater can be used outside the heating period. The heater 12 is shown to clarify that the heater protection water level can be destroyed or ignored in this embodiment.

[0150] In the fabrics soaking step S30, Water supply is completed and fabrics soaking is completed. That is, no further water supply may be performed and the fabrics may have absorbed the wash water to the maximum degree.

[0151] After the fabrics soaking step S30, the heating step S40 may be performed to enable washing at a high temperature. In the heating step S40, the drum is heated through the IH module 27. Therefore, the operation of turning on the IH module may always be performed while the drum is rotating.

[0152] As shown in FIG. 6, when the drum is stopped, the IH module 27 may be turned off. Driving the circulation pump may also be stopped. The IH module 27 may be provided at the top of the tub, and the fabrics are not placed on the upper side of the drum facing the IH module 27. Thus, a specific part of the drum may be overheated with the drum stopped. This is because heat cannot be transferred to the fabrics or wash water. Therefore, the IH module 27 may be turned off whenever the drum is stopped.

[0153] In the heating step S40, the drum is driven to uniformly heat the wash water and the fabrics. The driving of the drum may include tumbling driving and filtration driving. In addition, the driving of the drum may include tumbling driving and circulation driving. The tumbling driving and the circulation driving may be performed sequentially or alternately.

[0154] As shown in FIG. 7, as the drum rotates during the tumbling driving, the fabrics may be lifted by the lifter 16 and then fall due to gravity, and circulation water may be sprayed into the drum. In addition, the IH module may be driven to heat the drum.

[0155] As shown in FIG. 8, in the filtration driving or in the filtration driving within the circulation driving, as the drum rotates, the fabrics may come into close contact with the inner circumferential surface of the drum and integrally rotate together with the drum. This is because the centrifugal force according to rotation of the drum is stronger than the gravitational force. At this time, the circulation water may be sprayed into the drum and the IH module may be driven to heat the drum.

[0156] FIGS. 7 and 8 illustrate that wash water 18 is circulated and sprayed into the drum from the top of the drum, and a magnetic field 19 varied by driving of the IH module is provided to the drum. Eddy current is generated in the drum by change of the magnetic field, and heat is generated by the eddy current.

[0157] Thus, as shown in FIGS. 6 to 8, the heater protection water level may be destroyed in the entire heating period, and thus the water level may always be lower than the lowest end of the lower portion of the drum, that is, the circulation level.

[0158] In the tumbling driving and the circulation driving, the IH module 27 and the circulation pump 22 may operate. Wash water is sprayed onto the heated fabrics and drum by operation of the circulation pump 22. Thus, the heat of the heated drum may be effectively transferred to the wash water and the fabrics. That is, the driving of the drum, heating and driving of the circulation pump are performed at the same time.

[0159] As shown in FIG. 5, the period from the start of rotation of the drum to the stop of rotation of the drum may be the same as the circulation pump operation period. Since the circulation pump may be operated synchronously by turning on the motor, rotation of the drum and operation of the circulation pump may be started substantially at the same time. However, when the motor is turned off, the inertia force causes the drum to rotate for a short time to stop. Thus, the circulation pump may be turned off synchronously when the motor is off. Of course, the circulation pump may be turned off when the drum is stopped.

[0160] A period in which the drum starts and stops rotating may be the same as a period in which the IH module is turned on and off. However, the IH module may start to be turned on after the start of rotation of the drum, and may be turned off before rotation of the drum is stopped.

[0161] Therefore, the driving period of the drum may basically include or be the same as the driving period of the circulation pump and the driving period of the IH module.

[0162] When the motor is turned on, the rotational speed of the drum increases to a target speed and the drum rotates maintaining target speed. If the rotational speed of the drum is low, some areas of the drum may be rapidly heated. Therefore, the IH module may be turned on only when the rotational speed of the drum is higher than a certain speed after the motor is turned on. Thereby, the drum may be prevented from overheating.

[0163] Similarly, it is not desirable for the IH module to be kept on until the drum has come to a complete stop. This is because some areas of the drum may be heated rapidly at the time when the drum is stopped. Therefore, the IH module may be turned off when the rotational speed of the drum is lower than a certain speed after the motor is turned off. It is not desirable to turn off the IH module after the motor is turned off. Since the drum rotates due to inertial force, heating may be performed in the entire inertial rotation period to reduce the entire heating time. In addition, the IH module may need to be turned off when the speed of the drum decreases to a certain speed before the drum is completely stopped. Here, the rotational speed of the drum at which the IH module is turned on during acceleration of rotation of the drum may be the same as the rotational speed of the drum at which the IH module is turned off during deceleration of rotation of the drum. This speed may be about 15 RPM. That is, the same threshold RPM may be given. Lowering the threshold RPM may improve heating efficiency, but increase the risk of overheating. Conversely, increasing the threshold RPM may reduce the heating efficiency, but decrease the risk of overheating. Accordingly, the operation of the IH module may be controlled by setting the RPM corresponding to about 1/3 of the tumbling RPM as the threshold RPM.

[0164] Therefore, the on/off timing of the motor may be different from the on/off timing of the IH module.

[0165] According to this embodiment, in the heating step S40, the heater protection water level is meaningless as described above. As can be seen from FIG. 5, effective heating may be performed even when the water level is changed between the zero water level and the circulation water level in the heating period. The illustrated change in water level is merely an example and may vary between the zero water level and the circulation water level in a different form. When the heating target temperature of the wash water is lower than about 60°C, the amount of evaporated water is not large. This is because evaporation and condensation occur simultaneously.

[0166] According to this embodiment, prevention of overheating in the laundry apparatus may be implemented through control of driving of the IH module regardless of the amount of wash water. Accordingly, in the heating step S40, the actual operating rate of the motor may be greatly increased. For example, it may be increased to 80% or more up to approximately 90%. This rate is very high compared to the actual operating rate in the heating period of the conventional laundry apparatus, which is about 13%.

[0167] It can be seen that by increasing the actual operating rate, more mechanical force may be provided to enhance the washing effect. In addition, the washing temperature may be reached very quickly due to the characteristics of the IH module. That is, the mechanical force and the heating efficiency may be increased, energy may be saved, and the amount of heating time may be reduced.

[0168] In the heating step S40, the drum may be subjected to tumbling driving and circulation driving. The drum may temporarily stop after the tumbling driving, and then the circulation driving may be performed. This driving pattern may be repeated. That is, the heating step S40 may be performed through repetition of the driving pattern until the target temperature is sensed by the wash water temperature sensor.

[0169] In the heating step S40, the water level may vary between the zero water level and the circulation water level.

[0170] When only the tumbling driving is performed, a relatively large amount of wash water is needed to drive the circulation pump as described above. When the filtration driving is performed, heat may be excessively transferred to the fabrics, thereby causing thermal damage to the fabric. Therefore, performing only the tumbling driving or both the tumbling driving and the filtration driving in an alternating manner may not be preferable.

[0171] In this embodiment, the tumbling driving and the circulation driving may be repeated. Accordingly, if the circulation pump can be driven even with a relatively small amount of wash water, the fabrics may be effectively heated while preventing overheating of the fabrics.

[0172] In the circulation driving, the tumbling time may be longer than the filtration time.

[0173] As the tumbling time increases, the fabrics and the wash water may be evenly heated, and the washing effect according to heating may be increased. In this case, however, wash water for circulation may be insufficient. Therefore, the filtration driving should be performed for a proper time. As the filtration driving time increases, there is less concern about lack of wash water for circulation. However, the time for which the fabrics remain in close contact with the drum may increase, and thus the fabrics may overheat.

[0174] Therefore, in order to prevent overheating of the fabrics, to secure a sufficient amount of wash water for driving the circulation pump, and to improve heating and washing performance, the tumbling time and the filtration time should be appropriately assigned. FIG. 5 exemplarily illustrates repetition of a 26-second period of the tumbling driving, a 4-second period of pause, and a 38-second period of the circulation driving. FIG. 5 also exemplarily illustrates that the tumbling driving is performed for 26 seconds and the filtration driving is performed for 12 seconds during the circulation driving. According to this embodiment, the tumbling time may be longer than the filtration time, and specifically, be longer than or equal to twice the filtration time. In addition, the tumbling driving and the circulation driving may be performed alternately.

[0175] Hereinafter, an embodiment for preventing overheating in the heating step will be described in detail with reference to FIG. 9.

[0176] When the water supply is finished, the drum may be heated by driving the IH module. The fabrics accommodated in the drum may be heated by the heated drum.

[0177] The IH module faces only a part of the outer circumferential surface of the drum. Accordingly, when the IH module is driven with the drum stopped, only a certain part of the drum may be heated. In particular, when the IH module faces the top of the drum, it is difficult for heat to be transferred from the heated drum to the fabrics or wash water. Therefore, in this embodiment, driving of the drum and driving of the IH module may basically be operatively connected to each other. In particular, the driving period of the drum may include or be the same as the driving period of the IH module.

[0178] The drum accelerates when the motor is turned on and starts to be driven. The drum decelerates to stop when the motor is turned off. Therefore, the RPM at the start and end of the driving is very low. Therefore, the IH module may not be driven at the start and end of the driving.

[0179] In the example illustrated in FIG. 9, the IH module is driven when the drum accelerates to reach approximately 15 RPM. Similarly, the IH module may be turned off when the drum decelerates to reach approximately 15 RPM. In the acceleration of the drum, the IH module may be driven since the RPM of the drum is expected to increase later. In the deceleration of the drum, on the other hand, the RPM of the drum is is expected to decrease later. Therefore, the turn-off timing of the IH module may be synchronized with the turn-off timing of the motor. This is because heating the drum is ultimately intended to heat the fabrics and wash water, rather the drum.

[0180] Through the correlation between the drum and the driving period of the IH module, effective heating may be ensured and overheating of the drum may be prevented. Overheating of the fabrics may also be prevented.

[0181] In FIG. 9, the driving of the circulation pump is not shown. However, the driving of the circulation pump illustrated in FIG. 5 may be applied to this example in the same manner.

[0182] The driving period of the circulation pump may be set to be substantially the same as the driving period of the IH module. This is because wash water is delivered to the drum and the fabrics by the circulation pump. Since wash water, whose temperature is low, is supplied to the drum, which is at the highest temperature, overheating of the drum and fabrics may be prevented.

[0183] It may be further necessary to improve stability as well as control of the IH module by operative connection between driving of the IH module and driving of the drum and/or the circulation pump. To this end, the drying temperature sensor described above may be provided.

[0184] When the IH module is being driven, the IH module may be forcibly turned off if the drying temperature sensor senses the drum overheating. That is, even when the IH module is driven in operative connection with driving of the drum, it may be forcibly turned off. Of course, the drum may continue to be driven at this time.

[0185] For example, in driving of the drum for which the motor is set to be kept on for 36 seconds, when overheating of the drum is sensed by the drying temperature sensor at a time point of 30 seconds from the start time, driving of the IH module may be turned off immediately. And the motor may remain in the On state for the remaining 6 seconds. In other words, if driving of the drum is maintained when the IH module is forcibly turned off, heat may be effectively transferred to the fabrics and wash water. In addition, driving of the circulation pump may also be controlled in a similar manner to driving of the drum. In other words, the drum and the circulation pump may be controlled to be driven for a predetermined time even if the IH module is forcibly terminated.

[0186] Hereinafter, washing performance (shown in FIG. 10) of the conventional laundry apparatus and washing performance (shown in FIG. 11) according to this embodiment will be compared with reference to FIGS. 10 and 11,. In particular, the results of washing performance obtained based on the amount of wash water, washing temperature, and driving of the circulation pump and the drum in the heating period are compared with each other.

[0187] The fourth column of FIG. 10 shows washing performance and conditions in general washing of a conventional laundry apparatus.

[0188] In the heating period, wash water is heated to 40°C and the general washing condition for the amount of wash water needed in addition to fabrics soaking is approximately 2 to 4 liters. As described above, in this case, driving of the circulation pump should be limited or excluded regardless of the driving pattern of the drum. Under the general washing conditions, the washing performance is 100%, which may be referred to as reference washing performance.

[0189] As can be seen from the second and third columns, the heating period may not be present as the amount of the wash water is smaller than the reference condition, and thus the driving of the circulation pump may be limited regardless of the driving pattern of the drum. Therefore, the washing performance is inevitably lower than the reference washing performance.

[0190] As can be seen from the fifth column, as the amount of wash water is larger than the reference condition, the circulation pump may be driven in the heating period regardless of the driving pattern of the drum. Since the amount of wash water increases, the washing temperature will be about 34°C, which is lower than 40°C, when the same energy is used. Therefore, since the wash water temperature is low and the concentration of the detergent is low, the washing performance is inevitably lower than the reference washing performance.

[0191] The fourth column of FIG. 11 shows washing performance and conditions in general washing of the laundry apparatus according to this embodiment. The difference in washing performance from the reference conditions of the conventional laundry apparatus described above is not large. This is because the circulation pump can be driven in the heating period and the actual operating rate of the motor can be increased under a similar temperature condition and detergent concentration conditions to the conventional case. Of course, the case of the fifth column may be similar to this case.

[0192] However, it can be seen that the amount of wash water needed according to this embodiment is smaller than the amount of wash water needed in the conventional laundry apparatus, and that the heating may be performed with only 0 to 1 liter of wash water. These conditions are also shown in the third column, which may be the optimum conditions in this embodiment.

[0193] Since the amount of wash water is small, the washing temperature may be further increased with the same energy and the detergent concentration may be increased. In addition, the circulation pump may be driven according to the driving pattern of the drum. Therefore, very economical and effective washing may be performed and, and higher performance of washing may be exhibited.

[0194] Of course, when there is little residual water as shown in the drawing, the heating temperature may be increased, resulting in washing performance similar to the reference performance.

[0195] As described above, according to this embodiment, washing logic or washing conditions that cannot be implemented in the conventional laundry apparatus may be implemented, thereby enabling very economical and effective washing.

[0196] As is apparent from the above description, the present invention has effects as follows.

[0197] In one embodiment of the present invention, a laundry apparatus capable of increasing efficiency of fabrics soaking by driving a circulation pump in a period of fabrics soaking even when the amount of supplied wash water is small, and a control method thereof may be provided.

[0198] According to one embodiment of the present invention, a laundry apparatus capable of shortening the time needed for fabrics soaking while effective performing fabrics soaking, and a control method thereof may be provided.

[0199] According to one embodiment of the present invention, a laundry apparatus capable of improving washing performance and reducing energy consumption by increasing the actual operating rate of a drum and the actual operating rate of a circulation pump in a wash water heating period by destroying a heater protection water level, and a control method thereof may be provided.

[0200] According to one embodiment of the present invention, a laundry apparatus capable of enhancing washing performance by driving a circulation pump in a wash water heating period, and a control method thereof may be provided.

[0201] According to one embodiment of the present invention, a laundry apparatus capable of securing washing performance and saving energy by reducing energy needed to heat wash water, and a control method thereof may be provided.

[0202] According to one embodiment of the present invention, a laundry apparatus capable of performing washing using a small amount of wash water and high-concentration detergent water, and a control method thereof may be provided.

[0203] According to one embodiment of the present invention, a laundry apparatus capable of safely heating wash water despite the destruction of a heater protection water level, and a control method thereof may be provided.

[0204] According to one embodiment of the present invention, a laundry apparatus capable of heating a drum through an induction heating module and heating wash water through the heated drum, and a control method thereof may be provided.

[0205] According to one embodiment of the present invention, a laundry apparatus capable of preventing fabrics from being overheated and damage by substantially equalizing the heating period of the induction heating module and the heating period of the circulation pump, and a control method thereof may be provided.

[0206] According to one embodiment of the present invention, a safe laundry apparatus capable of effectively preventing overheating of the drum by substantially equalizing the heating period of the induction heating module and the rotation period of the drum or including the heating period in the rotation period of the drum, and a control method thereof may be provided. In addition, a laundry apparatus capable of preventing overheating of the drum through a drying temperature sensor capable of sensing the temperature of the drum, and a control method thereof may be provided.

[0207] According to one embodiment of the present invention, a safe laundry apparatus capable of preventing overheating through an induction heating module and a control method thereof may be provided. In addition, a laundry apparatus capable of enhancing the heating efficiency and washing efficiency by increasing a time for which the induction heating module is driven (i.e., an actual operating rate of the induction heating module) in a heating period, and a control method thereof may be provided.

[0208] According to one embodiment of the present invention, a laundry apparatus capable of preventing an induction heating module from overheating a drum by controlling driving of the drum and the circulation pump to be operatively connected to each other, in particular by operatively connecting the driving of the drum with the driving of the circulation pump, and a control method thereof may be provided.

[0209] According to one embodiment of the present invention, a safe laundry apparatus capable of forcibly stopping driving an induction heating module when overheating of the drum is sensed through a drying temperature sensor for detecting overheating of the drum, and a control method thereof may be provided. In particular, a laundry apparatus capable of quickly addressing overheat of the drum by maintaining scheduled driving of the drum and/or the circulation pump when the induction heating module is forcibly stopped, and a control method thereof may be provided.

[0210] According to one embodiment of the present invention, a safe laundry apparatus capable of preventing overheating by the induction heating module through a drying temperature sensor and a wash water temperature sensor for detecting the temperature of wash water, which are installed at different positions, targeting different objects, and operate at different sensing times, and a control method thereof may be provided.

Claims

1. A method of controlling a laundry apparatus including a tub (10), a drum and an induction heating module (27) mounted on the tub (10) to heat the drum through induction heating, the method comprising:

a water supply step of supplying wash water into the tub (10) through a water supply valve; and
a heating step (S40) of performing heating by driving the induction heating module (27) after termination of the water supply step,
wherein, in the heating step (S40), driving of the drum and driving of the induction heating module (27) are controlled to be operatively connected to each other,
wherein a period for driving the drum comprises a period for driving the induction heating module (27), and the driving of the induction heating module (27) is excluded outside the period for driving the drum.

2. The method of claim 1, wherein the driving of the drum comprises tumbling driving, and/or
wherein ON/OFF times of the motor for the driving of the drum are the same as ON/OFF times of the induction heating module (27).

3. The method of claim 1 or 2, wherein, in the heating step (S40), an ON time of the induction heating module (27) is later than an ON time of the motor.

4. The method of claim 3, wherein the induction heating module (27) is turned on when the motor is accelerated after the ON time of the motor and rotations per minute, RPM, of the drum is greater than or equal to predetermined RPM, the predetermined RPM being lower than RPM of tumbling, or
wherein an OFF time of the motor is the same as an OFF time of the induction heating module (27).

5. The method of claim 3,
wherein an OFF time of the induction heating module (27) is later than an OFF time of the motor and earlier than a stop time of the drum, and
wherein preferably the induction heating module (27) is turned off when the drum is decelerated after the OFF time of the motor, and rotations per minute, RPM, of the drum is less than or equal to predetermined RPM, the predetermined RPM being lower than RPM of tumbling.

6. The method of any one of claims 1 to 5, wherein the laundry apparatus further comprises a drying temperature sensor configured to sense a temperature of the drum,
wherein, when a temperature higher than or equal to a set temperature is sensed by the drying temperature sensor before the induction heating module (27) is turned off in operative connection with the driving of the drum, the driving of the induction heating module (27) is forcibly turned off.

7. The method of claim 6, wherein the driving of the drum is repeated a plurality of times in the heating step (S40), and
wherein preferably the laundry apparatus further comprises a wash water temperature sensor configured to sense a temperature of the wash water in the tub (10),
wherein the wash water temperature sensor is configured to sense the temperature of the wash water when the drum is stopped, and
wherein preferably the heating step (S40) is terminated when the wash water temperature sensor senses a preset temperature.

8. The method of any one of claims 1 to 7, wherein the laundry apparatus comprises a circulation pump configured to pump the wash water inside the tub (10) and supply the pumped wash water to an upper portion of the drum,
wherein the driving of the drum and driving of the circulation pump are operatively connected to each other in the heating step (S40).

9. The method of claim 8, wherein ON/OFF times of the motor for the driving of the drum are the same as ON/OFF times of the circulation pump.

10. The method of claim 9, wherein the heating step (S40) is performed while a water level of the wash water is lower than a lowest end of the drum, wherein preferably the water level of the wash water in the heating step (S40) is lower than or equal to a circulation water level formed by an amount of wash water smaller than or equal to an amount of wash water filling a circulation path for the driving of the circulation pump, and wherein preferably the amount of wash water stored in the tub (10) in the heating step (S40) to form a circulation water level is less than or equal to 1 liter.

11. The method of claim 10, wherein, in the heating step (S40), the driving of the drum comprises tumbling driving and filtration driving, and/or wherein, in the heating step (S40), the driving of the drum comprises circulation driving of performing the tumbling driving and the filtration driving in succession, and/or wherein, in the heating step (S40), the tumbling driving, stop and circulation driving of the drum are repeatedly performed.

12. A laundry apparatus comprising:

a tub (10) configured to accommodate wash water;
a drum rotatably provided in the tub (10), the drum accommodating fabrics therein;
a motor configured to drive the drum;
an induction heating module (27) mounted on the tub (10) to heat the drum through induction heating;
a water supply valve configured to supply wash water into the tub (10);
a water level sensor configured to sense a water level of the wash water in the tub (10); and
a controller configured to control driving of the motor, the induction heating module (27) and the water supply valve,
wherein the controller is configured to:

control ON/OFF of the motor and ON/OFF of the induction heating module (27) to be operatively connected to each other; and
control the induction heating module (27) to be driven when rotations per minute (RPM) of the drum after the motor is turned on is greater than or equal to predetermined RPM before reaching target RPM.

13. The laundry apparatus of claim 12, wherein the controller controls the induction heating module (27) to be turned off when the RMP is lower than or equal to than predetermined RMP before the drum is stopped at or after an OFF time of the motor.

14. The laundry apparatus of claim 12 or 13, further comprising:

a drying temperature sensor configured to sense a temperature of the drum,
wherein, when a temperature sensed by the drying temperature sensor is higher than or equal to a predetermined temperature, the controller excludes control of the motor and the induction heating module (27) in operative connection therebetween, and forcibly turns off the induction heating module (27).

15. The laundry apparatus of claim 14, wherein, when a time required from a start of the ON of the motor to the OFF of the motor is preset, and the induction heating module (27) is forcibly turned off before the preset required time elapses, the controller controls the motor to be turned off after the preset required time elapses, and wherein the laundry apparatus preferably further comprises:

a circulation pump configured to pump the wash water inside the tub (10) and supply the pumped wash water into the drum,
wherein the controller controls operation of the motor and operation of the circulation pump to be operatively connected to each other.

FIG. 1

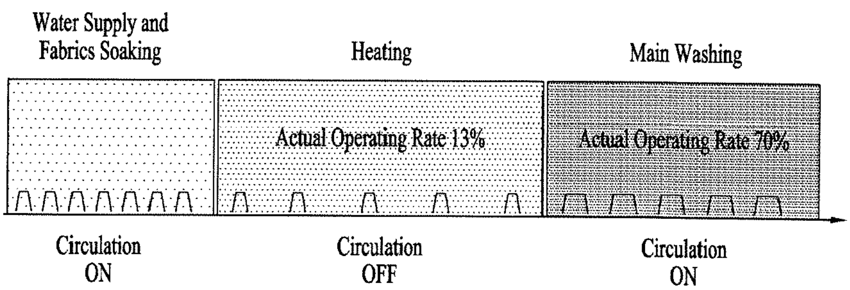

Water Supply and Fabrics Soaking
Heating
Main Washing
Actual Operating Rate 13%
Actual Operating Rate 70%
Circulation ON
Circulation OFF
Circulation ON

FIG. 2

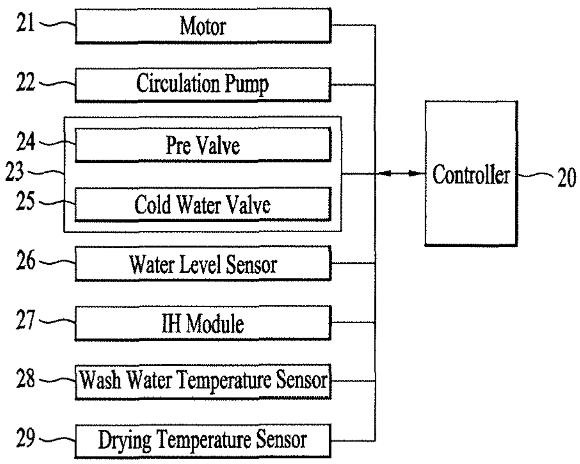

21
Motor
22
Circulation Pump
24
Pre Valve
23
25
Cold Water Valve
26
Water Level Sensor
27
IH Module
28
Wash Water Temperature Sensor
29
Drying Temperature Sensor
Controller
20

FIG. 3

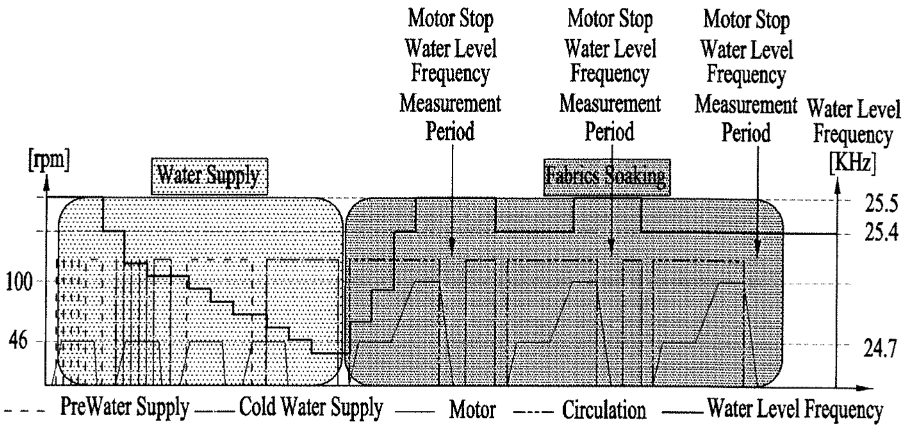

Motor Stop
Water Level
Frequency
Measurement
Period
Motor Stop
Water Level
Frequency
Measurement
Period
Motor Stop
Water Level
Frequency
Measurement
Period
Water Level
Frequency
[KHz]
[rpm]
Water Supply
Fabrics Soaking
100
46
25.5
25.4
24.7
PreWater Supply
Cold Water Supply
Motor
Circulation
Water Level Frequency

FIG. 4

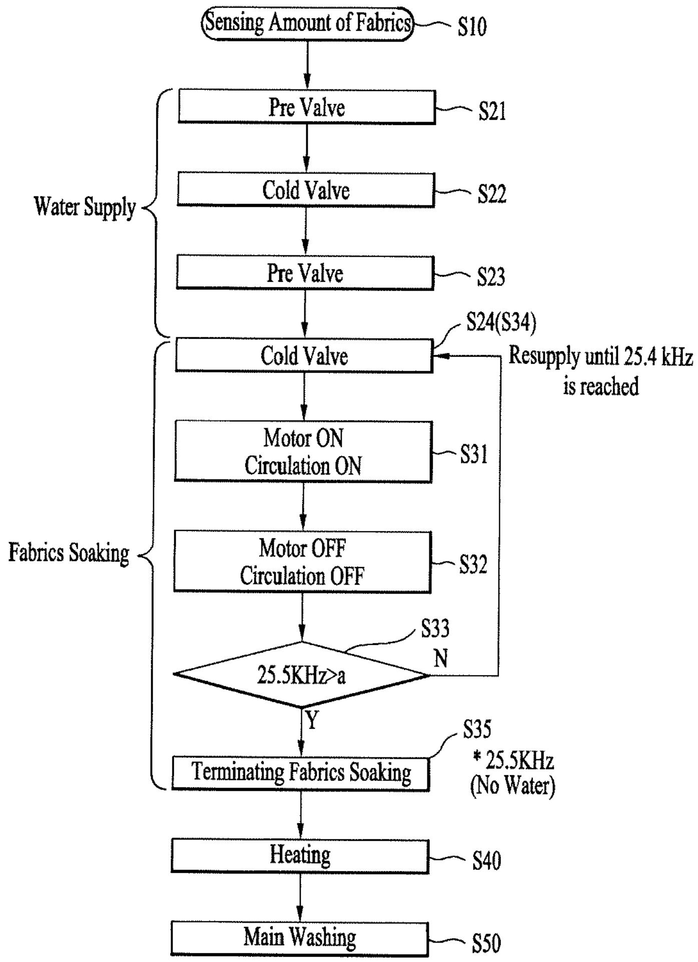

Sensing Amount of Fabrics
S10
Pre Valve
S21
Cold Valve
S22
Pre Valve
S23
Water Supply
S24(S34)
Cold Valve
Resupply until 25.4 kHz is reached
Motor ON
Circulation ON
S31
Motor OFF
Circulation OFF
S32
Fabrics Soaking
S33
N
25.5KHz>a
Y
S35
* 25.5KHz
(No Water)
Terminating Fabrics Soaking
Heating
S40
Main Washing
S50

FIG. 5

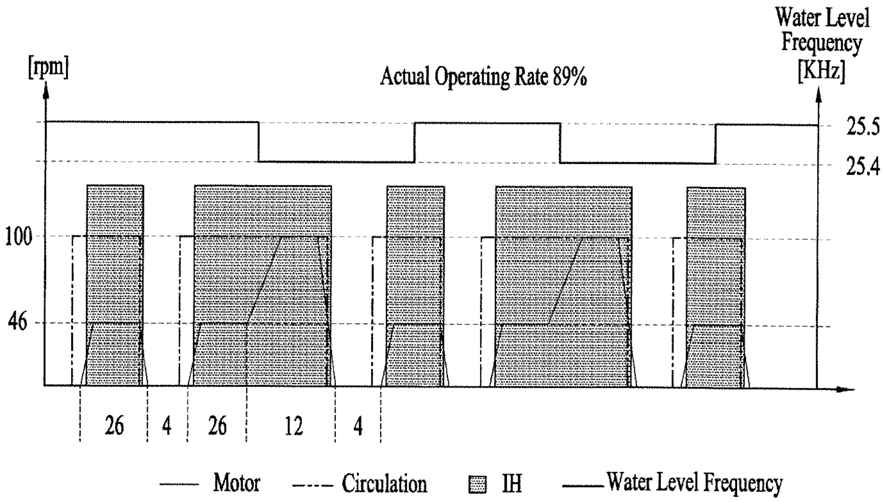

[rpm]
Actual Operating Rate 89%
Water Level Frequency [KHz]
25.5
25.4
100
46
26
4
26
12
4
Motor
Circulation
IH
Water Level Frequency

FIG. 6

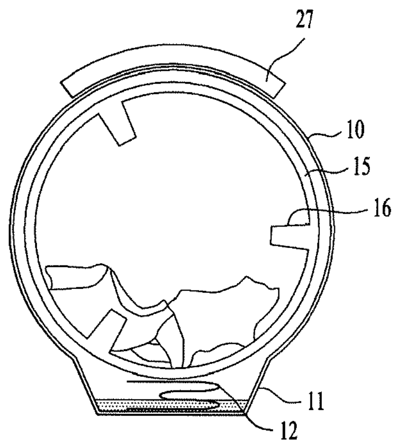


FIG. 7

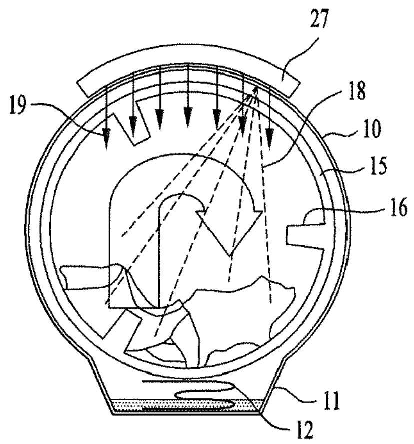


FIG. 8

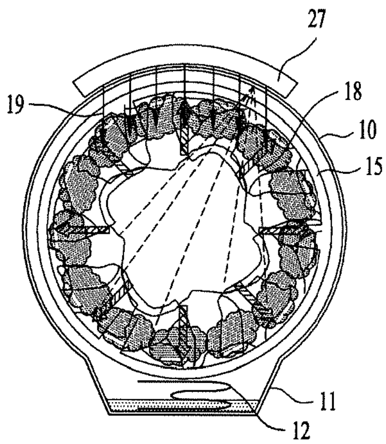
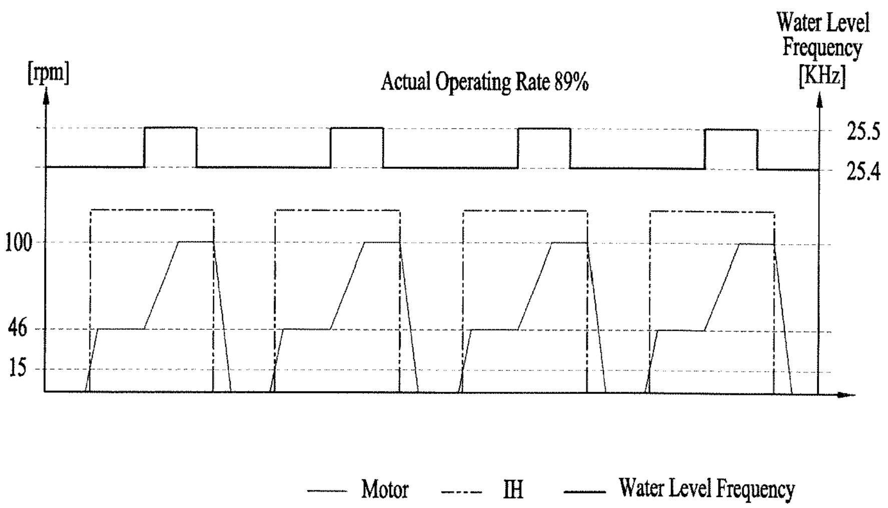


FIG. 9



Water Level
Frequency
[KHz]
[rpm]
Actual Operating Rate 89%
25.5
25.4
100
46
15
Motor
IH
Water Level Frequency

FIG. 10

Washing Performance	95%↓		97%↓		100%		95%	
Amount of Water	X		0~1ℓ		2~4ℓ		5ℓ~	
Washing Temperature	X		X		40℃		34℃	
Circulation	X	X	X	X	X	X	O	O
Motion								

FIG. 11

Washing Performance	98%		103%		100%		95%	
Amount of Water	X		0~1ℓ		2~4ℓ		5ℓ~	
Washing Temperature	58℃		52℃		40℃		34℃	
Circulation	X	X	X	O	O	O	O	O
Motion								

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EUROPEAN SEARCH REPORT

Application Number
EP 19 20 3139

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,P	WO 2019/164244 A1 (LG ELECTRONICS INC [KR]) 29 August 2019 (2019-08-29) * paragraph [0137] - paragraph [0193] * * paragraph [0217] - paragraph [0231] * * paragraph [0308] - paragraph [0449] * * claims; figures *	1-15	INV. D06F33/00 ADD. D06F39/04 D06F35/00
X A	DE 10 2008 043281 A1 (BSH BOSCH SIEMENS HAUSGERAETE [DE]) 6 May 2010 (2010-05-06) * paragraph [0001] - paragraph [0029]; claims; figures *	1,2 3-15	
X A	EP 3 246 451 A1 (MIELE & CIE [DE]) 22 November 2017 (2017-11-22) * paragraph [0028] - paragraph [0030] * * paragraph [0053] - paragraph [0064]; claims; figures *	1 2-15	
			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	17 January 2020	Popara, Velimir

2

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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L : document cited for other reasons

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17-01-2020

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2019164244 A1	29-08-2019	NONE	
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		EP 2350376 A1	03-08-2011
		PL 2350376 T3	31-08-2016
		WO 2010049289 A1	06-05-2010
EP 3246451 A1	22-11-2017	NONE	

EPO FORM P0459

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

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Patent documents cited in the description

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