Laundry machine and control method thereof

Disclosed is a laundry machine and a method of controlling steam supply therein. The control method comprising: a preparation operation of heating a heater (130) arranged within a duct (100); a steam generation operation of generating steam by directly supplying water to the heater (130); and a steam supply operation of supplying the generated steam into a tub (30) and/or drum (40), wherein the method further comprises an adjustment operation of varying implementation time of the preparation operation based on actual voltage of power supplied to the laundry machine.
Description

[0001] This application claims the benefit of Korean Patent Application Nos. 10-2012-0011743, filed on February 6, 2012, 10-2012-011744, filed on February 6, 2012, 10-2012-011745, filed on February 6, 2012, 10-2012-0011746, filed on February 6, 2012, 10-2012-0045237, filed on April 30, 2012, 10-2012-0058035 filed on May 31, 2012 and 10-2012-0058037, filed on May 31, 2012, which are hereby incorporated by reference as if fully set forth herein.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention relates to a laundry machine and a control method of a laundry machine, and more particularly to a control method of a steam supply mechanism of a laundry machine, e.g. a washing machine.

Discussion of the Related Art

[0003] Laundry machines include dryers for drying laundry, refreshers or finishers for refreshing laundry and washing machines for washing laundry. In general, a washing machine is an apparatus that washes laundry using detergent and mechanical friction. Based upon configuration, more particularly, based on the orientation of a tub that accommodates laundry, washing machines may basically be classified into a top-loading washing machine and a front-loading washing machine. In the top-loading washing machine, the tub is erected within a housing of the washing machine and has an entrance formed in a top potion thereof. As such, laundry is put into the tub through an opening that is formed in a top portion of the housing and communicates with the entrance of the tub. Also, in the front-loading washing machine, the tub faces upward within a housing and an entrance of the tub faces a front surface of the washing machine. As such, laundry is put into the tub through an opening that is formed in a front surface of the housing and communicates with the entrance of the tub. In both the top-loading washing machine and the front-loading washing machine, a door is installed to the housing to open or close the opening of the housing.

[0004] The above described types of washing machines may have various other functions, in addition to a basic wash function. For example, the washing machines may be designed to perform drying as well as washing, and may further include a mechanism to supply hot air required for drying. Additionally, the washing machines may have a so-called laundry freshening function. To achieve the laundry freshening function, the washing machines may include a mechanism to supply steam to laundry. Steam is vapor phase water generated by heating liquid water, and may have a high temperature and ensure easy supply of moisture to laundry. Accordingly, the supplied steam may be used, for example, for wrinkle-free, deodorization, and static charge elimination. In addition to the laundry freshening function, steam may also be used for sterilization of laundry owing to a high temperature and moisture thereof. Moreover, when supplied during washing, steam creates a high temperature and high humidity atmosphere within a drum or a tub that accommodates laundry. This atmosphere may provide a considerable improvement in washing performance.

SUMMARY OF THE INVENTION

[0005] The washing machines may adopt various methods to supply steam. For example, the washing machines may apply a drying mechanism to steam generation.

[0006] In the related art, there are laundry machines, in particular washing machines, that do not require an additional device for steam generation, and thus can supply steam to laundry without an increase in production costs. However, since these laundry machines of the related art do not propose optimized control or utilization of a drying mechanism, they have a difficulty in efficiently generating a sufficient amount of steam as compared to an independent steam generator that is configured to generate only steam. For the same reason, furthermore, the laundry machines of the related art cannot efficiently achieve desired functions, i.e. laundry freshening and sterilization and creation of an atmosphere suitable for washing as enumerated above.

[0007] Accordingly, the present invention is directed to a laundry machine, in particular a washing machine, and a control method thereof that substantially obviates one or more problems due to limitations and disadvantages of the related art.

[0008] An object of the present invention is to provide a laundry machine, in particular a washing machine, and a control method of a laundry machine capable of efficiently generating steam.

[0009] Another object of the present invention is to provide a laundry machine, in particular a washing machine, and a control method of a laundry machine capable of effectively performing desired functions via supply of steam.

[0010] 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.

[0011] To achieve these objects and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, a control method of a laundry machine, such as a washing machine,
includes heating a predetermined space within a duct that communicates with a tub of the laundry machine to a higher temperature than a temperature of the other space within the duct, directly supplying water to the heated predetermined space to generate steam, supplying air flow toward the heated predetermined space so as to transport the generated steam into the tub, and adjusting implementation time of the heating based on actual voltage of power supplied to the laundry machine.

[0012] The adjustment may include adjusting actuation time of a heater installed in the duct. Also, the adjustment may include adjusting partial implementation time of the heating that is performed without supply of water and air flow, or may include adjusting a duration for which only the heater installed in the duct is actuated.

[0013] More specifically, the adjustment includes measuring the actual voltage of power supplied to the washing machine, comparing the measured actual voltage with standard voltage of the supplied power, and determining actual implementation time of the heating based on the comparison result. In the adjustment, the measurement may be performed before the heating. Also, during the measurement, actuation of the laundry machine may stop. The adjustment may include reducing the implementation time of the heating if the actual voltage is greater than the standard voltage, and increasing the implementation time of the heating if the actual voltage is less than the standard voltage.

[0014] The adjustment may include measuring the actual voltage of power supplied to the laundry machine, checking implementation time corresponding to the measured voltage from a previously made data table, and setting the checked implementation time to the implementation time of the heating.

[0015] The control method may further include pausing actuation of the laundry machine for a predetermined time after the supply of air flow. Based on the adjusted implementation time of the heating, the adjustment may further include adjusting implementation time of the pause. The adjustment of the implementation time of the pause may include reducing the implementation time of the pause if the implementation time of the heating is increased, and increasing the implementation time of the pause if the implementation time of the heating is reduced.

[0016] According to another aspect of the present invention, a control method of a laundry machine, such as a washing machine, the laundry machine including a duct communicating with a tub, and a heater, a nozzle and a blower which are arranged within the duct, the method includes a preparation operation of heating the heater, a steam generation operation of generating steam by directly supplying water to the heater, and a steam supply operation of supplying the generated steam into the tub, wherein the method further comprises an adjustment operation of varying implementation time of the preparation operation based on actual voltage of power supplied to the laundry machine.

[0017] The implementation time of the preparation operation may be varied by adjusting actuation time of the heater installed in the duct.

[0018] The preparation operation may include performing first heating to heat only the heater without actuation of the nozzle and the blower, and performing second heating to heat the heater while actuating the blower installed in the duct, wherein the implementation time of the preparation operation varies by varying implementation time of the first heating.

[0019] In this case, the second heating may be performed for a fixed time.

[0020] The adjustment operation may include measuring the actual voltage of power supplied to the laundry machine, comparing the measured actual voltage with standard voltage of the supplied power, and determining actual implementation time of the preparation operation based on the comparison result.

[0021] The measurement may be performed before the preparation operation.

[0022] Actuation of the heater, the nozzle, and the blower may stop during the measurement.

[0023] The adjustment operation may include reducing the implementation time of the preparation operation if the actual voltage is greater than the standard voltage, and increasing the implementation time of the preparation operation if the actual voltage is less than the standard voltage.

[0024] The adjustment operation may include measuring the actual voltage of power supplied to the laundry machine, checking implementation time corresponding to the measured voltage from a previously made data table, and setting the checked implementation time to the implementation time of the preparation operation.

[0025] The control method may further include a pause operation of stopping actuation of the laundry machine for a predetermined time after the steam supply operation. Here, stopping actuation of the laundry machine may include at least one of stopping a drum movement and water/steam supply into the drum or tub.

[0026] Implementation time of the pause operation may be increased if the actual voltage is greater than the standard voltage, and implementation time of the pause operation may be reduced if the actual voltage is less than the standard voltage.

[0027] The increased time (or the reduced time) of the pause operation may correspond to the reduced time (or the increased time) of the preparation operation.

[0028] The adjustment operation may include varying the implementation time of the pause operation and the implementation time of the preparation operation based on the actual voltage of power supplied to the laundry machine.

[0029] The sum of the variable implementation time of the pause operation and the variable implementation time of the preparation operation may have a constant value.

[0030] A set of the preparation operation, the steam
generation operation and the steam supply operation may be repeated plural times.

[0031] The above described control method of the laundry machine may be applied to a laundry machine, in particular to a washing machine, that will be described hereinafter.

[0032] According to a further aspect of the present invention, a laundry machine, in particular a washing machine, comprises a tub and/or a rotatable drum, a duct configured to communicate with the tub or drum, a heater installed in the duct and configured to heat only a predetermined space within the duct, and a controller configured to perform any of the above-described methods.

[0033] According to another aspect of the present invention, a laundry machine, in particular a washing machine, includes a tub in which wash water is stored and/or a drum in which laundry is accommodated, the drum being rotatably provided, a duct configured to communicate with the drum and/or tub, a heater installed in the duct and configured to heat only a predetermined space within the duct, a nozzle installed in the duct, the nozzle serving to directly supply water to the heated predetermined space so as to generate steam, and a blower installed in the duct, the blower serving to blow air toward the predetermined space so as to supply the generated steam into the tub and/or drum.

[0034] According to another aspect of the present invention, a laundry machine, in particular a washing machine, includes a tub in which wash water is stored and/or a drum in which laundry is accommodated, the drum being rotatably provided, a duct configured to communicate with the drum and/or drum, a heater installed in the duct and configured to heat only a predetermined space within the duct, a nozzle installed in the duct, the nozzle serving to directly supply water to the heated predetermined space so as to generate steam, a blower installed in the duct, the blower serving to blow air toward the predetermined space so as to supply the generated steam into the tub and/or drum.

[0035] According to another aspect of the present invention, a laundry machine, in particular a washing machine, includes a tub in which wash water is stored and/or a drum in which laundry is accommodated, the drum being rotatably provided, a duct configured to communicate with the tub and/or drum, a heater installed in the duct and configured to heat only a predetermined space within the drum, and a recess formed in the drum to accommodate a predetermined amount of water such that the water in the recess is heated for steam generation.

[0036] The nozzle may include a head having a water ejection opening and a body integrally formed with the head, the body being configured to guide water to the head. The swirling device may be fitted into the body.

[0037] The swirling device may include a conical core extending along the center axis of the swirling device, and a flow-path spirally extending around the core.

[0038] The nozzle may further include a positioning structure to determine a position of the swirling device. More specifically, the positioning structure may include a recess formed in any one of the nozzle and the swirling device, and a rib formed at the other one of the nozzle and the swirling device, the rib being inserted into the recess.

[0039] According to another aspect of the present invention, a laundry machine, in particular a washing machine, includes a tub in which wash water is stored and/or a drum in which laundry is accommodated, the drum being rotatably provided, a duct configured to communicate with the tub and/or drum, a heater installed in the duct and adapted to be heated upon receiving power, at least one nozzle installed in the duct, the nozzle serving to directly eject water to the heated heater by ejection pressure thereof, and a blower installed in the duct, the blower serving to generate air flow within the duct and supply steam into the tub and/or drum, wherein the nozzle ejects water in approximately the same direction as the direction of air flow.

[0040] In this case, the nozzle may be provided between the heater and the blower.

[0041] Representing an installation position of the nozzle in consideration of an extending direction of the duct, the heater may be located at one longitudinal side of the duct, and the blower may be located at the other longitudinal side of the duct, and the nozzle may be located between the heater and the blower.

[0042] When the nozzle is provided between the heater and the blower, the nozzle may be spaced apart from the heater by a predetermined distance so as to be located close to the blower. That is, the nozzle may be located between the heater and the blower, and may be located closer to the blower than the heater.

[0043] In other words, the nozzle may be explained as being installed close to a discharge portion through which air having passed through the blower is discharged.

[0044] The nozzle may be installed in a blower housing surrounding the blower.

[0045] Here, the blower housing may include an upper housing and a lower housing, and the nozzle may be installed in the upper housing.

[0046] To install the nozzle, the upper housing may have an aperture into which the nozzle is inserted.

[0047] The nozzle may include a body and a head, and the head may be inserted into the aperture and be located within the duct. In addition, a portion of the body close to the head may be inserted into the aperture and be located within the duct. In this case, the longitudinal direction of the body may coincide with the ejection direction of the nozzle.

[0048] The at least one nozzle may include a plurality
of nozzles. Each of the plurality of nozzles may include a body and a head, and the plurality of nozzles may be connected to one another via a flange.

[0049] The flange may have a fastening hole for connection to the duct. Accordingly, the flange may be fixed to the duct as a fastening member (for example, a screw or a bolt) is coupled into the fastening hole. As such, the plurality of nozzles coupled to the flange may be fixed.

[0050] The nozzle may directly eject mist to the heater. Although the nozzle may supply a water jet to the heater, mist may be ejected to the heater for more efficient and rapid steam generation. Also, the nozzle may enable steam generation without water loss by directly supplying water to the heater.

[0051] The nozzle may include a spirally extending flow-path therein.

[0052] The laundry machine may further include a recess formed in the duct to accommodate a predetermined amount of water such that the water in the recess is heated for steam generation.

[0053] The recess may be located below the heater. In this case, the recess may be located immediately below the heater.

[0054] At least a portion of the heater may have a bent portion that is bent downward toward the recess. In this case, the bent portion may be located in the recess. Accordingly, when water is collected in the recess, the bent portion may contact the water in the recess.

[0055] Differently from the method in which the heater directly contact the water collected in the recess using the bent portion thereof, the water collected in the recess may be indirectly heated.

[0056] To realize the indirect heating, the laundry machine may further include a thermal conductive member coupled to the heater to transfer heat of the heater. In this case, at least a portion of the thermal conductive member may be located in the recess.

[0057] The thermal conductive member may include a heat sink mounted to the heater, at least a portion of the heat sink being located in the recess.

[0058] The recess may be located below a free end of the heater. This arrangement of the recess may be applied to both direct heating and indirect heating.

[0059] According to a further aspect of the present invention, a laundry machine, in particular a washing machine, includes a tub in which wash water is stored and/or a drum in which laundry is accommodated, the drum being rotatably provided, a duct configured to communicate with the tub and/or drum, a heater installed in the duct and adapted to be heated upon receiving power, a nozzle installed in the duct, the nozzle serving to directly eject water to the heated heater by ejection pressure thereof, and a blower installed in the duct, the blower serving to generate air flow within the duct and supply the generated steam to the tub and/or drum, wherein the nozzle is located between the heater and the blower and ejects water in approximately the same direction as the direction of air flow.

[0060] Explaining the arrangement of the above described configuration along the direction of the air flow within the duct, the blower, the nozzle, and the heater may be arranged in sequence. That is, if air flow occurs by rotation of the blower, the air discharged from the blower may pass the installation position of the nozzle and may reach the heater. In this case, the air having passed through the heater may be supplied into the tub. In particular, the nozzle may be installed to an upper portion of the blower housing surrounding the blower, more specifically, to an upper housing of the blower housing.

[0061] The above described respective features of the laundry machine may be individually applied to the laundry machine, or combinations of at least two features may be applied to the laundry machine. In particular, the laundry machine may include a washing machine or a dryer.

[0062] 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

[0063] 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:

[0064] FIG. 1 is a perspective view illustrating a washing machine according to the present invention;

[0065] FIG. 2 is a sectional view illustrating the washing machine of FIG. 1;

[0066] FIG. 3 is a perspective view illustrating a duct included in the washing machine according to the present invention;

[0067] FIG. 4 is a perspective view illustrating a blower housing of the duct illustrated in FIG. 3;

[0068] FIG. 5 is a plan view illustrating the duct of the washing machine;

[0069] FIG. 6 is a perspective view illustrating a nozzle installed in the duct of the washing machine;

[0070] FIG. 7 is a sectional view illustrating the nozzle of FIG. 6;

[0071] FIG. 8 is a partial sectional view illustrating the nozzle of FIG. 6;

[0072] FIG. 9 is a perspective view illustrating an alternative embodiment of the duct;

[0073] FIG. 10 is a side view illustrating the duct of FIG. 9;

[0074] FIG. 11 is a perspective view illustrating a heater installed to the duct of FIG. 9;

[0075] FIG. 12 is a perspective view illustrating an alternative embodiment of the duct;

[0076] FIG. 13 is a perspective view illustrating a heater installed in the duct of FIG. 12;
FIG. 14 is a perspective view illustrating an alternative embodiment of the duct; FIG. 15 is a plan view illustrating the duct of FIG. 14; FIG. 16 is a flowchart illustrating a control method of a washing machine according to the present invention; FIG. 17 is a table illustrating the control method of FIG. 16; FIGs. 18A to 18C are time charts illustrating the control method of FIG. 16; FIG. 19 is a flowchart illustrating an operation of judging the amount of supplied water; FIG. 20 is a flowchart illustrating operations to be performed when a sufficient amount of water is not supplied; FIG. 21 is a flowchart illustrating an operation of adjusting an implementation time of a heating operation based on an actual voltage; FIG. 22A is a flowchart illustrating an alternative embodiment of the adjusting operation of FIG. 21; FIG. 22B is a table illustrating an implementation time of the heating operation based on an actual voltage range that is applied to the adjusting operation of FIG. 21; FIG. 23 is a flowchart illustrating a control method of a washing machine including a steam supply process of FIG. 16; FIG. 24 is a plan view illustrating a duct to which a plurality of nozzles is applied; FIG. 25 is an exploded perspective view illustrating a nozzle assembly including a plurality of nozzles; FIG. 26 is a sectional view illustrating the nozzle assembly of FIG. 25; and FIG. 27 is an exploded perspective view illustrating the nozzle assembly of FIG. 25.

DETAILED DESCRIPTION OF THE INVENTION

Hereinafter, exemplary embodiments of the present invention to realize the above described objects will be described with reference to the accompanying drawings. Although the present invention is described with reference to a front-loading washing machine as illustrated in the drawings, the present invention may be applied to a top-loading washing machine without substantial modifications.

In the following description, the term ‘actuation’ refers to applying power to a relevant component to realize a function of the relevant component or to operate the relevant component. For example, ‘actuation’ of a heater refers to applying power to the heater to realize heating. In addition, an ‘actuation section’ of the heater refers to a section in which power is applied to the heater. When interrupting power applied to the heater, this refers to shutdown of ‘actuation’ of the heater. This is equally applied to a blower and a nozzle. With respect to the laundry machine itself, stopping actuation of the laundry machine may include at least one of stopping a drum movement and water/steam supply into the drum or tub.

As illustrated in FIG. 1, the washing machine may include a housing 10 that defines an external appearance of the washing machine and accommodates elements required for actuation. The housing 10 may be shaped to surround the entire washing machine. However, to ensure easy disassembly for the purpose of repair, as illustrated in FIG. 1, the housing 10 is shaped to surround only a portion of the washing machine. Instead, a front cover 12 is mounted to a front end of the housing 10 so as to define a front surface of the washing machine. A control panel 13 is mounted above the front cover 12 for manual operation of the washing machine. A detergent box 15 is mounted in an upper region of the washing machine. The detergent box 15 may take the form of a drawer that accommodates detergent and other additives for washing of laundry and is configured to be pushed into and pulled from the washing machine. Additionally, a top plate 14 is provided at the housing 10 to define an upper surface of the washing machine. Similar to the housing 10, the front cover 12, the top plate 14, and the control panel 13 define the external appearance of the washing machine, and may be considered as constituent parts of the housing 10. The housing 10, more specifically, the front cover 12 has a front opening 11 perforated therein. The opening 11 is opened and closed by a door 20 that is also installed to the housing 10. Although the door 20 generally has a circular shape, as illustrated in FIG. 1, the door 20 may be fabricated to have a substantially square shape. The square door 20 provides a user with a better view of the opening 11 and an entrance of a drum (not shown), which is advantageous in terms of improving the external appearance of the washing machine. As illustrated in FIG. 2, the door 20 is provided with a door glass 21. The user can view the interior of the washing machine through the door glass 21 to check the state of laundry.

Referring to FIG. 2, a tub 30 and a drum 40 are installed within the housing 10. The tub 30 is installed to store wash water within the housing 10. The drum 40 is rotatably installed within the tub 30. The tub 30 may be connected to an external water source to directly receive water required for washing. Additionally, the tub 30 may be connected to the detergent box 15 via a connection member such as a tube or a hose, and may receive detergent and additives from the detergent box 15. The tub 30 and the drum 40 are oriented such that entrances thereof face the front side of the housing 10. The entrances of the tub 30 and the drum 40 communicate with the above mentioned opening 11 of the housing 10. As such, once the door 20 is opened, the user can put laundry into the drum 40 through the opening 11 and the entrances of the tub 30 and the drum 40. To prevent leakage of
laundry and wash water, a gasket 22 is provided between the opening 11 and the tub 30. The tub 30 may be formed of plastic, in order to achieve a reduction in the material costs and the weight of the tub 30. On the other hand, the drum 40 may be formed of a metal to achieve sufficient strength and rigidity in consideration of the fact that the drum 40 must accommodate heavy wet laundry and shock due to laundry is repeatedly applied to the drum 40 during washing. The drum 40 has a plurality of through-holes 40a to allow wash water of the tub 30 to be introduced into the drum 40. A power device is installed around the tub 30 and is connected to the drum 40. The drum 40 is rotated by the power device. In general, the washing machine, as illustrated in FIG. 2, includes the tub 30 and the drum 40, which are oriented to have a center shaft that is substantially horizontal to an installation floor. However, the washing machine may include the tub 30 and the drum 40, which are obliquely oriented upward. That is, the entrances of the tub 30 and the drum 40 (i.e. front portions) are located higher than rear portions of the tub 30 and the drum 40. The entrances of the tub 30 and the drum 40 as well as the opening 11 and the door 20 associated with the entrances are located higher than the entrances, the opening 11 and the door 20 illustrated in FIG. 2. Accordingly, the user can put or pull laundry into or from the washing machine without bending his/her waist.

To further improve washing performance of the washing machine, hot or warm wash water is required based on the kind and state of laundry. To this end, the washing machine of the present invention may include a heater assembly including a heater 80 and a sump 33 to generate hot or warm wash water. The heater assembly, as illustrated in FIG. 2, is provided in the tub 30, and serves to heat wash water stored in the tub 30 to a desired temperature. The heater 80 is configured to heat wash water, and the sump 33 is configured to accommodate the heater 80 and wash water.

Referring to FIG. 2, the heater assembly may include the heater 80 configured to heat wash water. The heater assembly may further include the sump 33 configured to accommodate the heater 80. The heater 80, as illustrated, may be inserted into the tub 30, more specifically, into the sump 33 through an aperture 33a that is formed in the sump 33 and has a predetermined size. The sump 33 may take the form of a cavity or a recess that is integrally formed in the bottom of the tub 30. Accordingly, the sump 33 has an open top and internally defines a predetermined size of space to accommodate some of wash water supplied into the tub 30. The sump 33, as described above, is formed in the bottom of the tub 30 that is advantageous to discharge the stored wash water. Therefore, a drain hole 33b is formed in the bottom of the sump 33 and is connected to a drain pump 90 through a drain pipe 91. As such, the wash water within the tub 30 may be discharged outward from the washing machine through the drain hole 33b, the drain pipe 91, and the drain pump 90. Alternatively, the drain hole 33b may be formed in another location of the tub 30, instead of the bottom of the sump 33. Through provision of the sump 33 and the heater 80, the washing machine may function to heat wash water so as to utilize the resulting hot or warm wash water for washing of laundry.

Meanwhile, the washing machine may be configured to dry washed laundry for user convenience. To this end, the washing machine may include a drying mechanism to generate and supply hot air. As the drying mechanism, the washing machine may include a duct 100 configured to communicate with the tub 30. The duct 100 is connected at both ends thereof to the tub 30, such that interior air of the tub 30 as well as interior air of the drum 40 may circulate through the duct 100. The duct 100 may have a single assembly configuration, or may be divided into a drying duct 110 and a condensing duct 120. The drying duct 110 is basically configured to generate hot air for drying of laundry, and the condensing duct 120 is configured to condense moisture contained in the circulating air having passed through the laundry.

First, the drying duct 110 may be installed within the housing 10 so as to be connected to the condensing duct 120 and the tub 30. A heater 130 and a blower 140 may be mounted in the drying duct 110. The condensing duct 120 may also be disposed within the housing 10 and may be connected to the drying duct 110 and the tub 30. The condensing duct 120 may include a water supply device 160 to supply water so as to enable condensation and removal of moisture from the air. The drying duct 110 and the condensing duct 120, i.e. the duct 100, as described above, may be basically disposed within the housing 10, but may partially be exposed to the outside of the housing 10 as necessary.

The drying duct 110 may serve to heat air around the heater 130 using the heater 130, and may also serve to blow the heated air toward the tub 30 and the drum 40 disposed within the tub 30 using the blower 140. The heater 130 is installed so as to be exposed to the air within the duct 100 (more specifically, within the drying duct 110). As such, hot and dry air may be supplied from the drying duct 110 into the drum 40 by way of the tub 30, in order to dry laundry. Also, since the blower 140 and the heater 130 are actuated together, new unheated air may be supplied to the heater 130 by the blower 140, and thereafter may be heated while passing through the heater 130 so as to be supplied into the tub 30 and the drum 40. That is, supply of the hot and dry air may be continuously performed by simultaneous actuation of the heater 130 and the blower 140. Meanwhile, the supplied hot air may be used to dry the laundry, and thereafter may be discharged from the drum 40 into the condensing duct 120 through the tub 30. In the condensing duct 120, moisture is removed from the discharged air using the water supply device 160, whereby dry air is generated. The resulting dry air may be supplied to the drying duct 110 so as to be reheated. This supply may be realized by a pressure difference between the drying duct 110 and the condensing duct 120 that is caused by actuation...
of the blower 140. That is, the discharged air may be changed into hot and dry air while passing through the drying duct 110 and the condensing duct 120. As such, the air within the washing machine is continuously circulated through the tub 30, the drum 40, and thecondensing and drying ducts 120 and 110, thereby being used to dry the laundry. In consideration of the circulation flow of the air as described above, an end of the duct 100 that supplies the hot and dry air, i.e. an end or an opening of the drying duct 110 that communicates with the tub 30 and the drum 40 may serve as a discharge portion or a discharge hole 110a of the duct 100. The end of the duct 100, to which wet air is directed, i.e. an end or an opening of the condensing duct 120 that communicates with the tub 30 and the drum 40 may serve as a suction portion or a suction hole 120a of the duct 100.

[0102] The drying duct 110, more specifically, the discharge portion 110a, as illustrated in FIG. 2, may be connected to the gasket 22 so as to communicate with the tub 30 and the drum 40. On the other hand, as represented by a dotted line in FIG. 2, the drying duct 110, more specifically, the discharge portion 110a may be connected to an upper front region of the tub 30. In this case, the tub 30 may be provided with a suction port 31 that communicates with the drying duct 110, and the drum 40 may be provided with a suction port 41 that communicates with the drying duct 100. Also, the condensing duct 120, i.e. the suction portion 120a may be connected to the rear portion of the tub 30. To communicate with the condensing duct 120, the tub 30 may be provided at a lower rear region thereof with a discharge port 32. Owing to connection positions between the drying and condensing ducts 110 and 120 and the tub 30, the hot and dry air may flow within the drum 40 from the front portion to the rear portion of the drum 40 as represented by the arrows. More specifically, the hot and dry air may flow from the upper front region of the drum 40 to the lower rear region of the drum 40. That is, the hot and dry air may flow in a diagonal direction within the drum 40. As a result, the drying and condensing ducts 110 and 120 may be configured to allow the hot and dry air to completely pass across the space within the drum 40 owing to appropriate mounting positions thereof. As such, the hot and dry air may be uniformly diffused within the entire space within the drum 40, which may result in a considerable improvement in drying efficiency and performance.

[0103] The duct 100 is configured to accommodate various elements. To ensure easy installation of the elements, the duct 100, i.e. the drying and condensing ducts 110 and 120 may be composed of separable parts. In particular, most elements, for example, the heater 130 and the blower 140 are linked to the drying duct 110, and therefore the drying duct 110 may be composed of separable parts. Such a separable configuration of the drying duct 110 may ensure easy removal of interior elements from the drying duct 110 for the purpose of repair. More specifically, the drying duct 110 may include a lower part 111. The lower part 111 substantially has a space therein, such that the elements may be accommodated in the space. The drying duct 110 may further include a cover 112 configured to cover the lower part 111. The lower part 111 and the cover 112 may be fastened to each other using a fastening member. The duct 100 may include a blower housing 113 configured to stably accommodate the blower 140 that is rotated at high speeds. The blower housing 113 may also be composed of separable parts for easy installation and repair of the blower 140. The blower housing 113 may include a lower housing 113a configured to accommodate the blower 140 and an upper housing 113b configured to cover the lower housing 113a. Except for the upper housing 113b to be separated, the lower housing 113a may be integrally formed with the lower part 111 of the drying duct 110 to reduce the number of elements of the duct 100. FIGs. 3 to 5 illustrate the lower part 111 and the lower housing 113a, which are integrated with each other. In this case, it can be said that the drying duct 110 is integrated with the blower housing 113, and thus the drying duct 110 accommodates the blower 140. On the other hand, the lower housing 113a may be integrally formed with the condensing duct 120. The drying duct 110 is used to generate and transport high temperature air, and requires high heat resistance and thermal conductivity. Also, the housing 113a must stably support the blower 140 that is rotated at high speeds, and therefore must have high strength and rigidity. Accordingly, the lower housing 113a and the lower part 111, which are integrated with each other, may be formed of a metal. On the other hand, owing to the lower housing 113a and the lower part 111 which are formed of a metal to satisfy particular requirements, the cover 112 and the upper housing 113b may be formed of plastic to reduce the weight of the drying duct 110.

[0104] Moreover, the washing machine according to the present invention may be configured to supply steam to laundry, in order to provide the user with a wider array of functions. As discussed above in relation to the related art, supply of steam has the effects of wrinkle-free, deodorization, and static charge elimination, thus allowing laundry to be freshened. Also, steam may serve to sterilize laundry and to create an ideal atmosphere for washing. These functions may be performed during a basic wash course of the washing machine, whereas the washing machine may have a separate process or course optimized to perform the functions. The washing machine may include an independent steam generator that is designed to generate only steam, to realize the aforementioned functions via supply of steam. However, the washing machine may utilize a mechanism provided for other functions as a mechanism to generate and supply steam. For example, as described above, the drying mechanism includes the heater 130 as a heat source, and the duct 130 and the blower 140 as transportation means of air to the tub 30 and the drum 40, and thus may also be utilized to supply steam as well as hot air. Nevertheless,
to realize supply of steam, it is necessary to slightly modify a conventional drying mechanism. The drying mechanism modified for supply of steam will be described hereinafter with reference to FIGs. 3 to 15. Of these drawings, FIGs. 3, 5, 9, 12, and 14 illustrate the duct 100 from which the cover 112 is removed to more clearly show the interior configuration of the duct 100.

First, for supply of steam, it is necessary to create a high temperature environment suitable for steam generation. Accordingly, the heater 130 may be configured to heat air within the duct 100. As known, air has low thermal conductivity. Therefore, if the washing machine does not provide a means to forcibly transfer heat emitted from the heater 130 to other regions of the duct 100, for example, does not provide air flow by the blower 140, the heater 130 may function to heat only a space occupied by the heater 130 and the surrounding space. Accordingly, the heater 130 may heat a local space within the duct 100 to a high temperature for supply of steam. That is, the heater 130 may heat a partial space within the duct 100, i.e. a predetermined space S to a higher temperature than that of the remaining space of the duct 100. More specifically, to achieve such heating to a higher temperature, the heater 130 may be adapted to heat only the predetermined space S in a direct heating manner. In this case, the predetermined space S may be referred to as the heater 130. That is, the heater 130 and the predetermined space S may occupy the same area. Alternatively, the predetermined space S may include a space occupied by the heater 130 and the surrounding space within the duct close to the heater 130. That is, the predetermined space S is a concept including the heater 130. To achieve local and direct heating to a higher temperature, the heater 130 may rapidly create an environment suitable for steam generation.

The heater 130 is installed in the duct 100 (more particularly, in the drying duct 110) and is heated upon receiving electric power. The heater 130, as illustrated in FIGs. 3 and 5, may basically include a body 131. The body 131 may substantially be located in the duct 100 and serve to generate heat for heating of air. To this end, the body 131 may adopt various heating mechanisms, but may generally take the form of a hot wire. More specifically, the body 131 may be a sheath heater having a waterproof configuration to prevent breakdown of the heater 130 due to moisture that may accumulate in the duct 100. Preferably, the body 131 may be bent plural times in the same plane to maximize generation of heat in a narrow space. The heater 130 may include a terminal 132 electrically connected to the body 131 to apply electric power to the body 131. The terminal 132 may be located at a distal end of the body 131. The terminal 132 may be located at the outside of the duct 100 for connection with an external power source. A sealing member may be interposed between the body 131 and the terminal 132 to hermetically seal the duct 100 so as to prevent leakage of air and steam from the duct 100.

The heater 130 may be fixed to the bottom of the duct 100 (more specifically, to the lower part 111 of the drying duct 110) using a bracket 111b. In connection with the bracket 111b, a boss 111a may also be provided at the bottom of the duct 100. The boss 111a may protrude from the bottom of the duct 100 by a predetermined length. A pair of bosses 111a may be provided at both sides of the bottom of the duct 100 respectively. The bracket 111b may be fastened to the boss 111a to fix the heater 130. Moreover, the bracket 111b may be configured to support the body 131 of the heater 130. The bracket 111b, as illustrated, may extend across the body 131 to support the body 131 and may be configured to surround the body 131. Additionally, the bracket 111b may have a bent portion that is bent to match the contour of the body 131. The bent portion ensures that the body 131 is firmly supported without a risk of unintentional movement. The bracket 111b has a through-hole, through which a fastening member penetrates to fasten the bracket 111b to the boss 111a. As such, when using both the bracket 111b and the boss 111a, the heater 130 may be more stably fixed and supported within the duct 100. Also, the boss 111a serves to allow the heater 130 to be spaced apart from the bottom of the duct 100 by a predetermined distance, which ensures that the heater 130 may contact a greater amount of air while achieving smooth air flow. The bracket 111b may be formed of a metal capable of withstanding heat of the body 131.

A predetermined amount of water is required to generate steam in the heater 130. Thus, a nozzle 150 may be added to the duct 100 to eject water to the heater 130.

In general, steam refers to vapor phase water generated by heating liquid water. That is, liquid water is changed into vapor phase water via phase change when water is heated above a critical temperature. On the other hand, mist refers to small particles of liquid water. That is, mist is generated by simply separating liquid water into small particles, and does not entail phase change or heating. Thus, steam and mist are clearly distinguishable from each other at least in terms of phase and temperature thereof, and have something in common only in terms of supplying moisture to an object. The mist consists of small particles of water and has a greater surface area than liquid water. Thus, mist can easily absorb heat and be changed into high temperature steam via phase change. For this reason, the washing machine of the present invention may utilize, as a water supply means, the nozzle 150 that can divide liquid water into small particles of water, instead of an outlet that directly supplies liquid water. Nevertheless, the washing machine of the present invention may adopt a conventional outlet that supplies a small amount of water to the heater 130. On the other hand, the nozzle 150 may supply water, i.e. a water jet instead of mist by adjusting the pressure of water supplied to the nozzle 150. In any cases, the heater 130 creates an environment for steam generation, and thus may generate steam.

To generate steam, water may be supplied to
the heater 130 in an indirect manner. For example, the nozzle 150 may supply water to a space within the duct 100 rather than the heater 130. The water may be transported to the heater 130 via air flow provided by the blower 140 for steam generation. However, since water may be adhered to an inner surface of the duct 100 during transport, the supplied water does not completely reach the heater 130. Also, since the heater 130, as described above, has optimized conditions for steam generation by local and direct heating thereof, the heater 130 may sufficiently change the supplied water into steam.

[0111] In consideration of the above mentioned reasons, for efficient steam generation, the nozzle 150 may supply water to the heater 130 in a direct manner. Here, the nozzle 150 may supply water to the heater 130 using self-ejection pressure thereof. Here, the self-ejection pressure is the pressure of water supplied to the nozzle 150. The pressure of water supplied to the nozzle 150 may allow water ejected from the nozzle 150 to reach the heater 130. That is, the water ejected from the nozzle 150 is ejected to the heater 130 by the ejection pressure of the nozzle 150 without assistance of a separate intermediate medium. For the same reason, the nozzle 150 may supply water only to the heater 130. Moreover, the nozzle 150 may eject mist to the heater 130. As previously defined above, if the nozzle 150 directly ejects mist to the heater 130, effective steam generation even using ideal use of power may be achieved in consideration of an ideal environment created in the heater 130. Also, if the direct ejection of mist is performed only in the heater 130, this may ensure more effective steam generation.

[0112] The nozzle 150 may be oriented towards the heater 130. That is, a discharge hole of the nozzle 150 may be oriented towards the heater 130. In this case, the nozzle 150 may be arranged immediately above the heater 130 or may be arranged immediately below the heater 130, in order to directly supply water to the heater 130. However, the water supplied from the nozzle 150 (more specifically, mist), as illustrated in Figs. 3 and 5, is diffused within a predetermined angular range according to supply pressure of water, thereby traveling a predetermined distance. On the other hand, the height of the duct 100 is considerably limited to achieve a compact size of the washing machine. That is, the height of the heater 130 is likewise limited. Accordingly, if the nozzle 150 is arranged immediately above or immediately below the heater 130, this arrangement may prevent the water ejected from the nozzle 150 from being uniformly diffused throughout the heater 130 in consideration of the diffusion angle and traveling distance of water. This may prevent efficient steam generation. For the same reason, the inefficient steam generation may likewise occur even when a pair of nozzles 150 is arranged at both sides of the heater 130.

[0113] Alternatively, the nozzle 150 may be located at both ends of the heater 130, i.e. at any one of regions A and B. As described above, once the blower 140 is actuated, the interior air of the duct 100 is discharged from the blower 140 and passes through the heater 130. In consideration of the flow direction of air, the region A may correspond to a region at the front of the heater 130 or to a suction region, and the region B may correspond to a region at the rear of the heater 130 or to a discharge region. Also, the region A and the region B may correspond to an entrance and an exit of the heater 130 respectively. Accordingly, the nozzle 150 may be located in the region at the front of the heater 130 or in the suction region (i.e. in the region A) on the basis of the flow direction of air within the duct 100. On the other hand, the nozzle 150 may be located in the region at the rear of the heater 130 or in the discharge region (i.e. in the region B) on the basis of the flow direction of air within the duct 100. Even when the nozzle 150 is located in the region A or the region B as described above, it may be difficult for the water supplied from the nozzle 150 to completely reach the predetermined region S, and some of the water may remain at the outside of the predetermined region S. However, when the nozzle 150 is located in the region at the rear of the heater 130 or in the discharge region B, the water that does not reach the heater 130 remains near the region at the rear of the heater 130 or near the discharge region B. Accordingly, if the blower 140 is actuated, the water may be supplied into the tub 30 rather than being changed into steam. On the other hand, when the nozzle 150 is located in the region at the front of the heater 130 or in the suction region A, the water that does not reach the heater 130 may enter the heater 130 via air flow provided by the blower 140. Accordingly, positioning the nozzle 150 in the region A may ensure efficient change of all supplied water into steam. As such, to achieve efficient steam generation, the nozzle 150 may be located in the region A, i.e. in the region at the front of the heater 130 or in the suction region on the basis of the flow direction of air. Also, the nozzle 150 located in the region A is adapted to supply water in approximately the same direction as the flow direction of air within the duct 100, whereas the nozzle 150 located in the region B is adapted to supply water in an opposite direction to the flow direction of air. Accordingly, for the same reason as discussed above, in terms of the flow direction of air, the nozzle 150 may supply water to the heater 130 (i.e. to the predetermined region S including the heater 130) in approximately the same direction as the flow direction of air within the duct 100. Meanwhile, despite the above discussed reasons, the nozzle 150 may be installed at any one region or two or more regions of the regions A and B, regions at both sides of the heater 130, and regions immediately above and below the heater 130 as necessary.

[0114] As discussed above, for efficient water supply and steam generation, the nozzle 150 may be configured to directly supply water to the heater 130 and may be oriented towards the heater 130. For the same reason, the nozzle 150 may supply water in approximately the same direction as the flow direction of air within the duct 100. To satisfy the above described requirements, as
In the description above, the nozzle 150 has been described as being located in 'approximately' the same direction as the flow direction of air. Here, the term 'approximately' means that an ejection direction of the nozzle 150 corresponds to a longitudinal direction of the rectangular duct 100. As illustrated in FIG. 3, the duct 100 may have a streamlined rectangular shape. The water ejected from the nozzle 150 is ejected in a straight line by ejection pressure, and the air flow within the streamlined duct 100 is not necessarily a straight line. Thus, the water ejected from the nozzle 150 may not completely coincide with the flow direction of air within the duct 100. Therefore, the term 'approximately' means that the flow direction of air within the duct 100 and the ejection direction of water from the nozzle 150 are not contrary to each other, and more preferably means that an angle between the ejection direction of water from the nozzle 150 and the flow direction of air is less than 90 degrees. Most preferably, the angle between the ejection direction of water from the nozzle 150 and the flow direction of air within the duct 100 is less than 45 degrees.

The region A corresponds to a region between the heater 130 and the blower 140 in terms of a configuration of the duct 100. Thus, the nozzle 150 may be located between the heater 130 and the blower 140 in terms of a configuration of the duct 100. In other words, the nozzle 150 may be located between the heater 130 and an air flow generation source. That is, the heater 130 and the blower 140 are located respectively at one side and the other side of the duct 100 so as to be opposite to each other on the basis of a longitudinal direction of the duct 100. In this case, the nozzle 150 is located between the heater 130 provided at one side of the duct 100 and the blower 140 provided at the other side of the duct 100. Moreover, the nozzle 150 may be located between the region at the front of the heater 130 and the discharge region of the blower 140 (herein, the terms 'front' and 'rear' in relation to the heater 130 are explained on the basis of the flow direction of air within the duct 100, and assuming that the air passes a first point and a second point within the duct 100, the first point where the air first reaches is defined as the region at the front and the second point where the air reaches later is defined as the region at the rear). Also, as mentioned above, the water ejected from the nozzle 150 is diffused by a predetermined angle. If the nozzle 150 is arranged close to the heater 130, more specifically, close to the suction region of the heater 130, in consideration of the diffusion angle, a great part of the ejected water will be directly supplied to the inner wall surface of the duct 100 rather than the heater 130. Since the heater 130 has the highest temperature in the predetermined region S, it is advantageous, in terms of increased steam generation efficiency, that the greatest possible amount of ejected water directly enter the heater 130 of the predetermined region S and spread throughout the heater 130. Thus, to assist the greatest possible amount of water in directly entering the heater 130, the nozzle 150 may be spaced apart from the heater 130 as much as possible. When the nozzle 150 is spaced apart from the heater 130, in consideration of diffusion of water, the supplied water will substantially be distributed throughout the heater 130 starting from the suction region of the heater 130, i.e. the entrance of the heater 130, which may achieve efficient use of the heater 130, i.e. efficient heat exchange and steam generation. The greater the distance between the nozzle 150 and the heater 130, the smaller the distance between the nozzle 150 and the blower 140. For this reason, the nozzle 150 may be located close to the blower 140, and simultaneously may be spaced apart from the heater 130 by a predetermined distance. Also, to ensure that the nozzle 150 is spaced apart from the heater 130 as much as possible, the nozzle 150 may be located close to a discharge side of the blower 140. That is, the nozzle 150 is preferably installed close to the discharge side of the blower 140 from which the air having passed through the blower 140 is discharged. When the nozzle 150 is located close to the discharge side of the blower 140, the supplied water may be directly affected by the air flow discharged from the blower 140, i.e. by discharge force of the blower 140, and may be moved farther so as to uniformly contact the entire heater 130. On the other hand, with assistance of the air flow, high water pressure may not be applied to the nozzle 150, which may result in a lower price and increased lifespan of the nozzle 150. Moreover, to realize arrangement closer to the discharge side of the blower 140, as illustrated in FIGs. 3 and 5, the nozzle 150 may be installed to the blower housing 113. Further, for ease of installation and repair, the nozzle 150 may be installed to the separable upper housing 113b. As illustrated in FIG. 4, for installation of the nozzle 150, the upper housing 113b has an aperture 113c into which the nozzle 150 is inserted. The nozzle 150 may be inserted into the aperture 113c so as to be oriented towards the heater 130.

Referring to FIGs. 6 to 8, the nozzle 150 may consist of a body 151 and a head 152. The body 151 may have an approximately cylindrical shape suitable to be inserted into the aperture 113c. The nozzle 150 is inserted into the aperture 113c, and the head 152 to eject water is located within the duct 100. The body 151 may have a radially extending flange 151a. The flange 151a is provided with a fastening hole, by which the nozzle 150 may be fastened to the duct 100. To increase strength of the flange 151a, as illustrated in FIG. 6, a rib 151b may be formed at the body 151 to connect the flange 151a and the body 151 to each other. Additionally, the body 151 may have a rib 151b formed at an outer periphery thereof. The rib 151b is caught by an edge of the aperture 113c, which prevents the nozzle 151 from being separated from the duct 100, more specifically, from the upper housing 113b. The rib 151b may serve to determine an accurate installation position of the nozzle 150.
The head 152, as illustrated in FIGs. 7 and 8, may have a discharge hole 152a at a distal end thereof. When water is supplied at a predetermined pressure, the discharge hole 152a may be designed to divide the water into small particles of water, i.e. mist. The discharge hole 152a may be designed to additionally apply pressure to the water to be supplied, thereby allowing the water to be diffused by a predetermined angle and to travel by a predetermined distance. The diffusion angle (α) of the water to be supplied, for example, may be 40 degrees. The head 152 may have a radially extending flange 152b. Similarly, the body 151 may further have a radially extending flange 151d to face the flange 152b. If the body 151 and the head 152 are formed of plastic, the flanges 152b and 151d are melt-jointed to each other, whereby the body 151 and the head 152 may be coupled to each other.

As illustrated in FIG. 8 in detail, the head 152 may have a rib 152c formed at the flange 152b, and the body 151 may have a groove 151c formed in the flange 151d. As the rib 152c is inserted into the groove 151c, a contact area between the body 151 and the head 152 is increased. This ensures more firm coupling between the body 151 and the head 152. The nozzle 150, more specifically, the body 151 includes a flow-path 153 to guide the water supplied into the body 151. The flow-path 153, as illustrated in FIGs. 7 and 8, may spirally extend from a distal end of the body 151, i.e. from a discharge portion of the body 151. The spiral flow-path 153 causes swirling water to reach the head 152. As such, the water may be discharged from the nozzle 150 to have a greater diffusion angle and a longer traveling distance.

When the heater 130 generates steam, it may be necessary to transport the generated steam to the tub 30 and the drum 40 and finally to laundry, to realize desired functions. Thus, to transport the generated steam, the blower 140 may blow air toward the heater 130. That is, the blower 140 may generate air flow to the heater 130. The generated steam may be moved along the duct 100 by the air flow, and may finally reach laundry by way of the tub 30 and the drum 40. In other words, the blower 140 creates air flow within the duct 100 and supplies the generated steam into the tub 30 and the drum 40. The steam may be used to desired functions, for example, laundry freshening and sterilization and creation of an ideal washing environment.

As described above, the nozzle 150 has an optimized configuration to supply a sufficient constant amount of water to the heater 130. That is, the nozzle 150 has optimized arrangement and orientation, and other components of the nozzle 150 are appropriately designed for the same purpose. Nevertheless, it may be difficult to supply a sufficient amount of water to the entire heater 130 using only the single nozzle 150 illustrated in FIGs. 3 and 5. That is, when the single nozzle 150 is used, water may not be supplied to a partial region of the heater 130. For these reasons, the washing machine may include a plurality of nozzles 150. FIG. 24 illustrates a plurality of nozzles provided in the duct 100, preferably, two nozzles 150 by way of example. As illustrated in FIG. 24, when a plurality of nozzles 150 is provided, the heater 130 may be divided into a plurality of spaces by imaginary partitions and the nozzles 150 may be assigned to the respective spaces and each nozzle 150 may have an optimized configuration to match the corresponding space S. As such, uniform supply of water throughout the heater 130 may be realized by the plurality of nozzles 150. Also, for the same reason, the plurality of nozzles 150 may supply a sufficient amount of water to the heater 130 to generate a greater amount of steam. Effects of the plurality of nozzles 150 are clearly illustrated even in FIG. 24.

However, despite the above described advantages, the plurality of nozzles 150 requires a greater number of elements and processes as compared to the single nozzle 150 as described above. Thus, provision of the plurality of nozzles 150 may increase manufacturing costs of the washing machine. This problem may be easily solved by integrating elements of the plurality of nozzles 150 among various other methods. For example, all the elements of the nozzle 150 including the body 151 and the head 152 may be molded into a single body. However, as described above, the nozzle 150 has the spiral flow-path 153 formed in the body 151. Although the spiral flow-path 153 may assign a great diffusion angle and longer traveling distance to the water to be supplied, a complex configuration of the spiral flow-path 153 may make it difficult to fabricate the integral nozzle 150 having the spiral flow-path 153. For this reason, as illustrated in FIGs. 25 to 27, instead of the spiral flow-path 153, a swirling device 154 may be provided at the nozzle 150.

The swirling device 154 is basically configured to swirl water, similar to the spiral flow-path 153. More specifically, as illustrated in FIGs. 25 and 26, the swirling device 154 may include a core 154a arranged at the center thereof. The swirling device 154 may further include a body 154c configured to surround the core 154a, and the body 154c may have an approximately cylindrical shape as illustrated. The core 154a may extend along a center axis of the swirling device 154 and may have a conical shape. In particular, the core 154a may have at least one conical shape near a suction portion of the swirling device 154. The resulting conical portion of the core 154a, as illustrated, extends in an opposite direction to the flow direction of water supplied to the swirling device 154. That is, a pointed tip of the conical portion faces water stream supplied to the swirling device 154. With this arrangement, the supplied water is split by the pointed tip without substantial flow resistance, and thereafter is continuously guided along a slope of the tip. As such, the water stream supplied by the conical portion of the core 154a may be smoothly guided into the swirling device 154 without rapid flow resistance change. Although FIGs,
25 to 27 illustrate the core 154a having the conical portion located only close to the suction portion of the swirling device 154, the core 154a may generally have a conical shape. The swirling device 154 may further have a flow-path 154b formed around the core 154a. The flow-path 154b spirally extends around the core 154a. More specifically, as illustrated in FIG. 26, a predetermined clearance is formed between the core 154a and the body 154c, and the flow-path 154b spirally extends in the clearance. The supplied water is guided into the swirling device 154 by the core 154a, and is swirled by the flow-path 154b to thereby reach the head 152 of the nozzle 150. As such, the supplied water may be discharged from the nozzle 150 with a greater diffusion angle and a longer traveling distance.

[0123] The swirling device 154, as illustrated, is fabricated separately from other elements of the nozzle 150. Instead, due to separate fabrication of a complicated swirling structure, i.e. the swirling device 154, as mentioned above, other elements of the nozzle 150, more particularly, the body 151 and the head 152 may be integrally formed with each other as more clearly illustrated in FIG. 26. To ensure that the body 151 and the head 152, which are integrated with each other, are coupled to the duct 100, more specifically, to the upper housing 113b, the nozzle 150 may have the flange 151a having a fastening hole of a predetermined size. The flange 151a serves to connect the plurality of nozzles 150 to each other. That is, the plurality of nozzles 150 is fixed to the flange 151a. The nozzle 150 may further have a discharge hole 152a to discharge water to the heater 130 at a predetermined pressure. The separately fabricated swirling device 154 may be fitted into an integrated assembly of the body 151 and the head 152, i.e. into the nozzle 150. As illustrated in FIG. 26, the swirling device 154 may be fitted into the body 151, similar to the above described spiral flow-path 153. If the swirling device 154 and the body 151 are formed of plastic, the fitted swirling device 154 may be fused to the body 151 using various methods, for example, ultrasonic function. Although the fusion does not provide high coupling strength, the swirling device 154 may be easily coupled to the body 151 via fusion.

[0124] Meanwhile, to maximize utility of effects of water swirling, it is preferable that the eddy generated by the swirling device 154 be directly supplied to and discharged from the head 152. Thus, as illustrated in FIG. 26, the swirling device 154 is located close to the head 152. To this end, more specifically, the swirling device 154 is located at a connection between the body 151 and the head 152. However, since the body 151 has a substantially long length, it may be difficult to accurately push the swirling device 154 from one end to the other end of the body 151, i.e. to the connection between the body 151 and the head 152 such that the swirling device 154 is located close to the head 152. For this reason, the nozzle 150, as illustrated in FIG. 27, may have a positioning structure to determine a position of the swirling device 154. More specifically, as the positioning structure, the nozzle 150 or the swirling device 154 may have a recess. FIG. 27 illustrates a recess 154d formed in the swirling device 154 by way of example. The recess 154d may be formed in the body 154c at a position close to the nozzle 150. Instead of the swirling device 154, a recess may be formed in the nozzle 150. In this case, the recess may be formed in an inner surface of the body 151 facing the swirling device 154. On the other hand, as the positioning structure, the nozzle 150 or the swirling device 154 may have a rib to mate with the recess. FIG. 27 illustrates a rib 151e provided at the nozzle 150 by way of example. The rib 151e may be formed at an inner surface of the body 151 close to the swirling device 154. Instead of the nozzle 150, i.e. the body 151, a rib may be formed at the swirling device 154. In this case, the rib may be formed at the body 154c facing the nozzle 150, i.e. the body 151. When the swirling device 154 is fitted into the body 151, the swirling device 154 is aligned at an accurate position as the rib 151e is fitted into the recess 154d. Also, when the rib 151e or the recess provided at the body 151 is continuously formed in a longitudinal direction of the body 151, the swirling device 154 may be continuously guided from one end to the other end of the body 151, i.e. to the connection between the body 151 and the head 152 while remaining in the aligned state. Accordingly, through provision of the positioning structure, the swirling device 154 may be accurately and easily coupled to the body 151 so as to be located close to the head 152.

[0125] As described above, the swirling device 154 is configured to swirl water and is fabricated separately from the nozzle 150 to thereby be fitted into the nozzle 150. As such, the swirling device 154 may effectively replace the above described spiral flow-path 153, and the other elements of the nozzle may be integrally formed with the swirling device 154. For this reason, even when the plurality of nozzles 150 is provided, this may not increase the number of elements and processes, and consequently may not increase manufacturing costs of the washing machine while achieving improvement in steam generation performance.

[0126] Meanwhile, as illustrated in FIGs. 9, 10, 12 and 14, the duct 100 may have a recess 114 of a predetermined size. The recess 114 may be configured to accommodate a predetermined amount of water. To accommodate a predetermined amount of water, the recess 114 is formed in a lower region of the duct 100 and provides a predetermined volume of space. The water remaining in the duct 100 may be collected into the space of the recess 114. More specifically, the bottom of the recess 114 may be the bottom of the duct 100, and may be formed in the lower part 112 of the drying duct 110. Water may remain in the duct 100 for several reasons. For example, some of the water supplied from the nozzle 150 may remain in the duct 100 rather than being changed into steam. Even if the supplied water is changed into steam, the steam may be condensed into water via heat exchange with the duct 100. Also, moisture
contained in the air may be condensed via heat exchange with the duct 100 during drying of laundry. The recess 114 may be used to collect the remaining water. As clearly illustrated in FIG. 10, the recess 114 may have a predetermined gradient to easily collect the remaining water.

The recess 114 may additionally generate steam using the water accommodated therein. Heating is required to change the accommodated water into steam. Thus, the recess 114 may be located below the heater 130 such that the water accommodated in the recess 114 is heated using the heater 130. That is, it may be said that the recess 114 is located immediately below the heater 130. Moreover, since the space within the recess 114 is heated by the heater 110, the heater 130 may extend into the space within the recess 114. That is, the heater 130, as represented by a dotted line in FIG. 10, may include the space within the recess 114. With this configuration, in addition to the steam generated using the water supplied from the nozzle 150, the water in the recess 114 may be heated by the heater 130 and may be changed into steam. As such, a greater amount of steam may substantially be supplied, which enables more effective implementation of desired functions.

More specifically, as illustrated in FIGs. 9 and 11, the heater 130 may be configured to directly heat the water in the recess 114. To achieve the direct heating, at least a portion of the heater 130 is preferably located in the recess 114. That is, when the water is accommodated in the recess 114, a portion of the heater 130 may be immersed in the water accommodated in the recess 114. That is, the heater 130 may directly contact the water in the recess 114. Although the heater 130 may be immersed into the water in the recess 114 via various methods, as illustrated in FIGs. 9 and 11, a portion of the heater 130 may be bent toward the recess 114. In other words, the heater 130 may have a bent portion 131a that is immersed in the water accommodated in the recess 114. As such, the bent portion 131a is preferably located in the recess 114. In this case, the bent portion 131a is preferably located at a free end of the heater 130, and in turn the recess 114 is located below the bent portion 131a. As such, the recess 114 is located below the free end of the heater 130.

As illustrated in FIGs. 12 to 15, the heater 130 may serve to indirectly heat the water in the recess 114. For example, as illustrated in FIGs. 12 and 13, a thermal conductive member may be coupled to the heater 130 to transfer heat from the heater 130. At least a portion of the thermal conductive member is located in the recess 114. As the thermal conductive member, the heater 130 may include a heat sink 133 that is mounted to the heater 130 and is immersed in the water accommodated in the recess 114. The heat sink 133, as illustrated, has a plurality of fins, which has a configuration suitable for radiation. At least a portion of the heat sink 133 is located in the recess 114. As such, heat of the heater 130 is transferred to the water in the recess 114 through the heat sink 133. Alternatively, as illustrated in FIGs. 14 and 15, the heater 130 may include, as the thermal conductive member, a support member 111c protruding from the bottom of the recess 114 to support the heater 130. As mentioned above, the lower part 111 may be formed of a metal having high thermal conductivity and strength. In this case, the support member 111c may be formed of the same metal and may be integrally formed with the lower part 111. The support member 111c may have a cavity for accommodation of the heater 130, in order to stably support the heater 130 and to provide the heater with a wide electric heating area. As such, heat of the heater 130 is transferred to the water in the recess 114 through the support member 111c. The heater 130 comes into indirectly contact with the water in the recess 114 via the heat sink 133 or the support member 111c, i.e. a heating member. More specifically, the heating member 133 or 111c achieves thermal connection between the heater 130 and the water in the recess 114, thereby serving to heat the water using the heater 130.

Owing to the bent portion 131a and the heating member 133 or 111c as mentioned above, the heater 130 may directly or indirectly contact the water in the recess 114, thereby serving to more effectively heat the water. The heater 130 may heat the water in the recess 114 to generate steam via heat transfer through air, even without the structure for direct or indirect contact.

Through use of the steam supply mechanism as described above with reference to FIGs. 2 to 15, steam may be supplied into the washing machine, whereby, for example, laundry freshening and sterilization, and creation of an ideal washing environment may be realized. Further, many other functions may be performed by appropriately controlling, for example, steam supply timing and an amount of steam. All the above functions may be performed during a basic wash course of the washing machine. On the other hand, the washing machine may have additional courses optimized to perform the respective functions. As one example of the additional courses, hereinafter, so called a fresh course that is optimized to freshen laundry will be described with reference to FIGs. 16 to 20. To control the refresh course, the washing machine of the present invention may include a controller. The controller may be configured to control all courses that can be realized by the washing machine of the present invention as well as the refresh course that will be described hereinafter. The controller may initiate or stop all actuations of the respective elements of the washing machine including the above described steam supply mechanism. Accordingly, all the functions/actuations of the above described steam supply mechanism and all operations of a control method that will be described hereinafter are under control of the controller.

First, the method of controlling the refresh course may include a preparation operation S5 in which heating of the heater 130 is performed. The heating may be realized by various devices, more particularly, by the heater 130. The preparation operation S5 may basically create a high temperature environment that is suitable
for steam generation. That is, the preparation operation S5 is an operation of creating a high temperature environment for steam generation. As a result of performing the preparation operation S5 to provide a high temperature environment before a steam generation operation S6 that will be described hereinafter, it is possible to facilitate steam generation in the following steam generation operation S6.

[0133] More specifically, in the preparation operation S5, the heater 130, which occupies a partial space within the duct 100, may be heated to a higher temperature than that of the remaining space within the duct 100. The preparation operation S5 requires heating for a considerably short time because a minimum space required for steam generation, i.e. only the heater 130 is heated. Accordingly, the preparation operation S5 may adopt temporal heating as well as local and direct heating, which may minimize power consumption. The heating of the heater 130 may be performed for at least a partial duration of a preset duration of the preparation operation S5 under the assumption that it can create an environment required for desired steam generation. Preferably, the heating of the heater 130 may be performed for the duration of the preparation operation S5.

[0134] If an external environment of the heater 130 is changed during the preparation operation S5, for example, if air flow occurs around the heater 130, heat emitted from the heater 130 may be forcibly transferred to other regions of the duct 100, thereby causing unnecessary heating of these regions. Thus, local and temporal heating may be difficult. Further, it may be difficult to provide the heater 130 with an environment suitable for steam generation, and excessive power consumption may be expected. For this reason, the preparation operation S5 is preferably performed without occurrence of air flow around the heater 130. That is, the preparation operation S5 may include stopping actuation of the blower 140 that generates air flow for a predetermined time. Additionally, when the air flow occurs in the entire duct 100, that is, when air circulates through the duct 100, the tub 30, the drum 40, etc., this accentuates the above described results. Accordingly, the preparation operation S5 may be performed without air circulation using the duct 100. Meanwhile, the heater may not be sufficiently heated during the preparation operation S5, i.e. prior to completing the preparation operation S5. If water is supplied to the heater 130 during the preparation operation S5, a great amount of water may not be changed into steam, and thus a desired amount of steam may not be generated. Accordingly, the preparation operation S5 may be performed without supply of water to the heater 130. That is, the preparation operation S5 may include stopping actuation of the nozzle 150 that ejects water for a predetermined time. Elimination of occurrence of air flow and/or supply of water, preferably, may be maintained for the duration of the preparation operation S5. However, the disclosure is not necessarily limited thereto, and elimination of occurrence of air flow and/or supply of water may be maintained for a partial duration of the preparation operation S5.

[0135] To ensure creation of a high temperature environment for steam generation, preferably, actuation of the heater 130 is maintained for the duration of the preparation operation S5. In addition, actuation of the nozzle 150 stops for at least a partial duration of the implementation duration of the preparation operation S5. Preferably, actuation of the nozzle 150 stops for the implementation duration of the preparation operation S5. Also, actuation of the blower 150 may stop for at least a partial duration of the implementation duration of the preparation operation S5. Actuation of the blower 150 in the preparation operation S5 will be described later in relation to a first heating operation S5a and a second heating operation S5b that will be described hereinafter.

[0136] Elimination of occurrence of air flow and/or supply of water as described above may be achieved via various methods. However, to achieve this elimination, the steam supply mechanism, i.e. the elements within the duct 100 may be primarily controlled. Control of these elements is illustrated in FIGs. 17 and 18A to 18C in more detail. FIG. 17 schematically illustrates actuation of related elements during the entire refresh course using arrows. In FIG. 17, the arrows represent actuation of the relevant elements and the duration thereof. FIGs. 18A to 18C illustrate actuation of the relevant elements during the entire refresh course in more detail by adopting numerals each representing the actual implementation time of the corresponding operation. More specifically, in FIGs. 18A to 18C, numerals in “progress time” boxes represent the time (sec) passed after starting the refresh course, and numerals written behind respective device names represent the actual actuation time (sec) of each operation.

[0137] For example, the blower 140 is a major element that may generate air flow and air circulation. Thus, as illustrated in FIGs. 17 and 18B, the blower 140 may be shutdown for at least a partial duration of the preparation operation S5 in order to eliminate occurrence of air flow and/or air circulation with respect to the heater 130. That is, the blower 140 may be shutdown for the duration or for at least a partial duration of the preparation operation S5. Also, as described above, the nozzle 150 is a major element for supply of water within the duct 100. Thus, as illustrated in FIGs. 17 and 18B, the nozzle 150 may be shutdown during the preparation operation S5 so as not to supply water to the heater 130. Preferably, stopping actuation of the blower 140 and the nozzle 150 is maintained for the duration of the preparation operation S5. However, stopping actuation of the blower 140 and the nozzle 150 may be maintained only for a partial duration of the preparation operation S5. Meanwhile, the heater 130 may be continuously actuated for the duration of the preparation operation S5. Similarly, the heater 130 may be actuated only for a partial duration of the preparation operation S5.

[0138] As discussed above, occurrence of air flow may
basically prevent creation of an ideal high temperature environment for steam generation. Since the high temperature environment is the most important in aspect of the preparation operation S5, it may be preferable that the preparation operation S5 be performed at least without occurrence of air flow. For this reason, the preparation operation S5 may include stopping at least the blower 140. That is, the preparation operation S5 may include stopping actuation of the blower 140 while actuating the nozzle 150. Also, in consideration of the quality of steam to be additionally generated, at least a partial duration of the preparation operation S5 may do not include occurrence of air flow and supply of water. That is, the preparation operation S5 may include shutting down both the blower 140 and the nozzle 150. In this case, stopping actuation of both the blower 140 and the nozzle 150 may be performed at the final stage of the preparation operation S5. Accordingly, the steam generation operation S6 that will be described hereinafter may be performed after stopping actuation of both the blower 140 and the nozzle 150 ends. Meanwhile, despite the importance of elimination of occurrence of air flow, the preparation operation S5 may be performed without supply of water under occurrence of air flow. Accordingly, the preparation operation S5 may include stopping only actuation of the nozzle 150 without stopping actuation of the blower 140 (i.e. include shutting down only the nozzle 150 while actuating the blower 140). That is, the preparation operation S5 may include shutting down at least the nozzle 150. In this case, shutdown of the nozzle 150 may be performed at the final stage of the preparation operation S5. Even while actuation of the blower 140 and/or the nozzle 150 selectively stops, the heater 130 may be continuously actuated for the duration of the preparation operation S5. That is, as illustrated in FIGs. 17 and 18B, among the heater 130, the blower 140, and the nozzle 150 as major elements of the steam supply mechanism, only the heater 130 may be continuously actuated during the preparation operation S5. Nevertheless, the heater 130 may be actuated only for a partial duration of the preparation operation S5 if it can create an environment required for desired steam generation, i.e. a high temperature environment for the partial duration.

[0139] The preparation operation S5 may be performed for a first set time. As described above, actuation of the heater 130 may be maintained for at least a partial duration of the first set time of the preparation operation S5. Preferably, actuation of the heater 130 may be maintained for the first set time. Referring to FIG. 18, the preparation operation S5 may be performed for a very short time, for example, for 20 seconds. However, owing to the fact that the preparation operation S5 may include local and direct heating of only the heater 130, it is possible to create a high temperature environment suitable for steam generation with minimum power consumption even within the short time.

[0140] After completion of the preparation operation S5, the steam generation operation S6 in which water is supplied to the heated heater 130 is performed. The supply of water may be realized by various devices, more particularly, by the nozzle 150. In the steam generation operation S6, materials required for steam generation may be added to the previously created environment of the heater 130.

[0141] To generate steam, water may be indirectly supplied to the heater 130 using the nozzle 150. The indirect supply of water may utilize other devices except for the nozzle 150, for example, a typical outlet device. For example, water may be supplied into another space within the duct 100, rather than being supplied to the heater 130, using various devices, and then be transported to the heater 130 for steam generation via air flow provided by the blower 140. However, since water may be adhered to the inner surface of the duct 100 during transport, the supplied water may do not completely reach the heater 130. On the other hand, as described above, the heater 130 has optimized conditions for steam generation via direct heating in the preparation operation S5. Accordingly, in the steam generation operation S6, water may be directly supplied to the heater 130. The supply of water may be performed for at least a preset partial duration of the steam generation operation S6 if it can generate a sufficient amount of steam for the preset partial duration. However, preferably, the supply of water may be performed for the duration of the steam generation operation S6. Also, as described above, generation of a sufficient amount of high quality steam requires an ideal environment, i.e. a high temperature environment. Accordingly, the steam generation operation S6 preferably begins or is performed after the preparation operation S5 is performed for a required time, more specifically for a preset time. That is, the preparation operation S5 is performed for a preset time before the steam generation operation S6 begins.

[0142] As described above, steam refers to vapor phase water generated by heating liquid water. On the other hand, mist refers to small particles of liquid water. That is, mist can be changed into high temperature steam via phase change by easily absorbing heat. For this reason, in the steam generation operation S6, mist may be ejected to the heater 130. As described above with reference to FIGs. 6 to 8, the nozzle 150 may be optimally designed to generate and supply mist. Also, as described above with reference to FIGs. 6 to 8, the nozzle 150 ejects water to the heater 130 by ejection pressure thereof. In the steam generation operation S6, water may be ejected to the heater 130 via the nozzle 150 and ejection of the water from the nozzle 150 to the heater 130 may be achieved by ejection pressure of the nozzle 150. In the steam generation operation S6, water may be ejected to the heater 130 via the nozzle 150 that is provided between the blower 140 and the heater 130. Preferably, in the steam generation operation S6, the water from the nozzle 150 is ejected in approximately the same direction as the flow direction of air within the duct 100, to ensure supply of mist to the heater 130. With supply of mist, the
steam generation operation S5 may achieve efficient generation of a sufficient amount of steam from the heater 130. On the other hand, the nozzle 150 may supply water, i.e. a water stream or water jet instead of mist by adjusting the pressure of water supplied to the nozzle 150. In any cases, the heater 130 may generate steam owing to an environment thereof suitable for steam generation. A sufficient amount of water is not yet supplied during the steam generation operation S6, and therefore a sufficient amount of steam may not be generated. If air flow to the heater 130 occurs during the steam generation operation S6, the resulting insufficient amount of steam may be supplied into the tub 30 under assistance of the air flow. In particular, at the initial stage of the steam generation operation S6, likewise, a sufficient amount of steam may not be generated and supplied because the supplied water is scattered by the air flow to thereby flow past the heater 130. Moreover, since a predetermined time is required for change of the supplied water into steam, a great amount of liquid water may remain within the heater 130 during the steam generation operation S6. If air flow occurs during the steam generation operation S6 as mentioned above, a great amount of liquid water as well as the steam may be transported by the air flow, thereby being supplied into the tub 30. That is, in the steam generation operation S6, occurrence of air flow may deteriorate the quality of steam to be supplied into the tub 30, which may prevent effective implementation of desired functions. Accordingly, the steam generation operation S6 may be performed without occurrence of air flow to the heater 130. That is, actuation of the blower 140 preferably stops in the steam generation operation S6. Moreover, when air flow occurs throughout the duct 100, i.e. when the air circulates through the duct 100 and the tub 30, etc., the above described effects may more remarkably occur. For this reason, the steam generation operation S6 may be performed without air circulation. Although it is preferable that occurrence of air flow and/or air circulation (actuation of the blower 140) is continuously eliminated for the duration of the steam generation operation S6, occurrence of air flow and/or air circulation may be eliminated only for a partial duration of the steam generation operation S6.

Meanwhile, as the water supplied during the steam generation operation S6 absorbs heat emitted from the heater 130, the temperature of the heater 130 may drop. Such temperature drop may prevent the heater 130 from having an ideal environment for steam generation. Thus, it may be difficult to generate a sufficient amount of steam and to achieve high quality steam due to the presence of a great amount of liquid water. Accordingly, it is preferable that the heater 130 be heated in the steam generation operation S6 in order to maintain the ideal environment for steam generation during the steam generation operation S6. For this reason, the steam generation operation S6 may be performed along with heating of the heater 130. In this case, the heating may be performed for a partial duration of the steam generation operation S6, and moreover may be performed for the duration of the steam generation operation S6. Nevertheless, since the heater 130 has been sufficiently heated, steam may be generated to some extent in the steam generation operation S6 even without additional heating. Thus, the steam generation operation S6 may be performed without additional heating of the heater 130.

Although elimination of occurrence of air flow and/or implementation of heating may be performed via various methods, it may be easily achieved by controlling the steam supply mechanism, i.e. the elements within the duct 100. For example, as illustrated in FIGs. 17 and 18B, the blower 140 may be shut down during the steam generation operation S6 in order to prevent occurrence of air flow with respect to the heater 130. Preferably, stopping actuation of the blower 140 may be maintained for the duration of the steam generation operation S6. However, actuation of the blower 140 may stop only for a partial duration of the steam generation operation S6. In the case in which actuation of the blower 140 stops only for a partial duration of the steam generation operation S6, stopping actuation of the blower 140 is preferably performed at the final stage of the steam generation operation S6. That is, the blower 140 may be actuated at the first half of the steam generation operation S6, and actuation of the blower may stop at the second half of the steam generation operation S6. As described above, the heater 130 is a major element to heat the heater 130. Accordingly, as illustrated in FIGs. 17 and 18B, the heater 130 may be actuated during the steam generation operation S6, to generate heat required for the ideal environment of the heater 130. In this case, the heater 130 may be actuated at least only for a partial duration of the steam generation operation S6. Preferably, the heater 130 may be actuated for the duration of the steam generation operation S6. Also, as mentioned above, to realize the steam generation operation S6 that does not require additional heating, the heater 130 may be shut down during the steam generation operation S6. Stopping actuation of the heater 130 may be maintained for the duration of the steam generation operation S6. Preferably, the nozzle 150 may be continuously actuated for the duration of the steam generation operation S6. However, the nozzle 150 may be actuated only for a partial duration of the steam generation operation S6 if it can generate a sufficient amount of steam for the partial duration.

As discussed above, occurrence of air flow basically prevents generation of a sufficient amount of high quality steam. Since steam generation is the most important in aspect of the steam generation operation S6, it may be preferable that the steam generation operation S6 be performed at least without occurrence of air flow. Also, in consideration of a steam generation environment, the steam generation operation S6 may be performed along with heating of the heater 130 without occurrence of air flow. For these reasons, the steam generation operation S6 may include stopping actuation of
at least the blower 140. Also, the steam generation operation S6 may include stopping actuation of the blower 140, but actuating the heater 150.

[0146] The heater 130 has a limited size and may have difficulty in completely changing water into steam when excess water is supplied for a substantially long time. Thus, it is preferable that the steam generation operation S6 be performed for a second set time that is shorter than the first set time. Actuation of the nozzle 150 may be maintained for a partial duration of the second set time. Preferably, actuation of the nozzle 150 is maintained for the duration of the second set time. As illustrated in FIG. 18B, the steam generation operation S6 may be performed for a shorter time than in the preparation operation S5, for example, for 7 seconds. With the steam generation operation S6 that is performed for a short time, an appropriate amount of water may be supplied to the heater 130 and be completely changed into steam.

[0147] After completion of the steam generation operation S6, air may be blown to the heater 130 in order to move the generated steam (S7). That is, the air flow to the heater 130 may occur to allow the generated steam to be supplied into the tub 30 (S7). The occurrence of air flow may be performed by various methods, more particularly, by rotating the blower 140. Thus, the steam supply operation S7 performed after the steam generation operation S6 is an operation of supplying the generated steam into the tub 30. The steam supply operation S7 is performed after the steam generation operation S6 ends. As such, the preparation operation S5, the steam generation operation S6, and the steam supply operation S7 are performed in sequence, and the next operation is performed after completion of the previous operation.

[0148] The generated steam is moved along the duct 100 by the air flow, and is primarily supplied into the tub 30. Thereafter, the steam may finally reach laundry by way of the drum 40. The steam is used for desired functions, for example, laundry freshening and sterilization, or creation of an ideal washing environment. If the air flow can transport all of or a sufficient amount of the generated steam into the tub 30, the air flow may occur for a partial duration of the steam supply operation S7. However, preferably, the air flow may occur for the duration of the steam supply operation S7. Also, as described above, due to the fact that the steam supply operation S7 has a precondition of generation of a sufficient amount of steam to be supplied into the tub 30, it is preferable that the steam supply operation S7 begins after the steam generation operation S6 begins after the steam generation operation S6 is performed for a desired time, preferably, for a preset time. That is, the steam generation operation S6 is performed for a preset time before the steam supply operation S7 begins. Also, since the steam generation operation S6 is performed after the preparation operation S5 is performed for a predetermined time, the steam supply operation S7 begins after the preparation operation S5 and the steam generation operation S6 are sequentially performed for a predetermined time.

[0149] Meanwhile, the air within the tub 30 and/or the drum 40 has a lower temperature than the supplied steam. The supplied steam may be condensed into water via heat exchange with the air within the tub 30 and/or the drum 40. Accordingly, during the steam supply operation S7, a certain amount of the generated steam may be lost during transport, and may not reach laundry. Moreover, it may be difficult to provide laundry with a sufficient amount of steam and to achieve desired effects. For this reason, water may be supplied to the heater 130 during the steam supply operation S7 to ensure continuous steam generation. That is, the steam supply operation S7 may be performed along with supply of water to the heater 130. In this case, in addition to the steam generation operation S6, steam is continuously generated even during the steam supply operation S7. As such, a sufficient amount of water to compensate for water loss during transport may be prepared within a short time. Accordingly, despite water loss during transport, the washing machine may provide laundry with a sufficient amount of steam that the user can visually perceive, which ensures reliable acquisition of desired effects using steam. The supply of water may be performed for at least a partial duration of the steam supply operation S7. Preferably, to generate a greater amount of steam, the supply of water may be performed for the duration of the steam supply operation S7. If the supply of water is performed only for a partial duration of the steam supply operation S7, it is preferable that the supply of water is performed at the final stage of the steam supply operation S7.

[0150] Since the water supplied during the steam supply operation S7 is changed into steam by absorbing heat from the heater 130, temperature drop may prevent the heater 130 from acquiring an ideal environment for steam generation. Thus, to maintain the ideal environment for steam generation during the steam supply operation S7, it is preferable to perform heating of the heater 130 even during the steam supply operation S7. For this reason, the steam supply operation S7 may be performed along with heating of the heater 130. By maintaining the ideal environment for steam generation via heating, steam generation during the steam supply operation S7 may be more stably performed to achieve a sufficient amount of steam. In this case, the heating may be performed for at least a partial duration of the steam supply operation S7, and preferably, may be performed for the duration of the steam supply operation S7, in order to maintain the ideal environment for steam generation. When the supply of water (actuation of the nozzle 150) is performed during the steam supply operation S7, preferably, actuation of the heater 130 may depend on actuation of the nozzle 150. That is, when the steam supply operation S7 includes actuation of the nozzle 150 and the heater 130, actuation of the nozzle 150 is preferably performed simultaneously with actuation of the heater 130.

[0151] Although the supply of water and/or the heating
may be performed via various methods, it may be easily achieved by controlling the steam supply mechanism, i.e. the elements within the duct 100. For example, the nozzle 150 and the heater 130 may be actuated for at least a partial duration of the steam supply operation S7, in order to achieve the supply of water and heating. In this case, actuation of the nozzle 150 and actuation of the heater 130 are preferably performed at the final stage of the steam supply operation S7. However, as illustrated in FIGs. 17 and 18B, actuation of the nozzle 150 and the heater 130 is preferably maintained for the duration of the steam supply operation S7, to achieve efficient steam generation and to maintain the ideal environment for steam generation.

As described above, the heater 130 is actuated for at least a partial duration of the steam supply operation S7, and is preferably actuated for the duration of the steam supply operation S7. The nozzle 150 is actuated for at least a partial duration of the steam supply operation S7, and is preferably actuated for the duration of the steam supply operation S7.

In the case in which the heater 130 and the nozzle 150 are actuated simultaneously, it can be said that the blower 140, the heater 130 and the nozzle 150 are actuated simultaneously in the steam supply operation S7. In this case, actuation of the blower 130, the heater 130 and the nozzle 150 may be performed for at least a partial duration of the steam supply operation S7, and preferably, may be performed for the duration of the steam supply operation S7. If actuation of the blower 130, the heater 130 and the nozzle 150 is performed for a partial duration of the steam supply operation S7, preferably, the simultaneous actuation is performed at the final stage of the steam supply operation S7.

Meanwhile, water may be generated in the tub 30 by the steam supplied in the steam supply operation S7. For example, the air within the tub 30 and/or the drum 40 has a lower temperature than the supplied steam. Thus, the supplied steam may be condensed into water via heat exchange with the air within the tub 30 and/or the drum 40. Accordingly, even in the steam generation operation S6, the generated steam may be condensed by heat exchange even within the duct 100, and the condensed water may be supplied into the tub 30 via air flow. Thus, the condensed water may be finally gathered in the tub 30. As illustrated in FIG. 2, if the sump 33 is provided in the tub 30, the condensed water may be gathered in the sump 33. The condensed water may cause dried laundry to be wetted, which may prevent realization of desired functions by steam supply. For this reason, the water generated by steam supply during the steam generation and steam supply operations S6 and S7 may be discharged from the tub 30. For drainage of water, as illustrated in FIGs. 17 and 18B, the drain pump 90 may be actuated. Once the drain pump 90 is actuated, the water in the sump 33 may be discharged outward from the drying machine through the drain hole 33b and the drain pipe 91. The discharge of water may be performed for the duration of the steam generation and steam supply operations S6 and S7. Of course, the discharge of water may be performed only for a partial duration of the steam generation and steam supply operations S6 and S7 if rapid discharge of water is possible. Likewise, even the drain pump 90 may be actuated for the duration of the steam generation and steam supply operations S6 and S7, or may be actuated only for a partial duration of the steam generation and steam supply operations S6 and S7.

The heater 130 has a limited size, and thus supplying all the steam generated in the heater 130 into the tub 30 does not take a great time. Thus, the steam supply operation S7 may be performed for a third set time that is shorter than the second set time. Actuation of the heat-
As described above, the heater 130 may be reduced as illustrated in FIG. 18B, which may minimize implementation times of the operations may be gradually the respective operations S5 to S7 as described above, operation operation S6, for example, for 3 seconds. Therefore, actuation of the blower 140 in the steam supply operation S7 may be performed for a shorter time than in the steam generation operation S6, and preferably may be a half or one third of the actuation time of the nozzle 150 in the steam generation operation S6. As illustrated in FIGS. 17 and 18B, the steam supply operation S7 may be divided into the first heating operation S5a and the second heating operation S5b based on actuation of the blower 140. Thus, the preliminary rotation of the blower 140 may be performed only for a partial duration of the preparation operation S5. Moreover, since the blower 140 is not actuated during the steam generation operation S6, if the blower 140 is rotated only at the initial stage of the preparation operation S5, rotation of the blower 140 may not be maintained even due to inertia until the steam supply operation S7 begins. Accordingly, actuation of the blower 140 is performed at the final stage of the preparation operation S5 as clearly illustrated in FIGS. 17 and 18B. Preferably, actuation of the blower 140 may be performed only at the final stage of the preparation operation S5.

As described above, the heater 130 may be continuously actuated for the duration of the operations S5 to S7. However, this continuous actuation may cause the heater 130 to overheat. Thus, to prevent the heater 130 from overheating, the temperature of the heater 130 may be directly controlled. For example, if the temperature of air within the duct 100 or the temperature of the heater 130 rises to 85°C, the heater 130 may be turned off. On the other hand, if the temperature of air within the duct 100 or the temperature of the heater 130 drops to 70°C, the heater 130 may again be actuated.

Meanwhile, in the steam supply operation S7, to effectively transport the generated steam into the tub 30, it is necessary to generate sufficient air flow to the heater 130. The sufficient air flow may occur when the blower 140 is rotated at predetermined revolutions per minute or more, and it takes some time for the blower 140 to reach appropriate revolutions per minute. In particular, it takes the greatest time to restart rotation of the blower 140 in a state in which actuation of the blower 140 completely stops. However, in consideration of other related operations, the steam supply operation S7 is optimally set to be performed for a relatively short time. Therefore, the actuation time of the blower 140 at appropriate revolutions per minute may be shorter than the duration of the steam supply operation S7. Thus, sufficient air flow may not occur during the steam supply operation S7, and thus effective transport of the generated steam may not be possible. For this reason, to maximize performance of the blower 140 during the steam supply operation S7, the blower 140 may be preliminarily rotated, i.e. actuated before the steam supply operation S7. If the blower 140 is previously rotated before the steam supply operation S7, the steam supply operation S7 may begin during rotation of the blower 140. Accordingly, the revolutions per minute of the blower 140 may rapidly increase to appropriate revolutions per minute at the initial stage of the steam supply operation S7, which may ensure continuous occurrence of sufficient air flow.

The preliminary rotation of the blower 140 may be performed in the steam generation operation S6. However, as discussed above, occurrence of air flow in the steam generation operation S6 is not preferable because it causes deterioration in the quantity and quality of steam. Thus, the preliminary rotation of the blower 140 may be performed in the preparation operation S5. That is, as illustrated in FIGS. 17 and 18B, the preparation operation S5 may further include rotating, i.e. actuating the blower 140 for a predetermined time. Although occurrence of air flow in the preparation operation S5 does not have a direct effect on steam generation, it may prevent local heating and increase power consumption. Therefore, actuation of the blower 140 may be performed only for a partial duration of the preparation operation S5. Moreover, since the blower 140 is not actuated during the steam generation operation S6, if the blower 140 is rotated only at the initial stage of the preparation operation S5, rotation of the blower 140 may not be maintained even due to inertia until the steam supply operation S7 begins. Accordingly, actuation of the blower 140 is performed at the final stage of the preparation operation S5 as clearly illustrated in FIGS. 17 and 18B. Preferably, actuation of the blower 140 may be performed only at the final stage of the preparation operation S5.

As mentioned above, occurrence of air flow is not preferable even in the preparation operation S5, and therefore actuation of the blower 140 is considerably limited. The blower 140 is turned on only for a predetermined time so as to be rotated by power. After the predetermined time has passed, the blower 140 is directly turned off, and continues to rotate by inertia. Also, the blower 140 may be rotated at low revolutions per minute for the predetermined turn-on time thereof. The preparation operation S5 may be divided into the first heating operation S5a and the second heating operation S5b based on actuation of the blower 140. As illustrated in FIGS. 17 and 18B, the first heating operation S5a corresponds to the first half of the preparation operation S5 and does not include actuation of the blower 140. Thus, in the first heating operation S5a, only heating of the heater 130 is performed without supply of water and occurrence of air flow. The second heating operation S5b corresponds to the second half of the preparation operation S5 and includes the above described actuation of the blower 140. Thus, in the second heating operation S5b, actuation of the blower 140 and heating of the heater 130 are performed simultaneously. More specifically, the blower 140 is turned on so as to be rotated by power for a predetermined time, i.e. during the second heating operation S5b. That is, air flow to the heater 130 may occur in the second heating operation S5b. However, as described above, the blower 140 is actuated at low revolutions per minute, which minimizes a negative effect on heating of the heater 130 due to the air flow. Meanwhile, as illustrated in FIGS. 17 and 18B, the blower 140 may be continuously
actuated for the duration of the second heating operation S5b. Moreover, the blower 140, as illustrated in FIG. 18B, may be actuated for an additional time (for example, 1 second in FIG. 18B) after the second heating operation S5b begins. Thereafter, the blower 140 is turned off immediately after the second heating operation S5b ends. Once the blower 140 is turned off, the blower 140 is rotated by inertia during the steam generation operation S6. Thus, since the blower 140 is rotated at considerably low revolutions per minute during the steam generation operation S6, no substantial air flow to the heater 130 occurs. The inertia rotation of the blower 140 is continued to the steam supply operation S7. Thus, when the steam supply operation S7 begins, the blower 140 continues to rotate at low revolutions per minute. As such, a time required to begin rotation of the stopped blower 140 at the initial stage of the steam supply operation S7 is reduced, and rapidly increasing revolutions per minute of the blower 140 to an appropriate value is possible. Accordingly, sufficient air flow may continuously occur and the generated steam may be effectively transported for the duration of the steam supply operation S7.

The above described actuation involves actuation of the blower 140 and occurrence of air flow. Therefore, the preparation operation S5 including the above described actuation is performed without supply of water to the heater 130 and actuation of the nozzle 150. Also, since the blower 140 is rotated at low revolutions per minute, air circulation through the duct 100 does not occur. Thus, the preparation operation S5 may be performed without air circulation through the duct 100 even during actuation of the blower 140. That is, actuation of the blower 140 does not have a great effect on local heating and creation of the steam generation environment in the preparation operation S5. If efficient supply of a desired amount of steam may be realized in the steam supply operation S7 even without actuation of the blower 140, actuation of the blower 140 is preferably eliminated. As discussed above, in any cases, it is most effective to perform the preparation operation S5 without supply of water and occurrence of air flow. That is, actuation of the blower 140 is selective, and is not essential.

As described above, the preparation operation S5, the steam generation operation S6, and the steam supply operation S7 are functionally associated with one another for steam supply. Thus, as illustrated in FIGs. 16, 17 and 18B, these operations S5 to S7 constitute a single functional process, i.e. a steam supply process P2. Laundry freshening effects, i.e. wrinkle-free, static charge elimination, and deodorization effects may be achieved by simply supplying a sufficient amount of steam. As described above, the steam supply process P2 may achieve generation a sufficient amount of steam, and the steam supply process P2 may perform desired freshening functions without additional operations that will be described hereinafter. A set of the operations S5 to S7, i.e. the steam supply process P2 may be repeated plural times, and a greater amount of steam may be continuously supplied into the tub 30 to maximize the freshening effects. As described above with reference to FIG. 18B, the steam supply process P2 may be repeated twelve times. Also, as necessary, the steam supply process P2 may be repeated thirteen and fourteen times or more. Performing the steam supply process P2 once requires 30 seconds, and thus performing the steam supply process P2 twelve times requires about 360 seconds. However, a slight delay may occur during repetition of the process P2, and an additional delay may occur for the purpose of control. Accordingly, a subsequent operation of the steam supply process P2 may not begin after exactly 360 seconds.

The above described operations S5, S6 and S7 will hereinafter be described based on whether or not actuation of the heater 130, of the blower 140 and of the nozzle 150 is performed.

The heater 130 may be actuated throughout the preparation operation S5, the steam generation operation S6, and the steam supply operation S7. However, as in the above description of the respective operations, actuation of the heater 130 is intermittently performed or stops in some operations or at least a partial duration of some operations.

The blower 140 may be actuated for at least a partial duration of the steam supply operation S7, and is preferably actuated for the duration of the steam supply operation S7. In addition, to achieve more rapid actuation of the blower 140 in the steam supply operation S7, actuation of the blower 140 may be maintained for a predetermined time, i.e. for at least a partial duration of the preparation operation S5, and preferably may be maintained at the final stage of the preparation operation S5. In addition, actuation of the blower 140 preferably stops in the steam generation operation S6.

The nozzle 150 may be actuated for at least a partial duration of the steam generation operation S6, and is preferably actuated for the duration of the steam generation operation S6. Since actuation of the nozzle 150 causes water ejection to the heater 130, preferably, actuation of the nozzle 150 stops in the preparation operation S5 that creates a steam generation environment. Meanwhile, the nozzle 150 may be actuated for at least a partial duration of the steam supply operation S7, and is preferably actuated for the duration of the steam supply operation S7. Although the steam supply operation S7 is an operation of supplying the generated steam into the tub 30, to assist the user in visually checking that a sufficient amount of steam is generated and is supplied into the tub 30, actuation of the heater 130, of the nozzle 150, and of the blower 140 may be simultaneously performed for at least a partial duration of the steam supply operation S7. Preferably, actuation of the heater 130, of the nozzle 150, and of the blower 140 may be simultaneously performed for the duration of the steam supply operation S7.

In the steam supply operation S6 in which the nozzle 150 is actuated to generate steam without actuation of the blower 140, the generated steam is invisible.
under an environment in which the duct 100, the tub 30 and the drum 40 are kept at high temperatures. Thus, when only the blower 140 is actuated to supply the generated steam into the drum 40 after the steam supply operation S6, the supplied steam is invisible even if the user views the interior of the drum 40 through the transparent door glass 21. Thus, the user cannot check supply of steam, which causes poor product reliability.

[0169] On the other hand, according to the present invention, in the case in which the blower 140 is actuated during additional steam generation via actuation of the nozzle 150 and the heater 130 in the steam supply operation S7, the interior of the duct 100 and the drum 40 (including the tub 30) is kept at a relatively low temperature, causing at least some of the generated steam to be condensed, which has the effect of providing visible steam. That is, simultaneous actuation of the nozzle 150, the heater 130 and the blower 140 is helpful to provide visible steam owing to creation of the relatively low temperature environment. Thus, the user can visually check the steam supplied through the steam supply operation S7 through the door glass 21. Allowing the user to visually check supply of steam may provide the user with product reliability.

[0170] Meanwhile, if the washing machine suitable for steam supply owing to employment of a steam supply mechanism can be previously prepared, the steam supply process P2; S5 to S7 may be more efficiently performed. Thus, pre-treatment operations for preparation of the above described washing machine will be described hereinafter. In the pre-treatment operations, the above described operations S5 to S7 as well as all other operations that will be described hereinafter, if they are described as performing or eliminating any functions, this basically means that implementation or elimination of the functions is maintained for a preset duration of the corresponding operation or for a partial duration of the corresponding operation. Likewise, the same logic is applied to a description in which elements associated with the functions are actuated or shut down. Also, if any functions and/or actuation of any elements are not mentioned in the following respective operations, this may mean that the functions are not performed and the elements are not actuated, i.e. are shut down in the corresponding operation. As mentioned above, the above described logic may be applied in common to all operations that are described in the present invention.

[0171] The pre-treatment operations that will be described hereinafter may include a voltage sensing operation S1, a heater cleaning operation S2, a residual water discharge operation S3, a preliminary heating operation S4, and a water supply amount judging operation S12. The operations S1, S2, S3, S4 and S12 may be performed in common before the steam supply process P2, or some of the operations S1, S2, S3, S4 and S12 may be selectively performed before the steam supply process P2. If at least two of the operations S1, S2, S3, S4 and S12 are performed before the steam supply process P2, the implementation sequence of the at least two pre-treatment operations may be changed according to an actuation environment of the washing machine.

[0172] In the following description, for convenience, the voltage sensing operation S1, the heater cleaning operation S2, and the residual water discharge operation S3 are defined as constituting a pre-treatment process P1, and the water supply amount judging operation S12 is defined as a check process P6.

[0173] First, as a pre-treatment operation, the duct 100 may be preliminarily heated before the preparation operation S5 (S4). The preliminary heating operation S4 may be performed via various methods, but may be performed via circulation of high temperature air within the duct 100 and the tub 30 connected to the duct 100. The air circulation may be easily achieved using the elements within the duct 100 that constitute the steam supply mechanism. For example, referring to FIGs. 17 and 18B, to circulate high temperature air, the blower 140 and the heater 130 may be actuated. If the heater 130 emits heat, the heat is transferred along the duct 100 by air flow generated by the blower 140. Through the heat transfer and air flow, the air and the elements within the duct 100 may be heated. More specifically, through the heat transfer and air flow, the duct 100 (including the steam supply mechanism), the tub 30 and the drum 40 as well as the interior air thereof may be heated. That is, differently from the preparation operation S5 in which local heating of the heater 130 is achieved using the heater 130, the preliminary heating operation S4 may achieve substantial heating of the entire washing machine including the duct 100 and the internal elements thereof as well as the tub 30 and the drum 40. Also, differently from the preparation operation S5 that adopts direct heating of the heater 130, the preliminary heating operation S4 may indirectly heat the entire washing machine using air circulation. As illustrated in FIGs. 17 and 18B, the blower 140 and the heater 130 may be continuously actuated for the duration of the preliminary heating operation S4. Meanwhile, as illustrated in FIG. 18A, the blower 140 may be actuated for an additional time (for example, 1 second in FIG. 18A) after the preliminary heating operation S4 begins. That is, the blower 140 may be actuated for a predetermined time (for example, 1 second) at the initial stage of the water supply amount judging operation S12 that will be described hereinafter.

[0174] As described above, since the entire duct 100 is primarily heated by the preliminary heating operation S4, it is possible to substantially prevent the steam provided by the steam supply process P2; S5 to S7 from being condensed in the duct 100 prior to reaching the tub 30 and the drum 40. Also, since the preliminary heating operation S4 attempts heating of the entire tub 30 and of the entire drum 40, it is possible to prevent condensation of the steam within the tub 30 and the drum 40. Accordingly, a sufficient amount of steam can be supplied without unnecessary loss, enabling effective implementation of desired functions. The preliminary heating
As described above, residual water of the washing machine, more particularly, within the duct 100, the tub 30 and the drum 40 may prevent effective implementation of desired functions caused by steam supply. The residual water may also cause sudden condensation of the supplied steam and may cause dried laundry to be wetted again. For these reasons, discharge of the residual water from the washing machine may be performed (S3). The discharge operation S3 may be performed at any time before the preparation operation S5. The water present in the washing machine may undergo heat exchange with high temperature air, which may deteriorate efficiency of the preliminary heating operation S4. Thus, the discharge operation S3, as illustrated in FIGs. 17 and 18A, may be performed before the preliminary heating operation S4. To perform the discharge operation S3, the drain pump 90 may be actuated. Once the drain pump 90 is actuated, the water within the tub 30 may be discharged outward from the washing machine through the drain hole 33b and the drain pipe 91. Also, to facilitate discharge of the water, circulation of unheated air may be performed during the discharge operation S3. To circulate the unheated air, only the blower 140 may be actuated for a predetermined time (for example, 3 seconds) without actuation of the heater 130 during the discharge operation S3 (see FIGs. 17 and 18A). In this case, the blower 140 is preferably actuated at the final stage of the discharge operation S3. That is, the blower 140 may begin to be actuated during actuation of the drain pump 90 in the discharge operation S3, and the discharge operation S3 ends as actuation of the drain pump 90 stops. During the air circulation, the unheated air, i.e. room-temperature air acts to transport the water present in the duct 100, the tub 30 and the drum 40 by circulating through the duct 100, the tub 30 and the drum 40, and finally to collect the water in the tub 30, more particularly, in the bottom of the tub 30. If the sump 33 is provided at the bottom of the tub 30 as illustrated in FIG. 2, the residual water may be collected into the sump 33. It is impossible to discharge the residual water from the duct 100 by only actuation of the drain pump 90. However, through use of the air circulation, even the water in the duct 100 can be transported and discharged. Thus, the residual water can be more effectively discharged via the air circulation. The discharge operation S3 may be performed, for example, for 15 seconds as illustrated in FIGs. 17 and 18A.

During repeated actuations of the washing machine, impurities, such as lint, etc. may stick to a surface of the heater 130. These impurities may prevent actuation of the heater 130. For this reason, cleaning of the surface of the heater 130 may be performed before the preparation operation S5 (S2). The cleaning operation S2 may be performed at any time before the preparation operation S5. However, the cleaning operation S2 is designed to use a predetermined amount of water for efficient and rapid cleaning of the heater 130, and may be performed before the discharge operation S2 to enable discharge of water used for cleaning as illustrated in FIGs. 17 and 18A. More specifically, to perform the cleaning operation S2, the nozzle 150 ejects a predetermined amount of water to the heater 130. If excess water is ejected to the heater 130, a great amount of water may remain in the duct 100, which may have a negative effect on the following operations as mentioned above. Thus, the nozzle 150 may intermittently eject water to the heater 130. For example, the nozzle 150 may eject water for 0.3 seconds and then, be shut down for 2.5 seconds. The ejection and shutdown of the nozzle 150 may be repeated, for example, four times. As a result of removing impurities from the heater 130 via the cleaning operation S2, stable actuation of the heater 130 in the following operations, more particularly in the steam supply process P2 may be achieved. Also, in the cleaning operation S2, the ejected water may serve to cool the entire heater 130. As such, the entire surface of the heater 130 may have a uniform temperature, which ensures more stable and effective actuation of the heater 130 in the following operations. Meanwhile, as described above, a great amount of steam is continuously supplied into the tub 30 in the steam supply process P2. Since the detergent box 15 is connected to the tub 30, some of the steam may leak from the washing machine through the detergent box 15. The discharged steam may burn the user and may deteriorate reliability of the washing machine. To prevent steam leakage, a predetermined amount of water is supplied into the detergent box 15 in the cleaning operation S2. More specifically, a valve connected to the detergent box 15 is opened for a short time (for example, 0.1 seconds), and thus water may be supplied into the detergent box 15. With the supplied water, the interior of the detergent box 15 and the tub 30 to each other are wetted. As such, the steam leaked from the tub 30 is condensed by moisture present in the interior of the connection pipe and the interior of the detergent box 15, which prevents leakage of steam from the detergent box 15. A great amount of water is used to clean the heater 130 and prevent leakage of steam as described above, and residue of the water may deteriorate efficiency of the following operations. Accordingly, even during the cleaning operation S2, as illustrated in FIGs. 17 and 18A, the drain pump 90 may be actuated to discharge the used water. Although actuation of the drain pump 90 in the cleaning operation S2 may be performed for at least a partial duration of the cleaning operation S2, preferably, the drain pump 90 is actuated for the duration of the cleaning operation S2. The cleaning operation S2 may be performed, for example, 12 seconds as illustrated in FIGs. 17 and 18A.

To realize more efficient control, voltage applied to the washing machine may be sensed (S1). Control based on the sensing of voltage will be described in more detail in the relevant part of the disclosure.
As described above, the operations S1 to S4 may create an ideal environment for the following operations S5 to S7, i.e. for the steam supply process P2. That is, the operations S1 to S4 function to prepare the steam supply process P2. Thus, as illustrated in Figs. 16, 17, and 18A, the operations S1 to S4 constitute a single functional process, i.e. the pre-treatment process P1. The pre-treatment process P1 creates an ideal environment for steam generation and steam supply, and is substantially an auxiliary process of the steam supply process P2. If the steam supply process P2 is independently applied to supply steam to a basic wash course or other individual courses except for the laundry refresh course as mentioned above, the pre-treatment process P1 may be selectively applied to these courses.

Meanwhile, steam supplied in the steam supply process P2 may serve to freshen laundry via wrinkle-free, static charge elimination and deodorization owing to a desired high temperature and high humidity thereof. Nevertheless, to maximize effects of the freshening function, certain post-treatments may be additionally required. Also, since the supplied steam provides laundry with moisture, for user convenience, a post-treatment to remove moisture from the freshened laundry may be required.

As such a post-treatment, a first drying operation S9 may first be performed after the steam supply operation S7. As known, a process of rearranging fibrous tissues is required to remove wrinkles. Rearrangement of fibrous tissues requires provision of a certain amount of moisture and slow removal of moisture in fibers for a sufficient time. That is, slow removal of moisture may ensure smooth restoration of deformed fibrous tissues to an original state thereof. If fibers are dried at an excessively high temperature, only moisture may be rapidly removed from fibers, which causes deformation of fibrous tissues. For this reason, to slowly remove moisture, the first drying operation S9 may dry laundry by heating the laundry at a relatively low temperature. That is, the first drying operation S9 may substantially correspond to low temperature drying.

Although the first drying operation S9 may be performed via various methods, it may be performed by supplying the slightly heated air, i.e. the relatively low temperature air into the drum 30 for a predetermined time. The supplied heated air may finally be supplied to laundry within the drum 40. The supply of heated air may be easily achieved using the elements within the duct 100 that constitute the steam supply mechanism. For example, referring to Figs. 17 and 18C, the blower 140 and the heater 130 may be actuated to supply heated air. If the heater 130 emits heat, the surrounding air is heated by the heat, and the heated air may be transported along the duct 100 by air flow provided by the blower 140. The heated air may reach laundry by the air flow through the drum 30 and the drum 40. If the heater 130 is continuously actuated, the temperature of the supplied air continuously rises, and thus it is difficult to keep the air at a relatively low temperature. Accordingly, to supply the air that is heated to a relatively low temperature, the heater 130 may be intermittently actuated. For example, the heater 130 may be actuated for 30 seconds and be shut down for 40 seconds, and the actuation and shutdown may be repeated. Additionally, to supply the air that is heated to a relatively low temperature, the temperature of the air or the heater 130 may be directly controlled. For example, the heater 130 may be actuated if the temperature of air in the duct 100 or the temperature of the heater 130 drops to a first set temperature. In this case, the first set temperature may be 57°C. Also, if the temperature of air within the duct 100 or the temperature of the heater 130 rises to a second set temperature, the heater 130 may be shut down. In this case, the second set temperature is higher than the first set temperature, and for example, may be 58°C. On the other hand, as described above, the temperature of air or the temperature of the heater 130 may be kept at the first set temperature or the second set temperature (for example, 57°C to 58°C) that is within a relatively low temperature range even by simple control of the heater 130 based on the temperature. As such, in addition to the simple control of the heater 130 based on the temperature, intermittent actuation of the heater 130 may not be forcibly performed. Also, the interior temperature of the tub 30 exceeds a room-temperature in the steam supply process P2, and the first drying operation S9 requires a relatively low temperature environment. Thus, as illustrated in Figs. 17 and 18C, actuation of the heater 130 may begin after the blower 140 is actuated for a predetermined time (for example, 3 seconds). That is, only the blower 140 is actuated for a predetermined time at the initial stage of the first drying operation S9, and thereafter the blower 140 and the heater 130 may be actuated simultaneously.

As the slightly heated air, i.e. the relatively low temperature air is supplied to laundry by the above described first drying operation S9, fibrous tissues of the laundry may be slowly dried and rearranged. Thus, restoration of laundry having no wrinkles may be achieved. The first drying operation S9 may be performed, for example, for 9 minutes and 30 seconds as illustrated in FIG. 18C to slowly dry laundry for a sufficient time.

Since the supplied steam causes the laundry to be wetted, it is necessary to completely remove moisture from the laundry. Accordingly, a second drying operation S10 is performed after the first drying operation S9. To remove moisture from the laundry within a short time, the second drying operation S10 may be performed to dry laundry to a high temperature, i.e. to at least a higher temperature than that in the first drying operation S9. That is, the second drying operation S10 may correspond to high temperature drying as compared to the first drying operation S9.

Although the second drying operation S10 may be performed via various methods, the second drying operation S10 may be performed by supplying air having a considerably high temperature into the tub 30. At least
the second drying operation S10 may supply air having a higher temperature than that in the first drying operation S9. For example, as illustrated in FIGs. 17 and 18C, similar to the first heating operation S9, the heater 130 and the heater 13 may be actuated to supply the heated air, i.e. the high temperature air. Differently from intermittent operation of the first drying operation S9, the heater 130 may be continuously actuated to continuously supply high temperature air. However, while the heater 130 is continuously actuated, the heater 13 may overheat. Thus, to prevent the heater 13 from overheating, the temperature of air or the temperature of the heater 130 may be directly controlled. For example, if the temperature of the air within the duct 100 or the temperature of the air or the temperature of the heater 130 may be shut down. On the other hand, if the temperature of the air within the duct 100 or the temperature of the heater 130 drops to a lower fourth set temperature (for example, 90°C) than the third set temperature, the heater 130 may again be actuated. The fourth set temperature is higher than the second set temperature and is lower than the third set temperature.

As the heated air, i.e. the high temperature air is supplied to laundry by the above described second drying operation S10, the laundry may be completely dried within a short time. The second drying operation S10 may be performed, for example, for a shorter time of 1 minute than that in the first drying operation S9 as illustrated in FIGs. 17 and 18C. That is, the duration of the first drying operation S9 is longer than the duration of the second drying operation S10.

As described above, the first and second drying operations S9 and S10 are associated with each other to provide a drying function as a post-treatment. Thus, as illustrated in FIGs. 16 and 17, these operations S9 and S10 constitute a single functional process, i.e. a drying process P4.

After the steam supply process P2 is completed, a great amount of steam is present within the washing machine. As the steam is condensed, a thin water membrane is easily evaporated and the resulting condensed water is collected. The condensed water is not easily evaporated differently from the water membrane. For this reason, the pause operation S8 may prevent reduction of drying efficiency. The pause operation S8 may be performed, for example, for 3 minutes (180 seconds) as illustrated in FIG. 18B. The pause operation S8 performs an independent function to remove the water membrane from the elements, i.e. to remove moisture, and thus may be referred to as a single moisture removal process P3 similar to the other processes as defined above.

As the heated air is supplied to laundry, the user cannot wear the dried laundry despite completion of removal of moisture from the laundry. For this reason, the laundry may be cooled after the second drying operation S10 (S11). More specifically, the cooling operation S11 may supply unheated air to the laundry. For example, as illustrated in FIGs. 17 and 18C, to provide unheated air, the blower 140 and the heater 130 in FIG. 17, the washing machine and the laundry may be cooled after the second drying operation S10 (S11). The unheated air, i.e. the room-temperature air is transported through the duct 100, the drum 40 and the drum 40 to thereby be finally supplied to the laundry. The supplied room-temperature air may serve to cool the laundry via heat exchange between the air and the laundry. As a result, the user can directly wear the freshened laundry, which increases user convenience. Also, the supplied room-temperature air may act to cool all the elements of the washing machine including the duct 100, the tub 30, and the drum 40 to some extent. This may also substantially prevent the user from burning. The cooling operation S11 may be performed, for example, for 8 minutes as illustrated in FIG. 18B. The cooling operation S11 performs an independent function, and thus may be referred to as a single cooling process P5 similar to the other processes as defined above. As necessary, as illustrated in FIG. 17, the washing machine and the laundry may be additionally subjected to natural cooling by room-temperature air for a predetermined time after the cooling operation S11.

The refresh course illustrated in FIG. 16 may be completed by continuously performing the operations S1 to S11. In consideration of functions, the steam supply process P2 may efficiently generate a sufficient amount of high-quality steam by optimally controlling the steam supply mechanism, thereby performing desired functions of the refresh course. As auxiliary processes of the steam supply process P2, the pre-treatment process P1 creates...
an ideal environment for steam generation and the moisture removal process P3 creates an ideal environment for drying. The drying and cooling processes P4 and P5 perform post-treatments such as drying and cooling. With appropriate association of these processes, the refresh course may effectively perform desired functions, such as wrinkle-free, static charge elimination, and deodorization.

Meanwhile, if the nozzle 150 is abnormally actuated or breaks down, the amount of water supplied to the heater 130 in the steam generation operation S6 of the steam supply process P2 may be less than a preset value, or the supply of water may stop. Differently from other elements, abnormal actuation or breakdown of the nozzle 150 may have a direct effect on the amount of water supplied into the duct 100, more specifically, the amount of water supplied into the heater 130 (hereinafter referred to as ‘water supply amount’), and therefore abnormal actuation or breakdown of the nozzle 150 may be judged by judging the water supply amount. For this reason, as illustrated in FIGs. 16 to 18C, the refresh course may further include an operation of judging the amount of water supplied to the heater 130 (S12). The refresh course including the water supply amount judging operation S12 will hereinafter be described with reference to FIGs. 16 to 20.

In the water supply amount judging operation S12, the amount of water ejected to the heater 130 through the nozzle 150 is judged. The water supply amount judging operation S12 enables direct measurement of the amount of water that is actually supplied. However, the direct measurement may require expensive devices and may increase manufacturing costs of the washing machine. Thus, the water supply amount judging operation S12 may be performed by judging only whether or not a sufficient amount of water is supplied to the heater 130. That is, the judging operation S12 may adopt an indirect method of judging the water supply amount. As described above in relation to the steam supply process P2, if water supplied from the nozzle 150 is changed into steam, this naturally raises the temperature of air within the duct 100. More specifically, if a preset amount of water is supplied, a sufficient amount of steam is generated and the temperature of air within the duct 100 may rise to a certain level. On the other hand, if the water supply amount is reduced or the supply of water stops, a lower amount of steam may be generated and the temperature of air may drop. In consideration of this result, there is a direct correlation between the water supply amount and an increase rate in the temperature of air within the duct 100. That is, a greater water supply amount causes a greater temperature increase rate, and a smaller water supply amount causes a smaller temperature increase rate. Thus, in the water supply amount judging operation S12 using the indirect judgment method, the amount of water supplied to the heater 130 may be judged based on a temperature increase rate within the duct 100 for a predetermined duration.

As described above, a temperature increase rate caused by steam generation is judged for indirect judgment of the water supply amount in the water supply amount judging operation S12. Thus, the judgment of the temperature increase rate essentially requires steam generation. For this reason, the water supply amount judging operation S12 may basically include steam generation. As known, when water is changed into steam, the volume of water greatly expands. Thus, the generated steam is naturally discharged from the space S occupied by the heater 130. For this reason, to accurately measure a temperature increase rate, the water supply amount judging operation S12 may measure and determine a temperature increase rate of air at a position close to the heater 130 for a predetermined time. In other words, the temperature increase rate of air discharged from the space S occupied by the heater 130 and is mixed with and heated by the discharged steam. As the discharged air and steam directly enter the discharge portion 110a of the duct 110, the temperature increase rate of air in the discharge portion 110a of the duct 110 may be measured in the water supply amount judging operation S12. That is, the discharge portion 110a substantially means a region behind the heater 130, and the temperature increase rate of air discharged rearward from the heater 130 may be measured in the water supply amount judging operation S12. To control drying of laundry, the discharge portion 110a may be equipped with a sensor that measures the temperature of circulating hot air. In this case, the sensor may be used in both the drying operations S9 and S10 (including a typical laundry drying operation) as well as in the water supply amount judging operation S12. Thus, the above described water supply amount judging operation S12 is very advantageous for reduction in the manufacturing costs of the washing machine. Moreover, the water supply amount judging operation S12 may be performed at any time during the refresh course. Also, since the steam generation operation S6 performs generation of steam required for measurement of the temperature increase rate, the water supply amount judging operation S12 may be performed in the steam generation operation S6 during the steam supply process P2. However, to rapidly and accurately judge abnormal actuation of the nozzle 150, the water supply amount judging operation S12 may be performed immediately before the steam supply process P2, i.e. immediately before the preparation operation S5 as illustrated in FIGs. 16, 17 and 18A.

The water supply amount judging operation S12 will hereinafter be described in more detail with reference
to FIG. 19 based on the above described basic concept.

As described above, the water supply amount is judged using the temperature increase rate of air due to steam generation. Therefore, in the water supply amount judging operation S12, first, steam is generated from the heater 130 within the duct 100 for a predetermined time. During steam generation, the heater 130 within the duct 100 is heated as described above in relation to the steam supply process P2 (S12a). Also, water is directly ejected to the heated heater 130 for a predetermined time (S12a). That is, the heating and supply operation S12a is similar to the preparation operation S5 and the steam generation operation S6 of the above described steam supply process P2. To perform the heating and supply operation S12a, as illustrated in FIGs. 17 and 18A, the heater 130 and the nozzle 150 may be actuated. As described above in relation to the preparation operation S5 and the steam generation operation S6, it is preferable to supply water after implementation of heating for a predetermined time, to achieve appropriate steam generation. That is, it is preferable that the nozzle 150 be actuated after the heater 130 is actuated for a predetermined time. However, to rapidly measure the temperature increase rate of air in the following operations, quick steam generation may be achieved. Accordingly, as illustrated in FIGs. 17 and 18A, actuation of the heater 130 and of the nozzle 150 simultaneously begin in the heating and supply operation S12a. The judg- operation S12a has no intention of supplying steam as in the steam supply process P2, and may not require actuation of the blower 140. The heating and supply operation S12a may be continued for the duration of the judging operation S12, and for example, may be performed for 10 seconds.

If the heating and supply operation S12a is performed, i.e. if steam generation begins, a first temperature may be measured (S12b). The first temperature corresponds to the temperature of air discharged rearward from the heater 130. In other words, the first temperature corresponds to the temperature of air that is present at the outside of the heater 130 and is mixed with and heated by the steam discharged from the heater 130. As described above, the first temperature may correspond to the temperature of air at the discharge portion 110a of the duct 100. The steam is generated as soon as the heating and supply operation S12a begins and is naturally discharged from the heater 130. Thus, the measurement operation S12b may be performed at any time after the heating and supply operation S12a begins. However, to achieve reliability in the measurement of the temperature increase rate, the measurement operation S12b is preferably performed immediately after implementation of the heating and supply operation S12a, i.e. immediately after steam generation. Meanwhile, the gener- amount of steam is not great at the initial stage of the heating and supply operation S12a, and smooth dis- charge of steam from the space S occupied by the heater 130 may not be achieved. Thus, as illustrated in FIG. 18A, the blower 140 may be actuated for at least a partial duration of the heating and supply operation S12a corre- responding to the steam generation operation. In this case, the blower 140 is preferably actuated at the initial stage of the heating and supply operation S12a. For example, the blower 140 may be actuated for a short time (for example, 1 second) at the initial stage of the heating and supply operation S12a. The steam may be smoothly discharged from the heater 130 at the initial stage of the heating and supply operation S12a by the air flow provided by the blower 140. As such, the heater 130, the blower 140 and the nozzle 150 are simultaneously actu- ated for a predetermined time at the initial stage of the heating and supply operation S12a, and thereafter actuation of the blower 140 stops and only the heater 130 and the nozzle 150 are actuated.

After completion of the measurement operation S12b, a second temperature, which is the temperature of air discharged rearward from the heater 130 after a predetermined time has passed, is measured (S12c). That is, after the first temperature has been measured and the predetermined time has passed, the second temperature is measured. The air, which is a measurement object in the measurement operation S12c, is equal to the air as described above in relation to the measurement operation S9b.

After completion of the measurement operation S12c, the temperature increase rate may be calculated from the measured first and second temperatures (S12d). In general, the temperature increase rate may be acquired by subtracting the first temperature from the second temperature. The temperature increase rate of air discharged from the heater 130 for the predetermined time may be determined by the above described operations S12b to S12d.

Thereafter, the calculated temperature increase rate may be compared with a predetermined reference value (S12e). If the calculated temperature increase rate is less than a predetermined reference value in the comparison operation S12e, this means that the temperature increase is not sufficient. The result also means that the water supply amount is less than a predetermined value, and thus means that a sufficient amount of water is not supplied or supply of water stops, and thus a suffi- cient amount of steam is not generated. Accordingly, it may be judged that an insufficient amount of water less than a predetermined value is supplied if the calculated temperature increase rate is less than a predetermined reference value (S12f). On the other hand, if the calculated temperature increase rate is equal to or greater than the predetermined reference value in the comparison op- eration S12e, this means that the temperature increase is sufficient. The result also means that the water supply amount exceeds a predetermined value, and thus a suf- ficient amount of water is not supplied and a sufficient amount of steam is generated. Accordingly, it may be judged that a sufficient amount of water that is at least greater than a predetermined value is supplied if the calculated temperature increase rate is equal to or greater
than the reference value (S12g). In the comparison and
judging operations S12f and S12g, the predetermined
reference value may be experimentally or analytically ac-
quired, and may be, for example, 5°C.

If it is judged in the judging operation S12g that a
sufficient amount of water greater than a predetermined
value is supplied, normal actuation of the nozzle 150 with-
out breakdown may be judged.

Meanwhile, if it is judged in the judging opera-
tion S12e that a sufficient amount of water greater than
a predetermined value is supplied, a first algorithm to
generate and supply steam into the tub 30 may be per-
formed. In addition, if it is judged in the judging operation
S12e that a sufficient amount of water less than the pre-
determined value is supplied, a second algorithm having
no steam generation may be performed.

The first algorithm includes a steam algorithm
to supply steam into the tub 30, and a drying algorithm
to supply hot air into the tub 30. In this case, the steam
algorithm includes the above described steam supply
process P2, and the drying algorithm includes at least
one of the above described first and second drying op-
erations, and preferably includes both the first and sec-
ond drying operations. The second algorithm include at
least one of third and fourth drying operations that will be
described hereinafter, and preferably includes both the
third and fourth drying operations.

If it is judged in the judging operation S12e of
the water supply amount judging operation S12 that a
sufficient amount of water greater than the predeter-
dined value is supplied, as illustrated in FIG. 19, the pre-
paration operation S5 may be performed in succession.
That is, the steam supply process P2 may be performed.
Then, a set of the operations S5 to S7, i.e. the steam
supply process P2 may be repeated preset times.

After completion of the water supply amount
judging operation S12 using steam, a great amount of
steam is present within the duct 100. The steam may be
condensed at the surface of the elements within the duct
100, thereby preventing actuation of these elements. In
particular, the condensed water may prevent actuation
of the heater 130 during the steam supply process P2.
For this reason, actuation of the washing machine is
paused for a predetermined time after the water supply
amount judging operation S12 and before implementa-
tion of the first algorithm or the second algorithm (S13).
That is, the pause operation S13 is performed between
the water supply amount judging operation S12 and the
preparation operation S5 of the first algorithm. As illus-
trated in FIGs. 17 and 18B, actuations of all the elements
of the washing machine except for the drum 40 and the
motor for rotation of the drum 40 temporarily stops during
the pause operation S13. Thus, the condensed water on
the elements within the duct 100 including the heater 130
may be evaporated or naturally drops from these ele-
ments by the weight thereof. For this reason, the ele-
ments within the duct 100 including the heater 130 may
be normally actuated in the following operations. As il-

If it is judged in the judging operation S12e of
the water supply amount judging operation S12 that an
sufficient amount of water less than a predetermined
value is supplied (S12f), the steam supply process P2
insufficient amount of water less than a predetermined
pressure of water supplied to the nozzle 150 is abnor-
down of the nozzle 150 may be judged. The abnormal
actuation of the nozzle 150 may be caused by various
reasons, and for example, includes the case in which the
pressure of water supplied to the nozzle 150 is abnor-
mal low. The abnormal actuation or breakdown of the
nozzle 150, as mentioned above, may cause the heater
130 to overheat and damage to the washing machine.
Accordingly, if it is judged that a sufficient amount of water
is not supplied as in the judging operation S12f, actuation
of the washing machine may stop for the reason of safety.
Nevertheless, the refresh course may perform desired
functions even in the abnormal state. In particular, if the
nozzle 150 can function to supply water although the wa-
ter supply amount is small, the refresh course may be
modified to perform desired functions. To this end, FIG.
20 illustrates alternative operations.

As illustrated in FIG. 20, if it is judged that an
insufficient amount of water less than a predetermined
value is supplied (S12f), the steam supply process P2
may not longer be performed or repeated. That is, addi-
tional generation and supply of steam stops. Instead, the
second algorithm is performed. The second algorithm is
an algorithm having no steam generation and includes a
third drying operation S14. Since removal of wrinkles may
be the most important function in the refresh course, the
third drying operation S14 may remove wrinkles. As de-
scribed above, slow removal of moisture may ensure
smooth restoration of deformed fibrous tissues to an orig-
inal state thereof. If fiber is dried at an excessively high
temperature, only moisture may be rapidly removed from
fibers without removal of wrinkles. For this reason, to
slowly remove moisture from laundry, the third drying operation S14 may dry laundry by heating the laundry at a relatively low temperature. That is, the third drying operation S14 may correspond to low temperature drying similar to the first drying operation S9.

[0207] The third drying operation S14 may be performed by supplying the slightly heated air, i.e. the relatively low temperature air into the tub 30 for a predetermined time. To supply the heated air, the blower 140 and the heater 130 may be actuated. Also, to supply the slightly heated air, i.e. the relatively low temperature air, the heater 130 may be intermittently actuated (S14a). For example, the heater 130 may be actuated for 40 seconds and be shut down for 30 seconds, and the actuation and shutdown may be repeated. Additionally, since the third drying operation S10 is performed in a state in which high temperature steam is not supplied, the temperature of laundry and the temperature of the surrounding air in the third drying operation S10 are lower than those in the first drying operation S9. Accordingly, despite intermittent actuation of the same heater 130, the heater actuation time (40 seconds) in the drying operation S14 is set to be longer than the heater actuation time (30 seconds) in the first drying operation S9.

[0208] Similarly, stopping the steam supply process P2 may not provide a sufficient amount of moisture to laundry in the third drying operation S14. However, as described above, even in the first drying operation S9, it is advantageous to supply a predetermined amount of moisture and remove the supplied moisture for effective removal of wrinkles. For this reason, moisture may be supplied to the laundry in the third drying operation S14 (S14b). Supply of moisture to the laundry may be achieved by various ways. For example, vapor phase water or liquid water may be supplied to the laundry. However, as mentioned above, it is difficult to supply steam as vapor phase water in the third drying operation S14. On the other hand, mist, which consists of small particles of liquid water, is sufficiently effective to supply moisture to the laundry. Thus, mist may be supplied to the laundry in the moisture supply operation S14b. That is, the mist may be supplied into the tub 30 so as to be supplied to at least the laundry. Supply of mist may be achieved by various ways. For example, if the nozzle 150 can still be actuated although it is in an abnormal state, i.e. if the nozzle 150 can still supply a small amount of water, the nozzle 150 may eject mist. The air flow may continuously occur in order to supply heated air to laundry during the third drying operation S14. That is, the blower 140 may be continuously actuated during the third drying operation S14. Accordingly, the mist ejected from the nozzle 150 may be transported by the air flow provided by the blower 140 and may reach laundry by way of the duct 100, the tub 30, and the drum 40. The greater part of the ejected mist may be changed into steam while passing through the heater 130, which ensures effective implementation of desired functions of the refresh course. As a warning for the case in which the nozzle 150 completely breaks down, the washing machine may be equipped with a separate device to directly supply moisture to laundry, more particularly, to eject mist. The separate device may be actuated along with or independently of the nozzle 150. The mist supplied by the separate device may be at least partially changed into steam by a high temperature environment within the tub 30. Moreover, the nozzle 150 and the separate device may directly supply liquid water, instead of mist, to supply moisture to laundry.

[0209] The moisture supply operation S14b may begin at any time during the third drying operation S14. However, supplying moisture under a high temperature environment is basically advantageous to the following operation of removing the supplied moisture. Also, it is preferable that mist be ejected as a high temperature as possible in order to partially change the supplied mist into steam. Accordingly, the moisture supply operation S14b may be performed during heating of air to be supplied to laundry. That is, in the moisture supply operation S14b, moisture may be supplied during actuation of the heater 130 when the heater 130 is intermittently actuated. That is, through intermittent actuation of the heater 130, the third drying operation S14 includes an actuation duration for actuation of the heater 130 and a shutdown duration for shutdown of the heater 130. In this case, the moisture supply operation S14b may be performed for the actuation duration of the heater 130. Moreover, to achieve more reliable effects, the moisture supply operation S14b may be performed only while the air supplied to laundry is heated. That is, in the moisture supply operation S14b, moisture may be supplied only for actuation of the heater 130 as the heater 130 is intermittently actuated. More specifically, the moisture supply operation S14b is preferably performed for 40 seconds, for which the heater 130 is actuated. More preferably, the moisture supply operation S14b is performed for a partial duration of the final stage (for example, the last 10 seconds) of the actuation duration of the heater 130, for which the highest temperature environment can be generated. If excess moisture is supplied, this causes laundry to be wetted rather than removing wrinkles from laundry. Accordingly, the moisture supply operation S14b is performed only for a partial duration of the third drying operation S14. For the same reason, preferably, the moisture supply operation S14b is performed only for the first half of the third drying operation S14. The third drying operation S14 is performed in a state in which high temperature steam is not supplied, and may be performed, for example, for 20 minutes to achieve a sufficient time for removal of wrinkles. The duration of the third drying operation S14 is set to be longer than that of the similar first drying operation S9. The moisture supply operation S14b may be performed for the first half of the third drying operation S14 of 20 minutes, i.e. for 11 minutes after the third drying operation S14 begins.

[0210] It is necessary to remove moisture from laundry as the laundry is wetted by the supplied moisture. Accordingly, the second algorithm includes a fourth drying
operation S15 that is performed after the third drying operation S14. The fourth drying operation S15 may be substantially equal to the above described second drying operation S10 in terms of functions and detailed operations. Accordingly, all features discussed in relation to the second drying operation S10 may be directly applied to the fourth drying operation S15, and thus an additional description thereof will be omitted.

The above described third and fourth drying operations S14 and S15 are associated with each other to perform the freshening function when supply of steam is impossible and to provide the drying function. Accordingly, as illustrated in FIG. 20, the operations S14 and S15 may constitute a single functional process, i.e. a drying and refresh process P7.

Since the laundry having passed through the above described drying operations have a high temperature due to the heated air, the laundry may be cooled after the fourth drying operation S15 (S16). The cooling operation S16 may be substantially equal to the above described cooling operation S11 in terms of functions and detailed operations thereof. Accordingly, all the features discussed in relation to the cooling operation S11 may be directly applied to the cooling operation S16. Thus, an additional description thereof will be omitted hereinafter. The cooling operation S16 also performs an independent function, and may be referred to as a single cooling process P8 similar to the previously defined processes. As necessary, as illustrated in FIG. 17, natural cooling of the laundry and the washing machine may be additionally performed by room-temperature air after the cooling operation S16.

The refresh course as illustrated in FIG. 20 includes modified operations S14 to S16 to perform desired functions even when sufficient supply of steam or steam supply itself is impossible. In the modified refresh course, instead of the steam, mist may be supplied to laundry for supply of required moisture. Also, in the modified refresh course, steam may be partially supplied. Moreover, static charge elimination as well as wrinkle-free may be achieved via appropriate actuation of the related elements. Accordingly, even when supply of steam stops, the modified refresh course may perform optimized control of the elements of the washing machine, thereby realizing desired freshening functions.

Laundry may be tumbled in at least any one of the above described operations S1 to S13. For the laundry tumbling, as illustrated in FIGs. 17 and 18A to 18C, the drum 40 may be rotated. For example, the drum 40 may be continuously rotated in a given direction, and laundry is lifted to a predetermined height by lifters provided at the drum 40 and thereafter drops down, and this laundry movement is repeated. That is, the laundry is tumbled. Since the drum 40 and the laundry within the drum 40 have a great weight, they are greatly affected by inertia. Thus, rotation of the drum 40 does not require continuous supply of power by the motor. Even if the motor is shut down, rotation of the drum 40 and the laundry dry may be continued for a predetermined time by inertia. Accordingly, the motor may be intermittently actuated during rotation of the drum 40. For example, as illustrated in FIGs. 17 and 18A to 18C, the motor may be driven for 16 seconds and then be shut down for 4 seconds to reduce power consumption. Rotation of the drum 40 may ensure effective tumbling of laundry and effective implementation of desired functions in the respective operations S1 to S13. As such, tumbling of the laundry, i.e. rotation of the drum 40 may be continuously performed during all the operations S1 to S13. Moreover, tumbling of laundry may be directly applied even to the operations S14 to S16 for the above described modified refresh course. Also, so long as effective tumbling of the laundry is possible, other motions of the drum 40 may be applied. For example, instead of the above described tumbling, the drum 40 may be rotated in a given direction for a predetermined time and then is rotated in an opposite direction, and this rotation set may be continuously repeated. In addition, other motions may be applied as necessary.

In general, power of standard voltage is supplied at home and various electronic appliances including the washing machine are fabricated to match the standard voltage. However, voltage of power supplied at home has a slight deviation with respect to the standard voltage. Moreover, voltage of supplied power may be varied whenever the washing machine is actuated, and thus the deviation may also vary. The slight deviation has an effect on actuation of the washing machine, and in particular has an effect on performance of the heater 130 that uses electric power. More specifically, the heater 130 generates heat using electric resistance, and the electric resistance is affected by voltage of supplied power. Accordingly, if voltage of supplied power varies, this has an effect on the actual amount of heat generated by the heater 130. That is, if voltage of power greater than the standard voltage is supplied for a unit time, the heater 130 may generate greater heat than the expected amount of heat for a unit time. Also, if voltage of power less than the standard voltage is supplied for a unit time, the heater 130 may generate less heat than the expected amount of heat for a unit time. However, as described above, supply of heat using the heater 130, i.e. the preparation operation S5 is basically set to a preset duration, i.e. a fixed duration. In this case, if voltage of power greater than the standard voltage is supplied to the washing machine when the washing machine begins at least implementation of the refresh course of FIG. 16, the heater 130 generates greater heat than the expected amount of heat during the preparation operation S5. Thus, with the great voltage, the heater 130 may overheat, and when the heater 130 repeatedly overheats, this may cause damage to the heater 130 and fire. On the other hand, if voltage of power less than the standard voltage is supplied to the washing machine when the washing machine begins to be actuated, the heater 130 generates less heat than the expected amount of heat during the prep-
aration operation S5. As such, a sufficient amount of heat may not be supplied during the preparation operation S5, and thus a desired amount of steam may not be generated. As will be used for all general control, the implementation time of the preparation operation S5 is preset based on typical performance of the heater 130. However, if power having different voltage from the standard voltage is supplied to the washing machine, the heater 130 may be actuated based on the changed performance, which may make it difficult for the heater 130 to achieve desired performance from the preparation operation S5 during the preset implementation duration. Thus, in consideration of the actual voltage of power supplied to the washing machine, at least the preparation operation S5 may be require additional control. Control of the preparation operation S5 in consideration of voltage may be achieved via various methods. However, a total amount of heat supplied by the heater 130 during the preparation operation S5 may simply depend on the duration of the preparation operation S5, i.e. the implementation time of the preparation operation S5. Accordingly, even if performance of the heater 130 is changed by the supplied power, change of the performance and change of the amount of heat to be supplied may be appropriately adjusted by varying the implementation time. For this reason, as illustrated in FIGs. 16 and 21 to 22B, the refresh course of the present invention may additionally include an adjustment operation of changing the implementation time of the preparation operation S5 based on the actual voltage of power supplied to the washing machine. The adjustment operation S100 is preferably performed before the steam generation process P2 as a part of the pre-treatment process P1.

As described above, in the refresh course, since the preparation operation S5 is basically set to have a fixed implementation time, the adjustment operation S100 changes the preset implementation time of the preparation operation S5 based on the actual voltage of power supplied to the washing machine. Similarly, as described above, a main function of the preparation operation S5 heats the heater 130. To this end, the preparation operation S5 depends on the heater 130. Thus, the implementation time of the preparation operation S5 corresponds to the actuation time of the heater 130. For the same reason, the adjustment operation S100 may correspond to an operation of adjusting the actuation time of the heater 130. Meanwhile, the preparation operation S5 is divided into first and second heating operations S5a and S5b. The first heating operation S5a is basically performed for 13 seconds that corresponds to the greater part of the actuation time of the preparation operation S5. In the first heating operation S5a, only the heater 130 is heated without supply of water and occurrence of air flow (without actuation of the nozzle 150 and the blower 140). That is, only the heater 130 is purely actuated for heating during the first heating operation S5a. Thus, the first heating operation S5a determines main performance of the preparation operation S5 and is the most sensitive to change in the performance of the heater 130. For this reason, the adjustment operation S100 may adjust the implementation duration of the first heating operation S5a. That is, the adjustment operation S100 may be explained as an operation of adjusting a partial duration of the preparation operation S5 that is performed without supply of water and occurrence of air flow (i.e. the time of the heating operation S5a). On the other hand, the adjustment operation S100 may be explained as an operation of adjusting the time for which only the heater 130 is actuated (i.e. the first heating operation S5a). However, although the first heating operation S5a is a part of the preparation operation S5, if the implementation time of the first heating operation S5a is adjusted, the implementation of the preparation operation S5 is also adjusted. Thus, in the adjustment operation S100, adjustment of the implementation time of the first heating operation S5a corresponds to adjustment of the implementation time of the preparation operation S5. As such, if the implementation time of the adjustment operation S100 is adjusted, thereafter, the preparation operation S5, i.e. the first heating operation S5a is performed for the adjusted implementation time.

The adjustment operation S100 will hereinafter be described in more detail with reference to FIGs. 21 to 22B based on the above described basic concept.

Referring to FIG. 21, as described above, first, the actual voltage of power supplied to the washing machine may be measured (S110). The voltage measurement operation S110, as illustrated in FIG. 16, is equal to the voltage sensing operation S1. As described above in relation to the sensing operation S1, the voltage measurement operation S110 is performed for control based on the actual voltage. The voltage measurement operation S110 may be performed via various methods. However, if a separate measurement device is installed for voltage measurement, this may increase manufacturing costs of the washing machine. However, the controller of the washing machine has a resistor in a circuit thereof, and an actual voltage value of the supplied power may be conveniently measured using the resistor.

If other elements are actuated during the voltage measurement operation S110, power consumption occurs during actuation, and therefore it is difficult to measure the actual voltage of the supplied power. As illustrated in FIGs. 17 and 18A, the voltage measurement operation S110 (i.e. the operation S1) is performed in a state in which actuation of all the elements of the washing machine (including the heater 130, the nozzle 150, and the blower 140) stops. The voltage measurement operation S110 may be performed at any time before the preparation operation S5, the implementation time of which is adjusted by the adjustment operation S100. However, to ensure accurate voltage measurement without interference by actuation of other elements, the voltage measurement operation S110 is preferably performed as soon as the refresh course begins, i.e. before the cleaning operation S2 (see the sensing operation S1). Separately
from the voltage measurement operation S110, the following operations of the adjustment operation S100 may be performed at any time before the preparation operation S5. However, preferably, the following operations may be performed immediately after the voltage measurement operation S110. The voltage measurement operation S110 may be performed, for example, for 3 seconds as illustrated in FIG. 18A.

[0220] After completion of the voltage measurement operation S110, the measured voltage may be compared with the standard voltage of the supplied power (S121). The standard voltage is preset on a per country basis, and all electronic appliances including the washing machine are designed and controlled based on the standard voltage. The standard voltage is 220V in Korea and 110V in the Americas.

[0221] The actual implementation time of the preparation operation S5 may be determined based on the comparison result of the comparison operation S121.

[0222] If the measured voltage is less than the standard voltage, a sufficient amount of heat may not be supplied to the heater during the preparation operation S5 even when the preparation operation S5, more specifically, the first heating operation S5a is performed for a preset time. Thus, the refresh course may fail to generate a sufficient amount of steam for laundry freshness. Accordingly, if the measured voltage is less than the standard voltage, the implementation time of the preparation operation S5 may be increased (S131a). In the increase operation S131a, as mentioned above, the implementation time of the first heating operation S5a may be increased. Increase in the implementation time of the first heating operation S5a may be adjusted in consideration of a difference between the actual voltage and the standard voltage. On the other hand, the implementation time of the first heating operation S5a may be increased by a predetermined degree regardless of the magnitude of the difference between the actual voltage and the standard voltage. Meanwhile, if the measured voltage is equal to the standard voltage, the preparation operation S5, more particularly, the first preparation operation S5 may be performed for a preset time.

[0223] Despite the fact that the measured voltage is greater than the standard voltage, if the preparation operation S5, more specifically, the first heating operation S5a is performed for a preset time, the heater 130 may overheat, or damage to the heater 130 may occur, and moreover fire may occur. Thus, if the measured voltage is greater than the standard voltage, the implementation time of the preparation operation S5 may be reduced (S131b). In the reduction operation S131b, as mentioned above, the implementation time of the first heating operation S5a may be reduced. Reduction in the implementation time of the first heating operation S5a may be adjusted in consideration of an actual difference between the actual voltage and the standard voltage. The implementation time of the first heating operation S5a may be reduced by a predetermined degree regardless of the difference between the actual voltage and the standard voltage.

[0224] As described above, in the increase and reduction operations S131a and S131b, the implementation time of the preparation operation S5 is determined based on the result of the comparison operation S121.

[0225] As mentioned above, in consideration of the actual magnitude of the difference between the actual voltage and the standard voltage, the implementation time of the preparation operation S5 may be more accurately and appropriately adjusted. For example, if the difference between the actual voltage and the standard voltage is large, the implementation time of the preparation operation S5 may be greatly adjusted, i.e., may be greatly increased or reduced based on the difference, and vice versa. To achieve more accurate adjustment, the adjustment operation S100 as illustrated in FIGs. 22A and 22B may be applied. The adjustment operation S100 basically uses a table as illustrated in FIG. 22B. In the table of FIG. 22B, the implementation time of an ideal heating operation, more specifically, of the first heating operation S5a is preset based on the range of voltages analytically and experimentally measured in the table of FIG. 22B. The table of FIG. 22B is previously made and is stored in a storage device of the controller (for example, in a memory) to allow the user to refer to the table as necessary. The table of FIG. 22B is made in consideration of the actual difference between the actual voltage and the standard voltage by setting a plurality of voltage ranges and enables more accurate and detailed adjustment of the implementation time by assigning different implementation times to the respective voltage ranges.

[0226] Referring to FIG. 22A, similarly, the actual voltage of power supplied to the washing machine may be measured (S110). The voltage measurement operation S110 is equal to the above described measurement operation of FIG. 21 in all terms, and an additional description thereof will be omitted hereinafter.

[0227] After completion of the voltage measurement operation S110, the implementation time corresponding to the measured voltage is checked from the table (S122). In the check operation S122, the controller first searches for the range including the measured voltage from the table of FIG. 22B, and thereafter reads the implementation time of the corresponding heating operation, i.e., of the first heating operation S5a. Thereafter, the checked implementation time is set to the implementation time of the actual heating operation, i.e., of the first heating operation S5a by the controller (S132). As represented by the arrows in the table of FIG. 22B, the standard implementation time of 13 seconds is directly assigned to the standard voltage range of 225V to 234V. Here, the standard implementation time is preset based on the standard voltage as illustrated in FIG. 18B. On the other hand, as the measured voltage becomes less than the standard voltage, i.e., as the voltage range is reduced, the assigned implementation time of the first heating operation is gradually increased. Also, as the measured voltage becomes...
greater than the standard voltage, the assigned implementation time of the first heating operation is gradually reduced. Thus, similar to the operations S131a and S131b, even in a series of the check and setting operations S122 and S132, the implementation time of the preparation operation S5 is increased or reduced if the measured voltage is less than or greater than the standard voltage.

Accordingly, even if power of voltage less than the standard voltage is supplied and the heater 130 generates less heat than the expected amount of heat, a sufficient amount of heat for generation of a desired amount of steam may be supplied by increasing the implementation time of the operations S131a and S122/S132. Also, even if power of voltage greater than the standard voltage is supplied and the heater 130 generates greater heat than the expected amount of heat, it may be possible to prevent the heater 130 from overheating, or damage to the heater 130 by reducing the implementation time of the operations S131a and S122/S132. As such, even if performance of the heater 130 is changed by the actual voltage of the supplied power, change of the performance and change in the amount of heat may be appropriately adjusted by the adjustment operation S100 as illustrated in FIGs. 21 to 22B. For this reason, with the adjustment operation S100, the refresh course may generate a sufficient amount of steam without a risk of breakdown regardless of change in the voltage of the supplied power, and moreover, may improve the performance and reliability of the washing machine.

As described above, the implementation time of the preparation operation S5 may be increased or reduced by the adjustment operation S100, and the adjusted preparation operation S5 is repeated as the steam supply process P2 is repeated. As the implementation time of the preparation operation S5 is repeatedly increased or reduced by the adjustment operation S100 within the steam supply process P2, the entire variable time is amplified, and thus the time of the refresh course greatly varies. However, the great variation of the time may confuse the user. For this reason, the adjustment operation S100 may further include adjusting the time of the refresh course to a constant value based on the adjusted implementation time of the heating operation. The time of the refresh course may be adjusted by adjusting several operations except for the preparation operation S5, i.e. the first heating operation S5a. In particular, the pause operation S8 has a longer implementation time than other operations, and therefore is suitable for adjustment of the time of the refresh course. Accordingly, the adjustment operation S100 may further include adjusting the implementation time of the pause operation S8 based on the adjusted implementation time of the heating operation (S140).

The implementation time of the pause operation S8 is increased if the actual voltage is greater than the standard voltage, and is reduced if the actual voltage is less than the standard voltage.

In the adjustment operation S140, as illustrated in FIG. 21, if the implementation time of the preparation operation S5, i.e. of the first heating operation S5a is increased, the implementation time of the pause operation S8 may be reduced (S140a). If the implementation time of the preparation operation S5, i.e. of the first heating operation S5a is reduced, the implementation time of the pause operation S8 may be increased (S140a). Also, in the adjustment operation S140 of FIG. 22A, if the range including the measured voltage is searched from the table of FIG. 22B in the check operation S122, along with the implementation time of the heating operation assigned to the corresponding range, the implementation time of the pause operation S8 is read by the controller, and may be set to the actual implementation time of the pause operation S8. As illustrated in the table of FIG. 22B, in consideration of the increased or decreased implementation time of the first heating operation S5a and repeated implementations of the first heating operation S5a, the implementation time of the pause operation S8 is also set to be sufficiently increased or reduced. More specifically, as illustrated in the table of FIG. 22B, the implementation time of the pause operation S8 is reduced as the implementation time of the first heating operation S5a is increased, and is increased as the implementation time of the first heating operation S5a is reduced. That is, the adjustment operation S140 of FIG. 22A further includes adjusting the implementation time of the pause operation S8 similar to the operations S141a and S141b of FIG. 21.

In this case, the increased time (or the reduced time) of the pause operation S8 preferably corresponds to the reduced time (or the increased time) of the preparation operation S5. Thus, the sum of the variable implementation time of the pause operation S8 and the variable implementation time of the preparation operation S5 preferably has a constant value. Thus, the implementation time of the refresh course may be kept constant, which may provide the user with actuation reliability in the actuation time of the washing machine.

As described above, with the adjustment operation S140, the refresh course may always be performed for a constant time regardless of adjustment of the implementation of the heating operation, which may increase user convenience and reliability of the refresh course.

Meanwhile, the steam supply process P2: S3 to S5, as discussed above, may be directly applied to a basic wash course or other individual courses except for the refresh course owing to independent steam generation and supply functions thereof. FIG. 23 illustrates a basic wash course to which the steam supply process is applied. Functions of the steam supply process in the basic wash course will hereinafter be described by way of example with reference to FIG. 23.

In general, the wash course may include a wash water supply operation S100, a washing operation S200, a rinsing operation S300, and a dehydration operation.
S400. If the washing machine has a drying structure as illustrated in FIG. 2, the wash course may further include a drying operation S500 after the dehydration operation S400.

[0236] If the steam supply process is performed before the wash water supply operation S100 and/or during the wash water supply operation S100 (P2a and P2b), laundry may be previously wetted by supplied steam, and supplied wash water may be heated. If the steam supply process is performed before the washing operation S200 and/or during the washing operation S200 (P2c and P2d), supplied steam serves to heat air and wash water within the tub 30 and the drum 40, thereby creating a high temperature environment advantageous to washing. If the steam supply process is performed before the rinsing operation S300 and/or during the rinsing operation S300 (P2e and P2f), supplied steam similarly serves to heat air and rinse water so as to facilitate rinsing. If the steam supply process is performed before the dehydration operation S400 and/or during the dehydration operation S400 (P2g and P2h), supplied steam mainly serves to sterilize laundry. If the steam supply process is performed before the drying operation S500 and/or during the drying operation S500 (P2i and P2j), supplied steam serves to greatly increase the interior temperature of the tub 30 and of the drum 40, thereby causing easy evaporation of moisture from laundry. As necessary, to finally sterilize laundry, the steam supply process P2k may be performed after the drying operation S500. The above described steam supply process P2a to P2j basically functions to sterilize laundry using steam. Moreover, to assist the steam supply process, the preparation process P1 may also be performed.

[0237] As described above, the steam supply process P2 according to the present invention may create an atmosphere advantageous to washing by supplying a sufficient amount of steam, which may result in a considerable improvement of washing performance. Further, the steam supply process P2 may realize sterilization of laundry, and for example, may eliminate allergens.

[0238] In consideration of the above described steam supply mechanism, refresh course and basic washing course, the washing machine according to the present invention utilizes a high temperature air supply mechanism, i.e. a drying mechanism for steam generation and steam supply with only minimum modifications. The control method of the present invention, in particular, the steam supply process P2 provides optimized control of the drying mechanism, i.e. a modified steam supply mechanism. Accordingly, the present invention achieves minimum modification and optimized control for efficient generation and supply of a sufficient amount of high quality steam. For this reason, the present invention effectively provides laundry freshening and sterilization effects, improved washing performance, and various other functions with minimized increase in manufacturing costs.

[0239] It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

Claims
1. A control method of a laundry machine, the method comprising:
   a preparation operation of heating a heater arranged within a duct;
   a steam generation operation of generating steam by directly supplying water to the heater; and
   a steam supply operation of supplying the generated steam into a tub and/or drum, wherein the method further comprises an adjustment operation of varying implementation time of the preparation operation based on actual voltage of power supplied to the laundry machine.

2. The control method according to claim 1, wherein the implementation time of the preparation operation is varied by adjusting actuation time of the heater.

3. The control method according to claim 1 or 2, wherein in the preparation operation includes:
   performing first heating to heat the heater; and
   performing second heating to heat the heater while actuating a blower installed in the duct, wherein the implementation time of the preparation operation is varied by varying implementation time of the first heating.

4. The control method according to claim 3, wherein the first heating is performed without actuation of a nozzle and/or a blower, and/or wherein the second heating is performed for a fixed time.

5. The control method according to any one of claims 1 to 4, wherein the adjustment operation includes:
   measuring the actual voltage of power supplied to the laundry machine;
   comparing the measured actual voltage with standard voltage of the supplied power; and
   determining actual implementation time of the preparation operation based on the comparison result.

6. The control method according to claim 5, wherein the measurement is performed before the prepara-
tion operation, and/or wherein actuation of the heater, a nozzle, and/or a blower arranged in the duct stops during the measurement.

7. The control method according to any one of claims 5 or 6, wherein the adjustment operation includes reducing the implementation time of the preparation operation if the actual voltage is greater than the standard voltage, and increasing the implementation time of the preparation operation if the actual voltage is less than the standard voltage.

8. The control method according to any one of claims 1 to 4, wherein the adjustment operation includes:

   - measuring the actual voltage of power supplied to the laundry machine;
   - checking implementation time corresponding to the measured voltage from a data table; and
   - setting the checked implementation time to the implementation time of the preparation operation.

9. The control method according to any one of claims 1 to 8, further comprising a pause operation of stopping actuation of the laundry machine for a predetermined time after the steam supply operation.

10. The control method according to claim 9, wherein implementation time of the pause operation is increased if the actual voltage is greater than the standard voltage, and implementation time of the pause operation is reduced if the actual voltage is less than the standard voltage.

11. The control method according to claim 10, wherein the increased time (or the reduced time) of the pause operation corresponds to the reduced time (or the increased time) of the preparation operation.

12. The control method according to any one of claims 9 to 11, wherein the adjustment operation includes varying the implementation time of the pause operation and the implementation time of the preparation operation based on the actual voltage of power supplied to the laundry machine, and/or wherein the sum of the variable implementation time of the pause operation and the variable implementation time of the preparation operation has a constant value.

13. The control method according to any one of claims 9 to 12, wherein a set of the preparation operation, the steam generation operation and the steam supply operation is repeated plural times.

14. A laundry machine comprising:

   - a tub and/or a rotatable drum;
   - a duct configured to communicate with the tub or drum;
   - a heater installed in the duct and configured to heat only a predetermined space within the duct; and
   - a controller configured to perform a method according to any one of the preceding claims.

15. The laundry machine of claim 14, further comprising:

   - a nozzle and/or a blower arranged within the duct.
FIG. 1
FIG. 7
FIG. 8
FIG. 9
FIG. 12
FIG. 13
FIG. 16

START

SENSE VOLTAGE (ADJUST IMPLEMENTATION TIME OF HEATING OPERATION) (SI100)

P1

CLEAN HEATER

S2

DISCHARGE RESIDUAL WASH WATER

S3

PRE-HEATING

S4

S12

JUDGE AMOUNT OF SUPPLIED WATER

A

P6

PAUSE

S13

P2

HEAT HEATER IN DUCT

HEAT HEATER IN DUCT

S5

PERFORM FIRST HEATING

S5a

PERFORM SECOND HEATING

S5b

DIRECTLY SUPPLY WATER TO HEATED HEATER

S6

SUPPLY AIR FLOW IN DUCT

S7

P2

PAUSE

S8

P3

PERFORM FIRST DRYING

S9

P4

PERFORM SECOND DRYING

S10

COOLING

S11

END
<table>
<thead>
<tr>
<th>CHECK PROCESS (P0)</th>
<th>PRE-TREATMENT PROCESS (P1)</th>
<th>PRIMARY EXTRACT OF AMOUNT OF SURFACED WATER (SL./D.)</th>
<th>TREATMENT TIME (min.)</th>
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<td>79.08</td>
<td>93.81</td>
<td>82.35</td>
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<td>1 2 3 4 5 6 7 8 9 10</td>
<td>123 4 5 6 7 8 9 10</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
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<tr>
<td>VOICE/SPEAKING (sec.)</td>
<td>HEATER CLEANING (45 min.)</td>
<td>DRAWING OF RESIDUAL WATER (WATER/SUPP-A)</td>
<td>PRE-HEATING (45 min.)</td>
</tr>
<tr>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
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<td>1 2 3 4 5 6 7 8 9 10</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>DRUM (40)</td>
<td>PUMP (40)</td>
<td>NOZZLE (160)</td>
<td>HEATER (160)</td>
</tr>
<tr>
<td>1 2 3 4 5 6 7 8 9 10</td>
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</tr>
</tbody>
</table>

**FIG. 18A**
**FIG. 18B**


**TABLE**

- **STEAM SUPPLY PROCESS (P2)** (30 sec. * 12 times repeated)
- **MOISTURE REMOVAL PROCESS (P3)**

**Columns:**
- PAUSE(S13) (5 sec.)
- (S5) / FIRST HEATING (S5z) (13 sec.)
- PREPARATION (SECOND HEATING (S5b) (7 sec.)
- STEAM DESTOCATION (S5) (7 sec.)
- STEAM SUPPLY (S5c)
- PAUSE (S5) (180 sec.)

**Rotation:** 16° on / 4° off

**Notes:**
- BLOWER (140)
- HEATER (150)
- NOZZLE (150)
- PUMP (90)
- DRUM (40)
FIG. 18C

<table>
<thead>
<tr>
<th>PROGRESS TIME</th>
<th>DRYING PROCESS (P4)</th>
<th>COOLING PROCESS (P5)</th>
</tr>
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<tr>
<td></td>
<td>FIRST DRYING (S9) (9 min. 30 sec.)</td>
<td>SECOND DRYING (S10) (1 min.)</td>
</tr>
<tr>
<td>691</td>
<td>691</td>
<td>691</td>
</tr>
<tr>
<td>BLOWER(140)</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>HEATER(130)</td>
<td>~</td>
<td>567</td>
</tr>
<tr>
<td>NOZZLE(150)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PUMP(90)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DRUM(40)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ROTATION 16" on / 4" off
FIG. 19

HEAT HEATER AND SUPPLY WATER

MEASURE FIRST TEMPERATURE OF AIR AT REAR OF HEATER

MEASURE SECOND TEMPERATURE OF AIR AFTER PREDETERMINED TIME HAS PASSED

CALCULATE TEMPERATURE INCREASE RATE FROM FIRST TEMPERATURE AND SECOND TEMPERATURE

TEMPERATURE INCREASE RATE ≥ PREDETERMINED REFERENCE VALUE

NO

JUDGE THAT SUFFICIENT AMOUNT OF WATER IS NOT SUPPLIED

YES

JUDGE THAT SUFFICIENT AMOUNT OF WATER IS SUPPLIED

S5 OR S13
FIG. 20

A

PERFORM THIRD DRYING
INTERMITTENT ACTUATION OF HEATER
SUPPLY OF MOISTURE TO LAUNDRY

S14
S14a
S14b

PERFORM FOURTH DRYING

S15

COOLING

S16

END
FIG. 21

START

MEASURE ACTUAL VOLTAGE

S110 (S1)

ACTUAL VOLTAGE > STANDARD VOLTAGE

S121

YES

NO

S131a

INCREASE IMPLEMENTATION TIME OF HEATING OPERATION

S131b

REDUCE IMPLEMENTATION TIME OF HEATING OPERATION

S140

END

S140a

REDUCE IMPLEMENTATION TIME OF PAUSE OPERATION

S140b

INCREASE IMPLEMENTATION TIME OF PAUSE OPERATION
FIG. 22A

START

MEASURE ACTUAL VOLTAGE

CHECK IMPLEMENTATION TIME CORRESPONDING TO MEASURED VOLTAGE FROM PREVIOUSLY MADE TABLE

SET CHECKED IMPLEMENTATION TIME TO IMPLEMENTATION TIME OF HEATING OPERATION

ADJUST IMPLEMENTATION TIME OF PAUSE OPERATION

END
## FIG. 22B

<table>
<thead>
<tr>
<th>MEASURED VOLTAGE RANGE (V)</th>
<th>IMPLEMENTATION TIME OF FIRST HEATING OPERATION S5 (sec.)</th>
<th>IMPLEMENTATION TIME OF PAUSE OPERATION S8 (sec.)</th>
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<tr>
<td>~</td>
<td>27.0</td>
<td>12.0</td>
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<td>11.0</td>
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<td>275</td>
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FIG. 26
## DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<tr>
<th>Category</th>
<th>Citation of document with indication, where appropriate, of relevant passages</th>
<th>Relevant to claim</th>
<th>CLASSIFICATION OF THE APPLICATION (IPC)</th>
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<tr>
<td>X</td>
<td>EP 1 873 297 A2 (LG ELECTRONICS INC [KR]) 2 January 2008 (2008-01-02) 1,2,9, 13,14</td>
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<td>INV. D06F39/00 D06F39/04 D06F39/08</td>
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The present search report has been drawn up for all claims.

Place of search: Munich
Date of completion of the search: 13 June 2013
Examiner: Prosig, Christina

**CATEGORY OF CITED DOCUMENTS**

- **X**: particularly relevant if taken alone
- **Y**: particularly relevant if combined with another document of the same category
- **A**: technological background
- **P**: intermediate document
- **T**: theory or principle underlying the invention
- **E**: earlier patent document, but published on, or after the filing date
- **D**: document cited in the application
- **L**: document cited for other reasons
- **A**: member of the same patent family, corresponding document
# ANNEX TO THE EUROPEAN SEARCH REPORT
## ON EUROPEAN PATENT APPLICATION NO.

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on 13-06-2013. The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

<table>
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<tr>
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For more details about this annex: see Official Journal of the European Patent Office, No. 12/82
REFERENCES CITED IN THE DESCRIPTION

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