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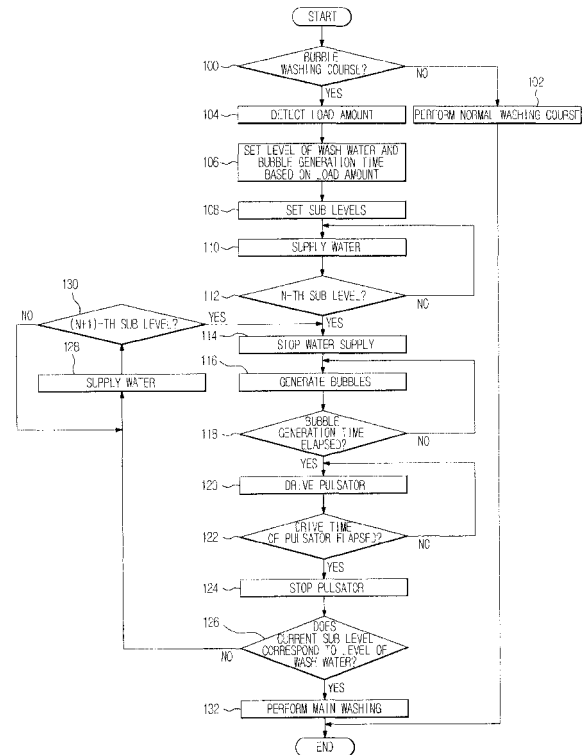
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(54) **Washing machine and control method thereof**

(57) A control method of a washing machine to supply wash water in stages, generate bubbles and supply the generated bubbles. The control method includes supplying wash water to a tub to a predetermined level in stages one or more times during a washing cycle, generating bubbles at the respective stages at which the wash water is supplied to the tub, and driving a pulsator so that the bubbles are introduced into a wash tub.

FIG. 10



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Description

BACKGROUND

1. Field

[0001] Embodiments relate to a washing machine using bubbles and a control method thereof.

2. Description of the Related Art

[0002] Generally, a washing machine is an apparatus which applies energy, such as impact, to laundry to separate contaminants from the laundry. Based on how energy is applied to the laundry, a washing machine may be classified as a pulsator washing machine, an agitator washing machine or a drum washing machine.

[0003] The pulsator washing machine performs washing using a water current generated by rotating a disk-shaped pulsator. The agitator washing machine rotates a wing-shaped agitator extending upward from the center of the bottom of a washing tub in alternating directions to perform washing. The drum washing machine drops laundry through rotation of a drum to apply impact to the laundry, thereby washing the laundry.

[0004] In such a washing machine, washing is performed after most wash water is supplied through one-time supply of water to a predetermined level, and therefore, the washing is performed after detergent is dissolved in a sufficient amount of water. For this reason, the detergent is not sufficiently dissolved in water at the early stage of washing with the result that removal of contaminants based on chemical action of the detergent is not effectively achieved. Also, a large amount of water is consumed, and therefore, washing is performed using relatively low-concentration detergent liquid with the result that decomposition and removal of contaminants are not effectively achieved.

[0005] A washing machine has been proposed wherein detergent is sufficiently dissolved in wash water during washing to perform washing using high-concentration detergent liquid even at the early stage of washing. In this washing machine, a small amount of water is supplied into a wash tub, the wash tub and a pulsator are rotated at high speed to form high-concentration detergent liquid containing sufficiently dissolved detergent, water is supplied to a predetermined level, and washing is performed. In this washing machine, however, laundry placed below the level reached by the small amount of water supplied into the wash tub to form high-concentration detergent liquid is affected by the detergent liquid. As a result, the detergent is not uniformly transferred to the laundry vertically distributed in the wash tub, and therefore, non-uniform washing is performed. Also, the laundry may be damaged during rotation of the wash tub and the pulsator at high speed so as to sufficiently dissolve the detergent.

SUMMARY

[0006] It is an aspect of one or more embodiments to provide a washing machine that supplies wash water in stages, sufficiently dissolves detergent without high-speed rotation of a wash tub and a pulsator, generates bubbles, and supplies the generated bubbles into the wash tub so that high-concentration detergent liquid containing sufficiently dissolved detergent is uniformly transferred to laundry and a control method thereof.

[0007] Additional aspects of one or more embodiments will be set forth in part in the description which follows and, in part, will be apparent from the description, or may be learned by practice of the invention.

[0008] In accordance with an aspect of one or more embodiments, a control method of a washing machine including a tub, a wash tub mounted in the tub and a pulsator rotatably mounted in the wash tub, includes supplying wash water to the tub to a predetermined level in stages one or more times during a washing cycle, generating bubbles at the respective stages at which the wash water is supplied to the tub, and driving the pulsator so that the bubbles are introduced into the wash tub.

[0009] Supplying wash water to the tub to a predetermined level in stages one or more times during a washing cycle may include setting sub levels of the respective stages at which the wash water is supplied to the tub and supplying the wash water to the tub so that the level of the wash water reaches the sub levels of the respective stages.

[0010] Setting sub levels of the respective stages at which the wash water is supplied to the tub may include setting sub levels of the respective stages based on the amount of laundry placed in the wash tub.

[0011] The sub levels may include a first sub level at which a nozzle mounted at a lower part of the tub to supply bubbles to the tub is submerged.

[0012] Bubble generation time may be adjusted in proportion to an interval between the sub levels.

[0013] Drive time of the pulsator may be adjusted in proportion to an interval between the sub levels.

[0014] Driving the pulsator may include driving the pulsator in one direction for a predetermined time.

[0015] The predetermined time may be about 4 seconds or less.

[0016] Driving the pulsator may include driving the pulsator in alternating directions for a predetermined time.

[0017] Driving the pulsator in alternating directions for a predetermined time may include changing drive directions of the pulsator after stopping the pulsator for a predetermined time.

[0018] The predetermined time may be about 4 seconds or less and drive time of the pulsator in one direction is set to be shorter than the time during which the pulsator is stopped.

[0019] The drive time of the pulsator in one direction may be about 1 second or less and the time during which the pulsator is stopped may be about 3 seconds or less.

[0020] The control method may further include driving the pulsator to perform washing using mechanical force when the level of the wash water reaches the predetermined level.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] These and/or other aspects of embodiments will become apparent and more readily appreciated from the following description of embodiments, taken in conjunction with the accompanying drawings of which:

FIG. 1 is a sectional view illustrating a washing machine according to an embodiment;

FIG. 2 is a control block diagram of the washing machine according to an embodiment;

FIGS. 3 to 9 are views illustrating a bubble generation process of the washing machine according to an embodiment; and

FIG. 10 is a flow chart illustrating a bubble generation and supply process of the washing machine according to an embodiment.

DETAILED DESCRIPTION

[0022] Reference will now be made in detail to embodiments, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout.

[0023] FIG. 1 is a sectional view illustrating a washing machine according to an embodiment.

[0024] As shown in FIG. 1, the washing machine includes a tub 11 mounted in a machine body 10 to contain water (wash water or rinse water) and a wash tub 12 rotatably mounted in the tub 11 to contain laundry. The wash tub 12 has a plurality of holes 13. A pulsator 14 is rotatably mounted in the wash tub 12. The pulsator 14 rotates clockwise or counterclockwise to generate a water current.

[0025] At the outside bottom of the tub 11 are mounted a motor 15 to generate drive force to rotate the wash tub 12 and the pulsator 14 and a power transmission device 16 to simultaneously or selectively transmit the drive force from the motor 15 to the wash tub 12 and the pulsator 14.

[0026] The motor 15 is a direct drive type motor having a variable speed function. The drive force from the motor 15 is simultaneously or selectively transmitted to the wash tub 12 and the pulsator 14 by upward or downward movement of the power transmission device 16. A belt and pulley type motor may be used instead of the direct drive type motor. Reference numeral 17 indicates a hollow spin-drying shaft coupled to the wash tub 12 and reference numeral 18 indicates a wash shaft mounted in the hollow part of the spin-drying shaft 17 so as to be

connected to the pulsator 14 through the tub 11 and the spin-drying shaft 17.

[0027] In the tub 11 is mounted a level sensor 19 to detect the amount (level) of water in the tub 11. The level sensor 19 may detect a frequency varying depending upon the amount of water supplied into the tub 11 to measure the level of water. The level sensor 19 measures the level of water so that a predetermined amount of wash water or rinse water is supplied to the tub 11 or so that a predetermined amount of water is drained.

[0028] Above the tub 11 is mounted a water supply device 20 to supply wash water to the tub 11. The water supply device 20 includes a water supply valve 23 to control water supply and a water supply pipe 21 connected between the water supply valve 23 and a detergent supply device 30.

[0029] One end of the water supply pipe 21 is connected to an external water supply source (not shown), and the other end of the water supply pipe 21 is connected to the detergent supply device 30.

[0030] The detergent supply device 30 includes a case 31 and a detergent container 33 detachably mounted in the case 31 to contain detergent. The case 31 is provided at the bottom thereof with a discharge port 35 through which wash water having detergent dissolved therein is discharged.

[0031] Water, supplied through the water supply pipe 21, passes through the detergent supply device 30. As a result, the water is supplied into the tub 11 together with detergent.

[0032] Below the tub 11 are mounted a circulation device 50 to circulate wash water in the tub 11 and a drainage device 60 to drain wash water from the tub 11. The circulation device 50 and the drainage device 60 are symmetrical with respect to a pump case 40. Between the tub 11 and the pump case 40 is mounted a connection hose 41 to guide wash water from the tub 11 to the pump case 40.

[0033] The circulation device 50 includes a circulation pump 51 to supply wash water, guided to the pump case 40, into the tub 11, a circulation pipe 52 mounted at the outlet side of the circulation pump 51 to circulate wash water, a circulation nozzle 53 mounted at the outlet of the circulation pipe 52 to supply wash water to the lower part of the tub 11, an air introduction hole 54 formed at the circulation nozzle 53 to allow air to be introduced into the lower part of the tub 11 therethrough so that bubbles are generated in the wash water supplied into the lower part of the tub 11, and an air guide pipe 55 to guide air, suctioned from the tub 11 through an air suction hole 56, to the air introduction hole 54.

[0034] One end of the circulation pipe 52 is connected to the circulation pump 51, and the other end of the circulation pipe 52 is connected to the tub 11 via the circulation nozzle 53. Upon operation of the circulation pump 51, therefore, wash water from the tub 11 is guided to the pump case 40 through the connection hose 41, and the wash water, guided to the pump case 40, is supplied

to the tub 11 through the circulation pipe 52. In this way, circulation of wash water is achieved.

[0035] The circulation nozzle 53, for example, is a Venturi tube which reduces the pressure of circulating wash water. Air, suctioned through the air suction hole 56, is naturally introduced into the circulation nozzle 53 through the air introduction hole 54 via the air guide pipe 55. As a result, bubbles are generated from the detergent in the wash water without an additional power-driven air supply device.

[0036] In an embodiment, the circulation device 50 generates bubbles so that laundry in the wash tub 12 is washed by the bubbles. The principle of bubble generation is as follows.

[0037] When wash water, discharged by the circulation pump 51, passes through the circulation nozzle 53 via the circulation pipe 52, the pressure of the wash water is abruptly lowered with the result that air from the wash tub 11 is introduced into the circulation nozzle 53 through the air introduction hole 54. Consequently, air bubbles are generated in wash water supplied to the lower part of the tub 11 to generate bubbles which are mixture of detergent in the wash water and the air bubbles. Due to the generation of the bubbles, the volume of the wash water is increased, and therefore, sufficiently dissolved detergent liquid is uniformly distributed to the laundry placed in the wash tub 12, thereby achieving uniform washing.

[0038] The drainage device 60 includes a drainage pump 61 to drain the wash water, guided to the pump case 40, to the outside and a drainage pipe 62 mounted at the outlet side of the drainage pipe 61 to drain wash water.

[0039] In an embodiment, the circulation pump 51 and the drainage pump 61 are symmetrical with respect to the pump case 40. Alternatively, the circulation pump 51 and the drainage pump 61 may be mounted side by side in the same direction of the machine body 10. The positions of the circulation pump 51 and the drainage pump 61 are not restricted so long as wash water is circulated and drained by the circulation pump 51 and the drainage pump 61.

[0040] FIG. 2 is a control block diagram of the washing machine according to an embodiment. The washing machine includes an input unit 60, a controller 62, a drive unit 64, a level sensor 19 and a display unit 66.

[0041] The input unit 60 transmits operation information, such as a washing course (for example, a bubble washing course or a normal washing course), spin-drying RPM, and the addition of rinsing, which are selected by a user, to the controller 62.

[0042] The controller 62 is a microprocessor to control the overall operations of the washing machine, such as washing, rinsing, and spin-drying, based on the operation information transmitted from the input unit 60. The controller 62 stores the level of wash water, bubble generation time, and drive cycle of the pulsator 14, to provide an algorithm to enable bubbles to be uniformly absorbed

by laundry while reducing damage to the laundry due to mechanical force during a washing cycle using bubbles.

[0043] When the bubble washing course is input, the controller 62 sets the level of wash water to be supplied to the wash tub 12 and bubble generation time based on the amount of laundry in the wash tub 12.

[0044] The controller 62 divides the level of wash water set based on the amount of laundry into a plurality of sub levels so that wash water is not supplied to the set level of wash water at once but is supplied in stages, i.e. the level of wash water reaches the set level of wash water through the sub levels.

[0045] The controller 62 may set the sub levels in proportion to the level of wash water set based on the amount of laundry. For example, when 3 kg of laundry is present and the set level of wash water is 15 L, the set level of wash water is divided into four sub levels, the set level of wash water may be divided into two sub levels when 1.5 kg of laundry is present and the set level of wash water is 7.5 L. The sub levels may be set by uniformly dividing the level of wash water set based on the weight of laundry, without being limited thereto. If a large amount of laundry is placed, the lower portion of the laundry may be denser than the upper portion of the laundry due to gravity. Consequently, the sub levels may be set so as to have a smaller interval at the lower portion of the laundry. The sub levels may be set so that a sub level at a certain stage is lower than a sub level at the next stage.

[0046] The controller 62 controls the water supply valve 23 to perform water supply in stages as described above.

[0047] At each stage, to supply wash water so that the wash water reaches a corresponding sub level, the controller 62 drives the circulation pump 51 for a bubble generation time set based on the amount of laundry to generate bubbles and supply the generated bubbles into the tub 11.

[0048] When the bubble generation time has elapsed, the controller 62 stops the generation of bubbles and drives the pulsator 14 according to a previously stored drive cycle of the pulsator 14 so that bubbles supplied into a space between the tub 11 and the wash tub 12 are introduced into the wash tub 12 and are uniformly adsorbed by laundry.

[0049] The controller 62 may drive the pulsator 14 in one direction, i.e. clockwise or counterclockwise. Alternatively, the controller 62 may drive the pulsator 14 in alternating directions.

[0050] When the pulsator 14 is driven in one direction, a drive cycle of the motor 15 to provide drive force to the pulsator 14 may be set so that a drive cycle including on time and off time of the motor 15 at a drive operation rate of, for example, 2"/5" (2 seconds on/5 seconds off), 3"/4" (3 seconds on/4 seconds off) and 4"/3" (4 seconds on/3 seconds off), but not limited to these combinations, does not exceed a predetermined time (for example, about 10 seconds).

[0051] When the pulsator 14 is driven in alternating

directions, a drive cycle of the motor 15 to provide drive force to the pulsator 14 may be set so that a drive cycle including on time and off time of the motor 15 at a drive operation rate of, for example, 1"/3"/1"/3" (clockwise 1 second on/3 seconds off and counterclockwise 1 second on/3 seconds off, the order of clockwise and counterclockwise directions may be reversed. The same statement applies to the following), 1.5"/2.5"/1.5"/12.5" (clockwise 1.5 seconds on/2.5 seconds off and counterclockwise 1.5 seconds on/2.5 seconds off) and 2"/2"/2"/2" (clockwise 2 seconds on/2 seconds off and counterclockwise 2 seconds on/2 seconds off), but not limited to these combinations, does not exceed a predetermined time (for example, about 10 seconds).

[0052] When the pulsator 14 is driven twice in alternating directions, a drive cycle of the motor 15 to provide drive force to the pulsator 14 may be repeated twice at a drive operation rate of, for example, 0.5"/1.5"/0.5"/1.5"/0.5"/1.5"/0.5"/1.5" (clockwise 0.5 seconds on/1.5 seconds off, counterclockwise 0.5 seconds on/1.5 seconds off, clockwise 0.5 seconds on/1.5 seconds off, and counterclockwise 0.5 seconds on/1.5 seconds off, but not limited to these combination, the order of clockwise and counterclockwise directions may be reversed). The drive operation rate may be set so that a drive cycle including on time and off time of the motor 15 does not exceed a predetermined time (for example, about 10 seconds).

[0053] When the pulsator 14 is driven in alternating directions, a drive cycle may be set so that the drive direction of the pulsator 14 is changed without drive off time of the pulsator 14.

[0054] When the pulsator 14 is driven as described above, laundry may be damaged due to mechanical friction if on time of the motor 15 is set to be long. For this reason, the on time of the motor may be set to a predetermined time (about 4 seconds or less).

[0055] When the pulsator 14 is frequently rotated at a short drive cycle (on time + off time) within the predetermined time (for example, about 10 seconds), bubbles located between the tub 11 and the wash tub 12 that have not been introduced into the wash tub 12 are introduced into the wash tub 12 by a centripetal water current generated by the rotation of the pulsator 14. During this process, the high-concentration detergent on the bubble surfaces is uniformly adsorbed by the laundry placed in the wash tub.

[0056] During a washing cycle, the controller 62 controls the level of wash water, bubble generation time, and drive time of the pulsator, as previously described, to control the operations of the water supply valve 23, the circulation pump 51 and the motor 15 so that the bubbles are uniformly adsorbed by the laundry while reducing damage to the laundry due to mechanical force.

[0057] The drive unit 64 drives the water supply valve 23, the circulation pump 51 and the motor 15 according to a drive control signal from the controller 62.

[0058] The level sensor 19 detects a frequency varying depending upon the amount of water supplied into the

tub 11 to measure the level of water so that a predetermined amount of water is supplied and drained.

[0059] The display unit 66 displays an operation state of the washing machine according to a display control signal from the controller 62.

[0060] FIGS. 3 to 9 are views illustrating a bubble generation process of the washing machine according to an embodiment. For example, as shown in FIGS. 3 to 9, the level of wash water set based on the amount of laundry is divided into three sub levels, i.e. a first sub level □, a second sub levels □ and a third sub level □. Hereinafter, bubble generation during such water supply in stages will be described as an example.

[0061] Referring to FIG. 3, wash water (water + detergent) is supplied into the tub 11 to the first sub level □. The first sub level may be set as a level at which the circulation nozzle 53 is submerged.

[0062] Referring to FIG. 4, the circulation pump 50 is operated when the wash water is supplied into the tub 11, and the wash water discharged from the circulation pump 51 passes through the circulation nozzle 53, which is, for example, a Venturi tube, via the circulation pipe 52.

[0063] When the pressure of the wash water is reduced while passing through the circulation nozzle 53, air from the tub 11 is introduced into the circulation nozzle 53 through the air introduction hole 54. The air, introduced into the circulation nozzle 53, is sprayed to the wash water supplied into the tub 11 and a space between the tub 11 and the wash tub 12, to generate air bubbles in the wash water. The air bubbles, generated in the wash water, rise to the surface of the wash water between the tub 11 and the wash tub 12, to generate bubbles. The bubbles move to the upper part of the space between the tub 11 and the wash tub 12. At this time, some of the bubbles generated between the tub 11 and the wash tub 12 are introduced into the wash tub 12 through bottom holes formed at the bottom of the wash tub 12 or through side holes formed at the side of the wash tub 12. However, most of the bubbles are located along the space between the tub 11 and the washing tub 12 where movement resistance is not present.

[0064] Referring to FIG. 5, the pulsator 14 is driven clockwise or counterclockwise to introduce the bubbles located along the space between the tub 11 and the wash tub 12 into the wash tub 12. When the pulsator 14 is driven clockwise or counterclockwise, a centripetal water current is generated, and therefore, the bubbles located along the space between the tub 11 and the wash tub 12 are introduced into the wash tub 12. The pulsator 14 may be driven in one direction. Alternatively, the pulsator 14 may be driven in alternating directions. When the bubbles are introduced into the wash tub 12, the bubbles are uniformly absorbed by the laundry located at a predetermined level equal to or higher than a first sub level □, and therefore, high-concentration detergent liquid is transferred to the laundry.

[0065] Referring to FIG. 6, when the rotation of the pulsator 14 is stopped and the bubbles are uniformly ab-

sorbed by the laundry located at a predetermined level equal to or higher than the first sub level □, wash water is supplied to the tub 11 until the level of water reaches a second sub level □ which is higher than the first sub level □. The second sub level □ may be set to not greater than the height of laundry to which detergent liquid is to be transferred to the laundry through the bubbles generated at the first sub level □. In this way, the level next to the predetermined level is set so that detergent liquid is uniformly transferred to the laundry placed in the wash tub.

[0066] Among the bubbles generated at the first sub level □, the bubbles which have not been adsorbed by the laundry, i.e. the remaining bubbles, rise together with wash water during supply of the wash water to the second sub level □. During this process, the remaining bubbles, generated at the first sub level □, may be preliminarily transferred to the laundry after the supply of water to the second sub level □ and before bubbles are generated when the wash water is supplied to the second sub level □ and transferred to the laundry.

[0067] Referring to FIG. 7, when the wash water is supplied to the second sub level □, bubbles are generated and move to the upper part of the space between the tub 11 and wash tub 12. Most of the bubbles are located along the space between the tub 11 and the washing tub 12 where movement resistance is not present.

[0068] Referring to FIG. 8, the bubbles located along the space between the tub 11 and the wash tub 12 are introduced into the wash tub 12 by a centripetal water current generated through rotation of the pulsator 14. When the bubbles are introduced into the wash tub 12, the bubbles are uniformly absorbed by the laundry located at a predetermined level equal to or higher than the second sub level □, and therefore, high-concentration detergent liquid is transferred to the laundry.

[0069] Referring to FIG. 9, when the rotation of the pulsator 14 is stopped and the bubbles are uniformly absorbed by the laundry located at a predetermined level equal to or higher than the second sub level □, wash water is supplied to the tub 11 until the level of water reaches a third sub level □ which is higher than the second sub level □ of FIG. 6. The third sub level □ may be set in the same manner as in the second sub level □.

[0070] Among the bubbles generated at the second sub level □, the bubbles which have not been adsorbed by the laundry, i.e. the remaining bubbles, rise together with wash water during supply of the wash water to the third sub level □. During this process, the remaining bubbles, generated at the second sub level □, may be preliminarily transferred to the laundry after the supply of water to the third sub level □ and before bubbles are generated when the wash water is supplied to the third sub level □ and transferred to the laundry.

[0071] When the wash water is supplied to the third sub level □, the bubble generation and the introduction of the bubbles into the wash tub 12 described with reference to FIGS. 4 and 5 or 7 and 8 are repeated. Through

these processes, the high-concentration detergent on the surfaces of the bubbles is uniformly absorbed by the laundry placed in the wash tub 12.

[0072] FIG. 10 is a flow chart illustrating a bubble generation and supply process of the washing machine according to an embodiment.

[0073] When a user puts laundry in the wash tub 12 and selects operation information, such as a washing course, spin-drying RPM and the addition of rinsing, the operation information selected by the user is input to the controller 62 through the input unit 60.

[0074] The controller 62 determines, based on the operation information input through the input unit 60, whether the washing course selected by the user is a bubble washing course (100). Upon determining that the washing course selected by the user is not a bubble washing course, the controller 62 performs a normal washing course (102).

[0075] Upon determining that the washing course selected by the user is a bubble washing course, the controller 62 detects the amount (load amount) of the laundry placed in the wash tub 12 (104) and sets the level of wash water to be introduced into the wash tub 12 according to the detected amount of the laundry and bubble generation time (106).

[0076] Subsequently, the controller 62 divides the level of wash water so that the wash water is supplied in stages until the level of the wash water reaches the level of the wash water set based on the amount of the laundry and decides sub levels at the respective stages at which the wash water is supplied (108).

[0077] Further, the controller 62 controls the water supply valve 23 to supply water to the tub 11. At this time, detergent in the detergent supply device 30 is dissolved in the supplied water, and therefore, wash water (water + detergent) is supplied to the tub 11 (110).

[0078] At this time, the level of the supplied wash water is detected by the level sensor 19, and the controller 62 determines whether the level of the wash water is an N-th sub level (N being a natural number) (112). Hereinafter, it is assumed that N is 1. Upon determining that the level of the wash water is not a first sub level, the controller 62 controls wash water to be continuously supplied until the level of the wash water reaches the first sub level. Upon determining that the level of the wash water is the first sub level, the controller 62 turns the water supply valve 23 off to stop the supply of wash water (114).

[0079] When the wash water is supplied to the first sub level, the controller 62 generates bubbles (116). The controller 62 operates the circulation pump 51. When the circulation pump 51 is operated, the wash water from the tub 11 is guided to the pump case 40 through the connection hose 41. The wash water, guided to the pump case 40, is supplied to the lower part of the tub 11 through the circulation pipe 52. In this way, the wash water is circulated. When the wash water passes through the circulation nozzles 53 via the circulation pipe 52, water pressure is abruptly lowered with the result that air is naturally

introduced into the circulation nozzle 53 through the air introduction hole 54. The air, introduced into the circulation nozzle 53, is sprayed to the wash water supplied to the lower part of the tub 11 and mixed with the detergent.

[0080] As a result, bubbles are generated at the surface of the wash water. At this time, most of the bubbles formed between the tub 11 and the wash tub 12 are located along the space between the tub 11 and the washing tub 12 where movement resistance is not present.

[0081] Subsequently, the controller 62 determines whether bubble generation time has elapsed (118). Upon determining that the bubble generation time has not elapsed, the controller 62 continuously generates bubbles and supplies the generated bubbles to the tub 11.

[0082] Upon determining that the bubble generation time has elapsed, the controller 62 drives the pulsator 14 so that all the bubbles located along the space between the tub 11 and the washing tub 12 are introduced into the wash tub 12 (120). The controller 62 may drive the pulsator 14 in one direction, i.e. clockwise or counter-clockwise, or alternating directions.

[0083] Subsequently, the controller 62 determines whether drive time of the pulsator 14 has elapsed (122). Upon determining that the drive time of the pulsator 14 has not elapsed, the controller 62 continuously drive the pulsator 14 at a drive operation rate of the motor as previously described. Upon determining that the drive time of the pulsator 14 has elapsed, the controller 62 stops the drive of the pulsator 14 (124).

[0084] When the drive time of the pulsator 14 has ended, the controller 62 determines whether the current first sub level is the level of wash water set based on the amount of the laundry (126). Upon determining that the current sub level is lower than the level of wash water set based on the amount of the laundry, the controller 62 controls the water supply valve 23 to supply wash water. At this time, the level of the supplied wash water is detected by the level sensor 19, and the controller 62 determines whether the level of the wash water is an (N+1)-th sub level, i.e. a second sub level (130). Upon determining that the level of the wash water is not the second sub level, the controller 62 controls wash water to be continuously supplied until the level of the wash water reaches the second sub level. Upon determining that the level of the wash water is the second sub level, the controller 62 turns the water supply valve 23 off to stop the supply of wash water (114).

[0085] Subsequently, the controller 62 repeats the processes of 116 to 124 at which bubbles are generated, the generated bubbles are supplied to the tub 11, and the pulsator 14 is driven. That is, controller 62 supplies wash water to the tub 11 in stages one or more times until the level of the wash water reaches respective sub levels, generates bubbles at each stage, supplies the generated bubbles to the tub 11, drives the pulsator 14, and introduces the bubbles into the wash tub 12.

[0086] Subsequently, when the current sub level reaches the level of wash water set based on the amount

of the laundry, the controller 62 performs a main washing cycle to remove sweat or dirt from the laundry using the bubbles (132).

[0087] As is apparent from the above description, wash water is supplied in stages, and bubbles are generated at each stage. Consequently, high-concentration detergent liquid is uniformly transferred to laundry through the bubbles irrespective of the location of the laundry in the wash tub, thereby effectively removing contaminants from the laundry.

[0088] Also, the rotation of the pulsator and the wash tub is minimized during a bubble generation and supply process, thereby preventing tangling of or damage to laundry due to high-speed rotation.

[0089] Although a few embodiments have been shown and described, it would be appreciated by those skilled in the art that changes may be made in these embodiments without departing from the principles and spirit of the invention, the scope of which is defined in the claims and their equivalents.

Claims

1. A control method of a washing machine comprising a tub, a wash tub mounted in the tub and a pulsator rotatably mounted in the wash tub, the control method comprising:

supplying wash water to the tub to a predetermined level in stages one or more times during a washing cycle;
generating bubbles at the respective stages at which the wash water is supplied to the tub; and
driving the pulsator so that the bubbles are introduced into the wash tub.

2. The control method according to claim 1, wherein supplying wash water to the tub to a predetermined level in stages one or more times during a washing cycle comprises:

setting sub levels of the respective stages at which the wash water is supplied to the tub; and
supplying the wash water to the tub so that the level of the wash water reaches the sub levels of the respective stages.

3. The control method according to claim 2, wherein setting sub levels of the respective stages at which the wash water is supplied to the tub comprises setting sub levels of the respective stages based on an amount of laundry placed in the wash tub.

4. The control method according to claim 3, wherein the sub levels comprise a first sub level at which a nozzle mounted at a lower part of the tub to supply bubbles to the tub is submerged.

5. The control method according to claim 2, wherein bubble generation time is adjusted in proportion to an interval between the sub levels.
6. The control method according to claim 2, wherein drive time of the pulsator is adjusted in proportion to an interval between the sub levels. 5
7. The control method according to claim 1, wherein driving the pulsator comprises driving the pulsator in one direction for a predetermined time. 10
8. The control method according to claim 7, wherein the predetermined time is about 1 minute or less. 15
9. The control method according to claim 1, wherein driving the pulsator comprises driving the pulsator in alternating directions for a predetermined time.
10. The control method according to claim 9, wherein driving the pulsator in alternating directions for a predetermined time comprises changing drive directions of the pulsator after stopping the pulsator for a predetermined time. 20
11. The control method according to claim 10, wherein the predetermined time is about 4 minute or less and drive time of the pulsator in one direction is set to be shorter than the time during which the pulsator is stopped. 25 30
12. The control method according to claim 11, wherein the drive time of the pulsator in one direction is about 1 minute or less and the time during which the pulsator is stopped is about 3 minute or less. 35
13. The control method according to claim 1, further comprising driving the pulsator to perform washing using mechanical force when the level of the wash water reaches the predetermined level. 40
14. The control method according to claim 2, wherein the sub levels are set so as to have a smaller interval at the lower portion of the laundry. 45
15. The control method according to claim 1, wherein a drive cycle including on time and off time of the pulsator, does not exceed 10 seconds. 50

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FIG. 1

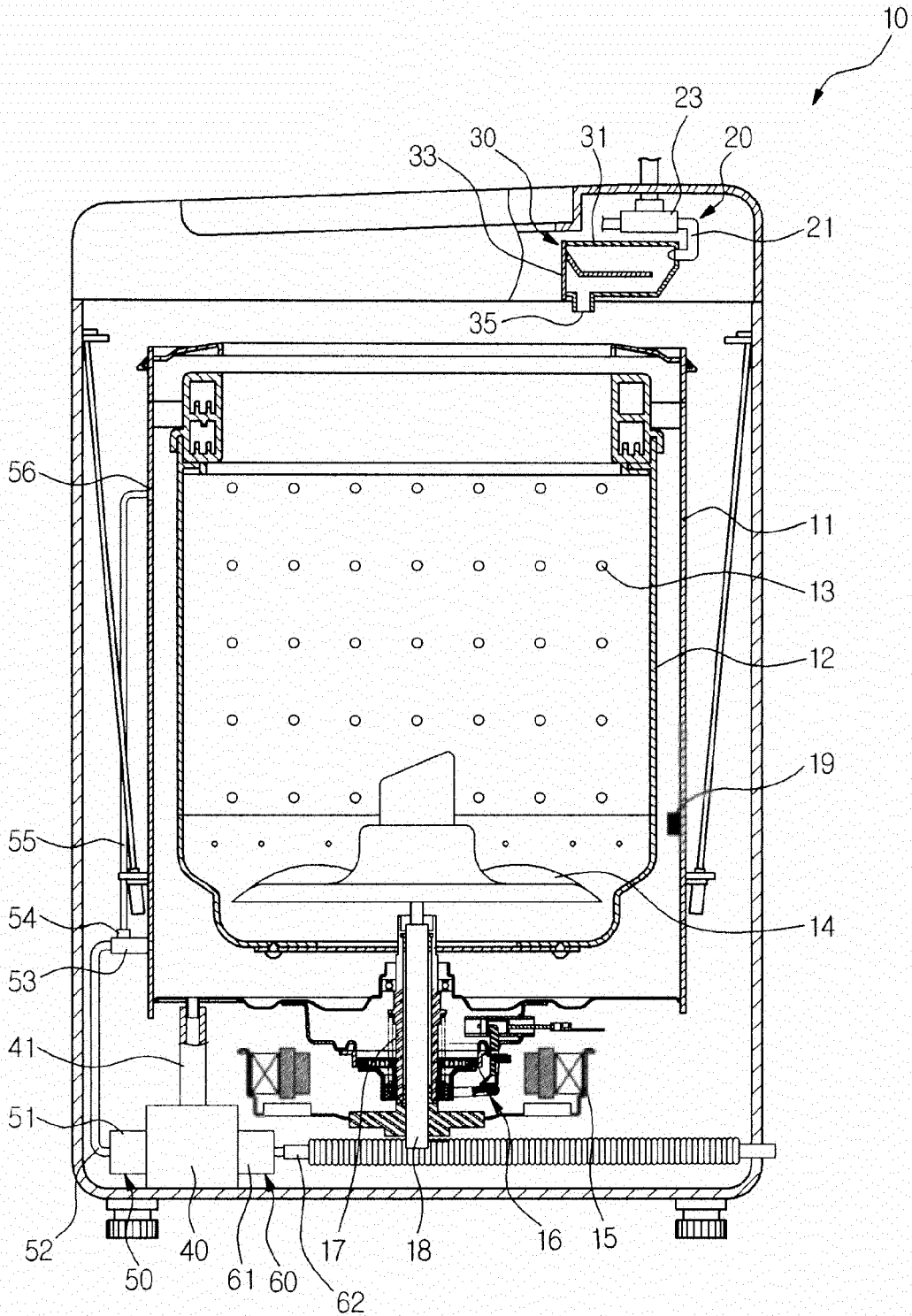


FIG. 2

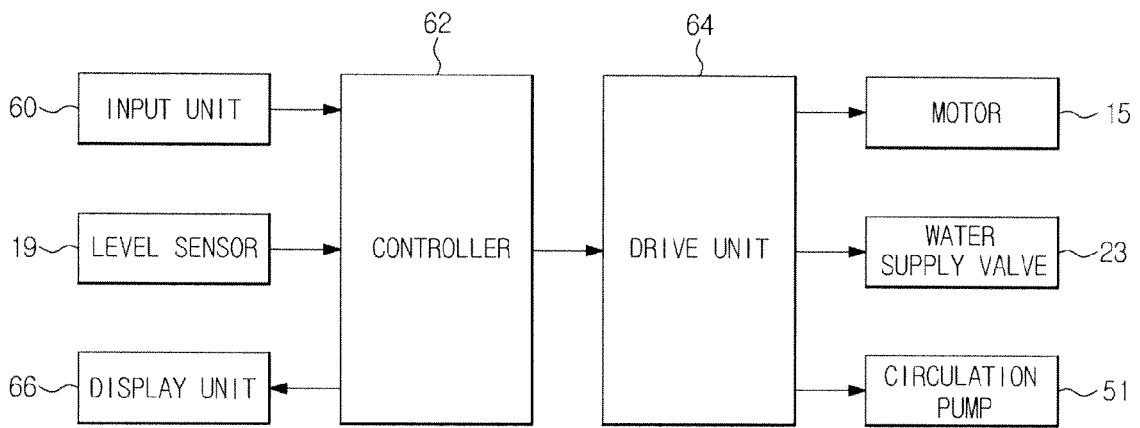


FIG. 3

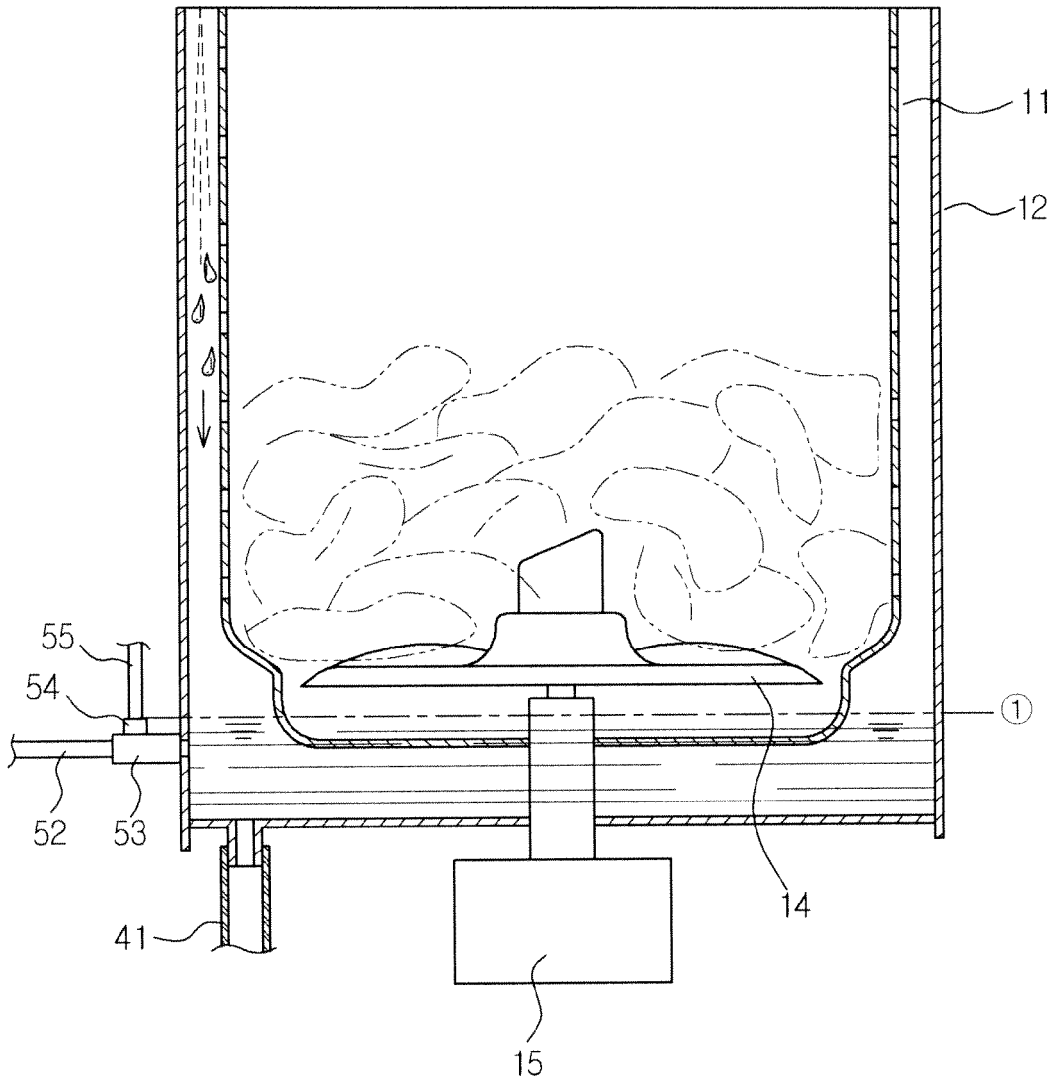


FIG. 4

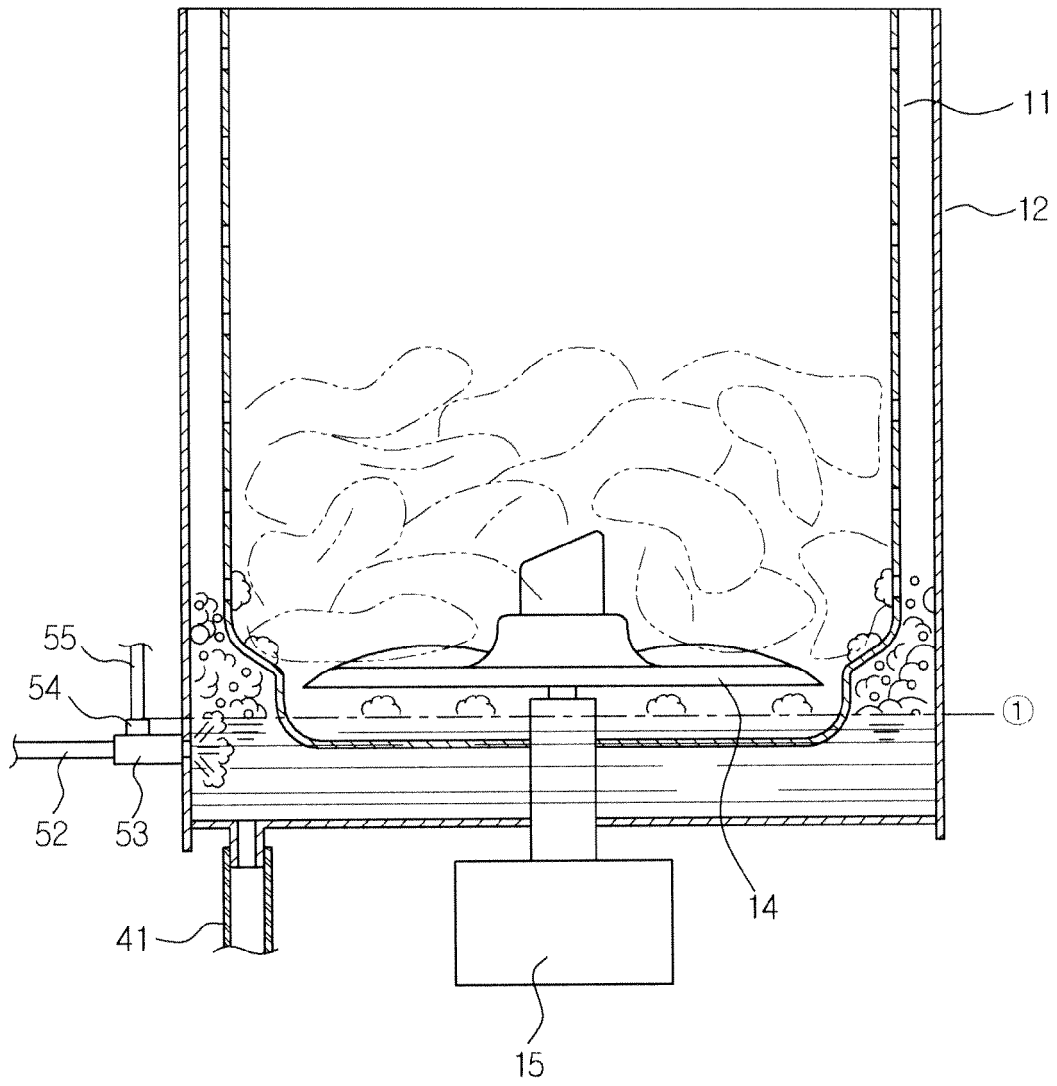


FIG. 5

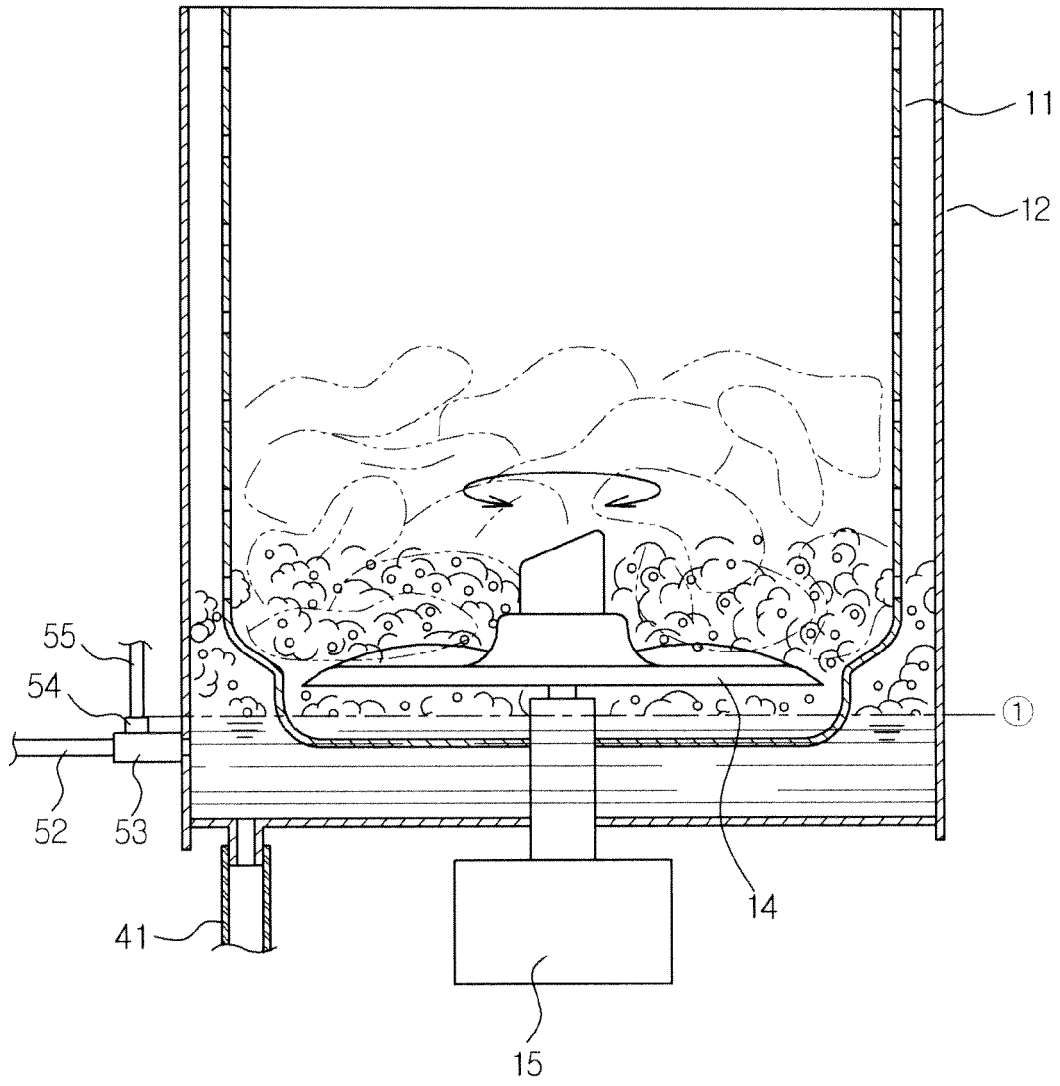


FIG. 6

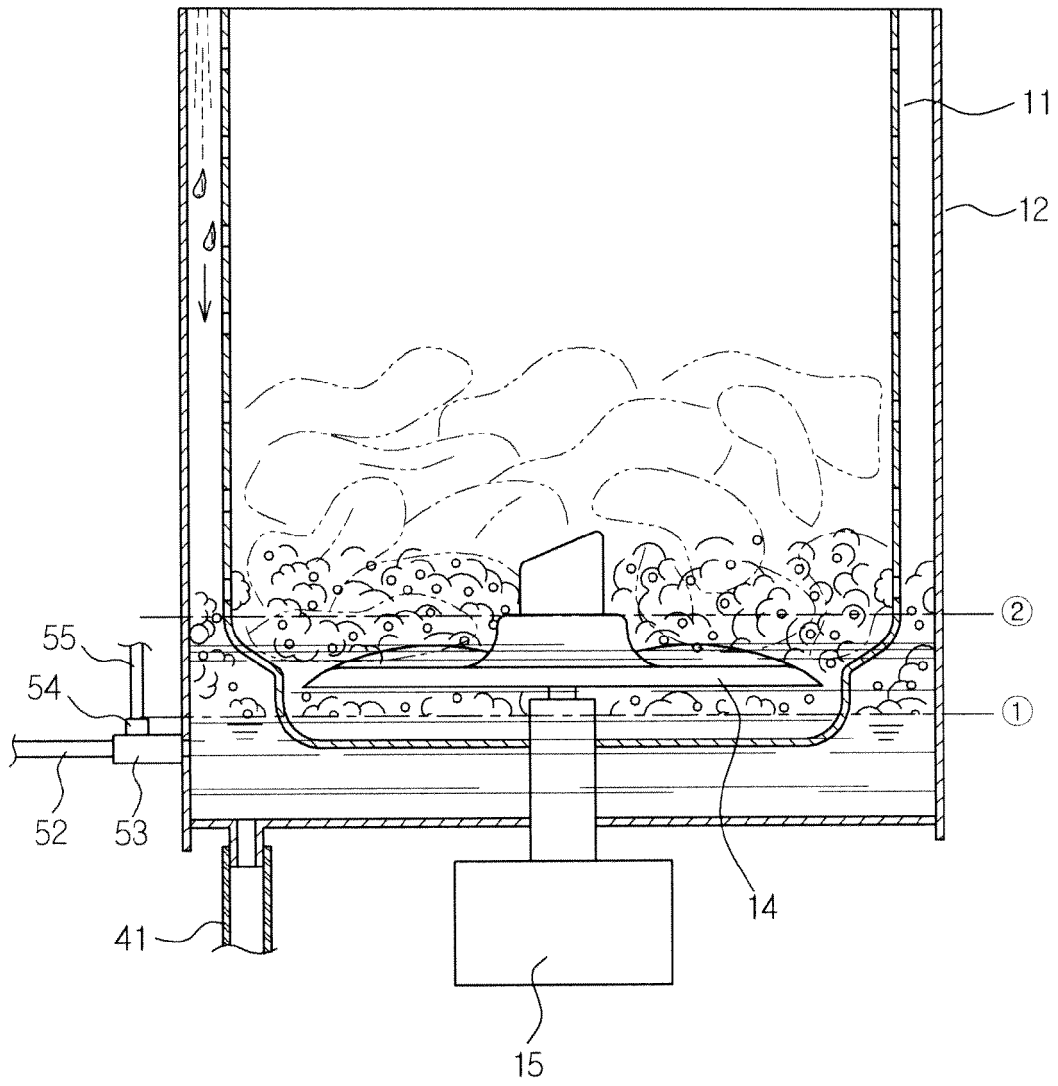


FIG. 7

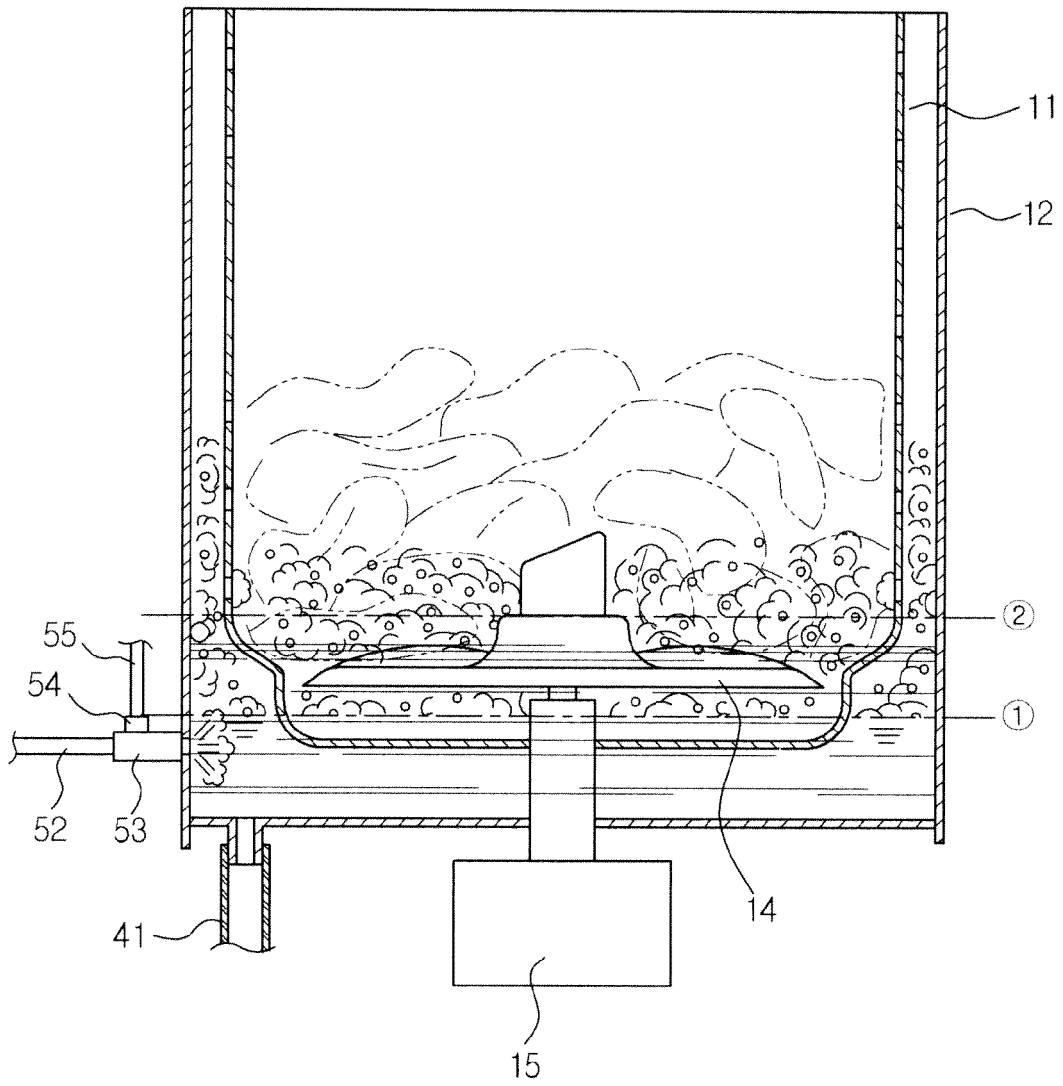


FIG. 8

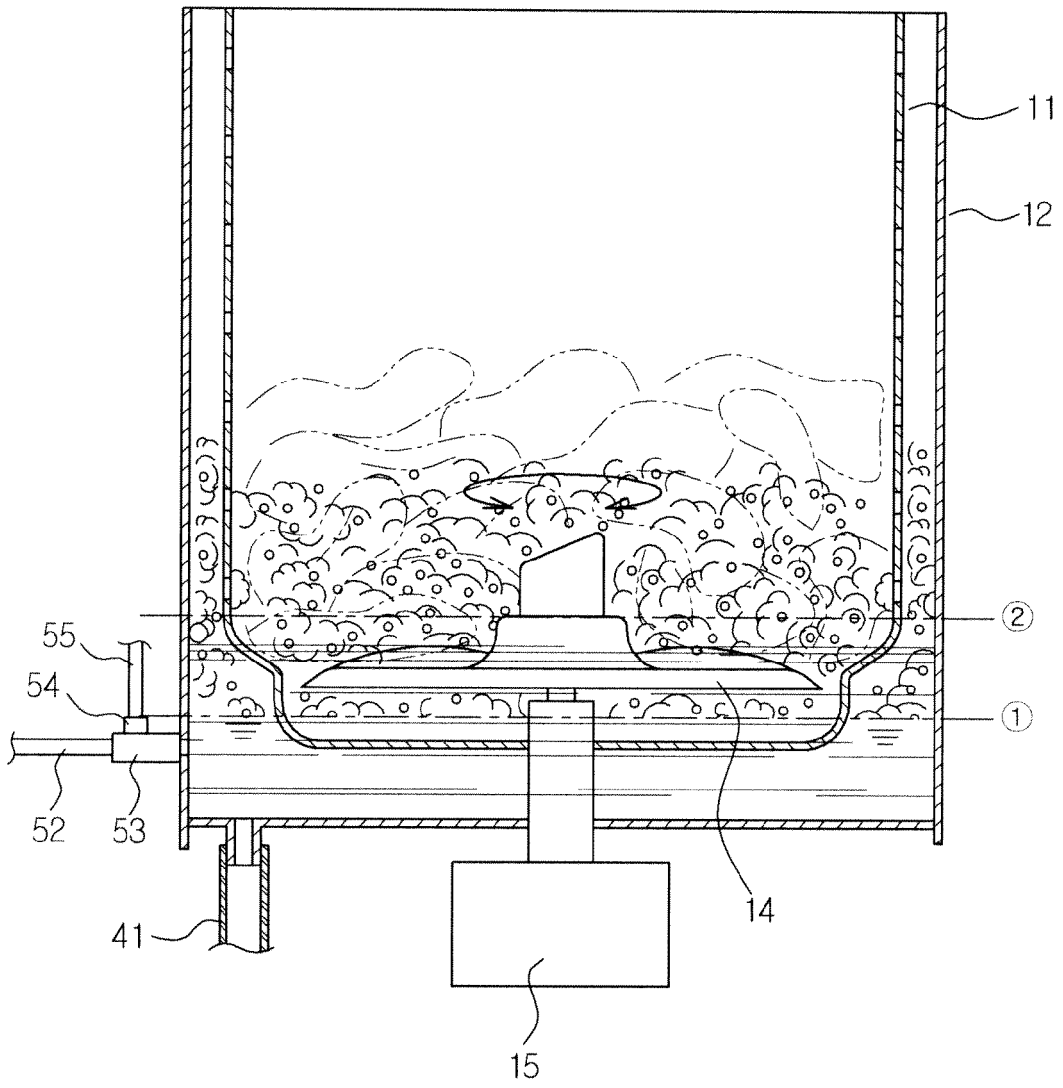


FIG. 9

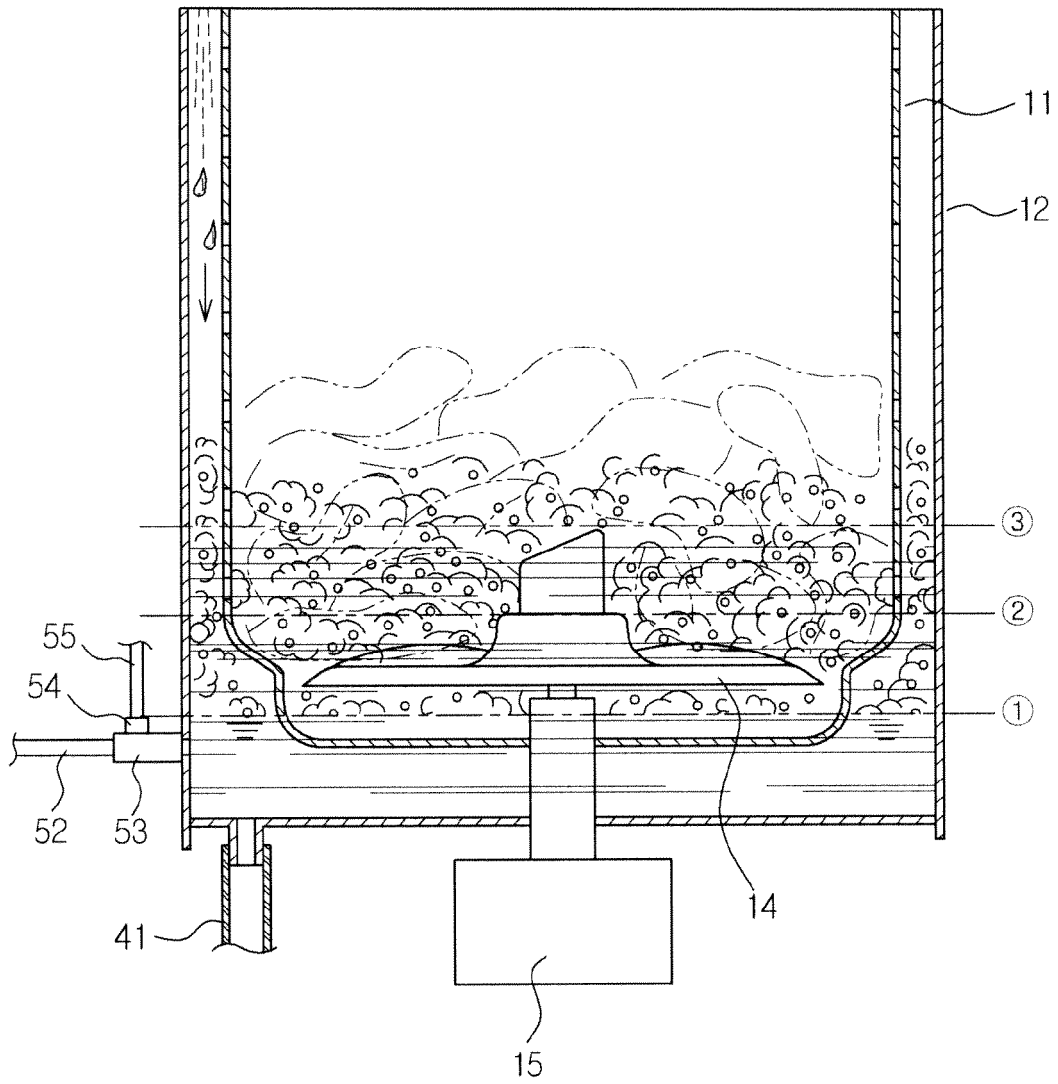
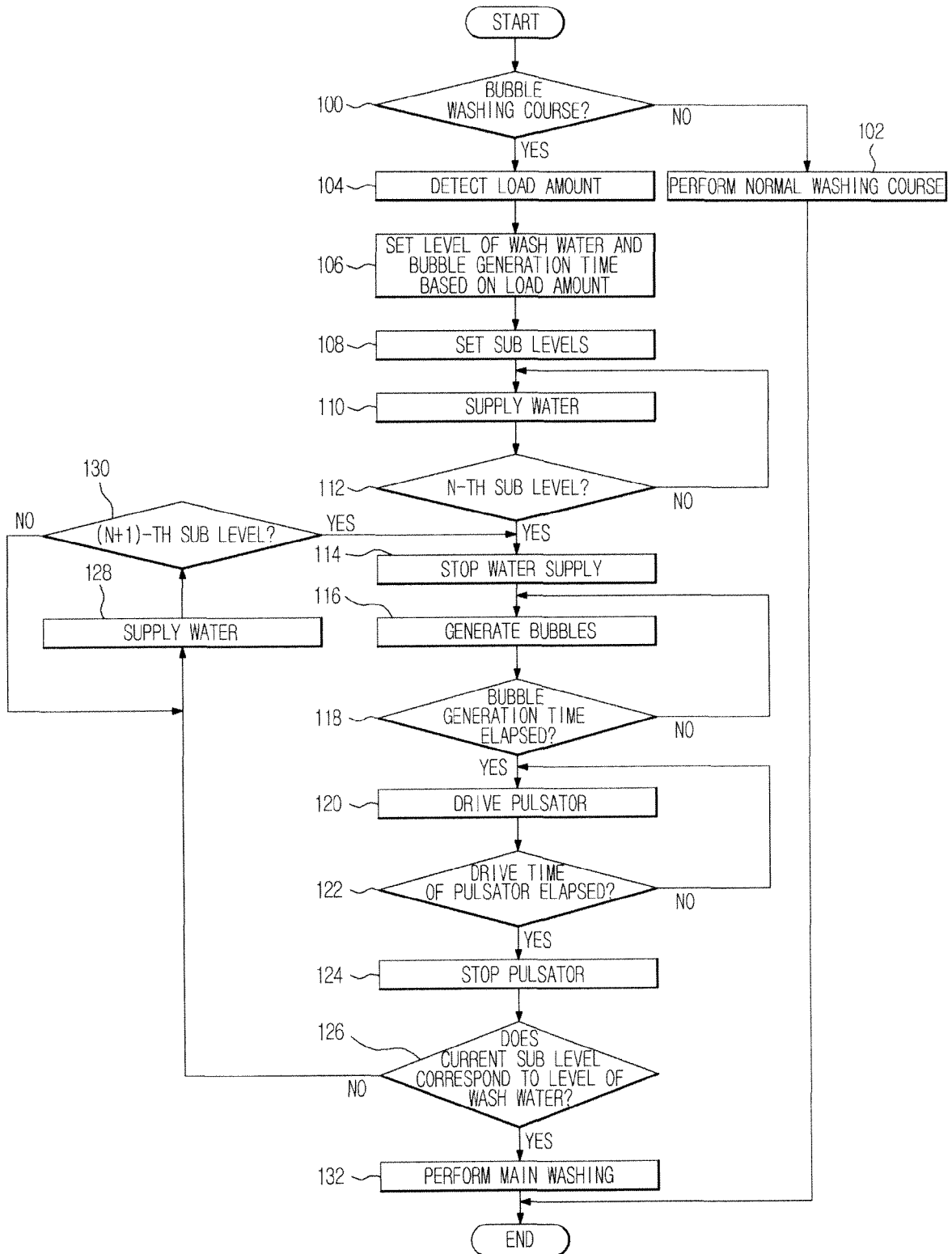


FIG. 10





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CATEGORY OF CITED DOCUMENTS		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 & : member of the same patent family, corresponding document	
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