US 20120060300A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2012/0060300 A1

(43) Pub. Date: Mar. 15, 2012

Kim et al.

(54) METHOD FOR WASHING AND WASHING MACHINE

(75) Inventors: **Youngjong Kim**, Seoul (KR); **Kyubum Lee**, Seoul (KR); **Aekyung Chae**, Seoul (KR)

(73) Assignee: **LG ELECTRONICS INC.**, Seoul (KR)

(21) Appl. No.: **13/229,442**

(22) Filed: **Sep. 9, 2011**

(30) **Foreign Application Priority Data**

Sep. 13, 2010 (KR) 10-2010-0089610
Nov. 10, 2010 (KR) 10-2010-0111620
Nov. 11, 2010 (KR) 10-2010-0112253

Publication Classification

(51) **Int. Cl.**
D06L 1/20 (2006.01)
D06F 39/10 (2006.01)
D06F 21/00 (2006.01)

(52) **U.S. Cl.** ..... **8/137**; 68/18 F

(57) **ABSTRACT**

A washing machine includes an outer tub and an inner tub rotatably provided in the outer tub, a spray nozzle spraying wash water into the inner tub, a circulation passage connecting the outer tub to the spray nozzle, and a filter provided in series with the circulation passage. A first pump directs the wash water from the outer tub to the circulation passage and to the spray nozzle so that foreign substances suspended in the wash water can be collected in the filter. A drain passage between the filter and spray nozzle connects the outer tub to the circulation passage. A second pump directs the wash water supplied to the circulation passage through the drain passage such that the wash water passes through the filter in a reverse direction and thus the foreign substances collected in the filter are exhausted out of the washing machine together with the wash water.

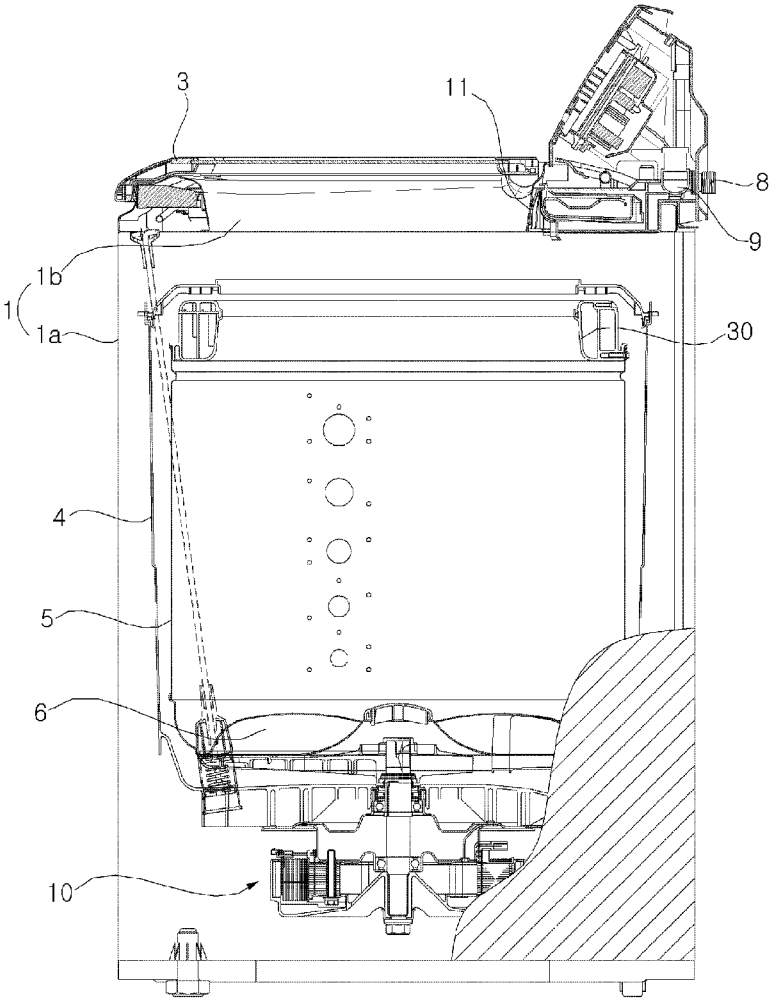


Fig. 1

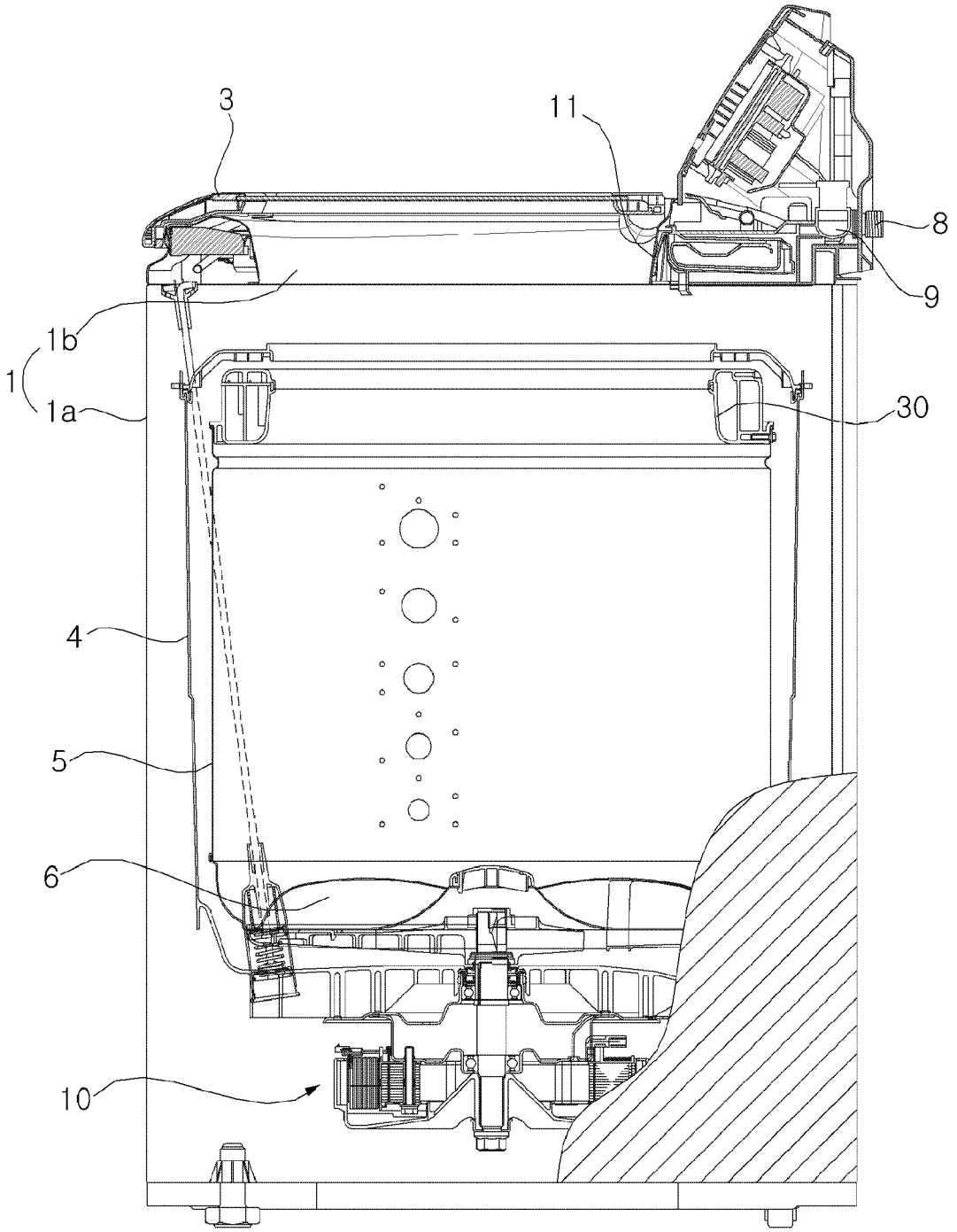


Fig. 2

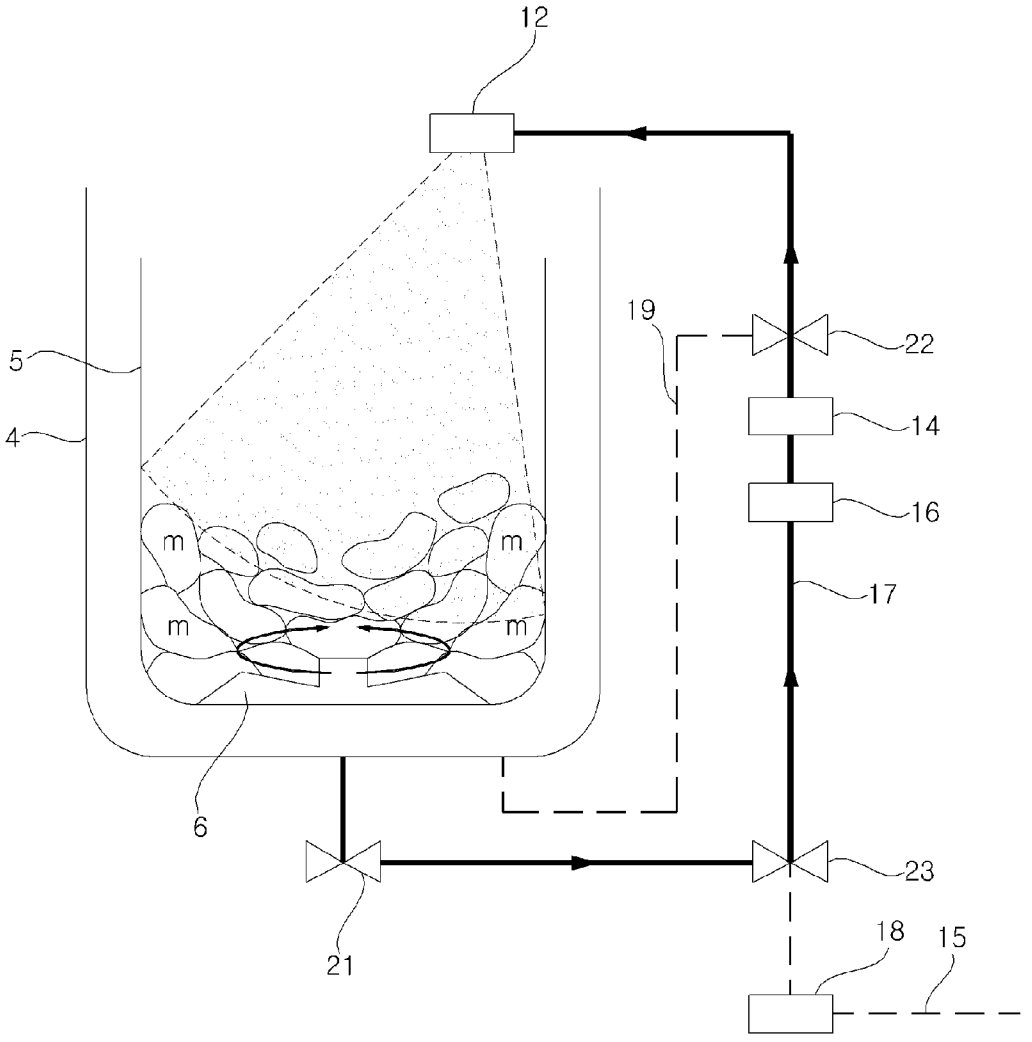


Fig. 3

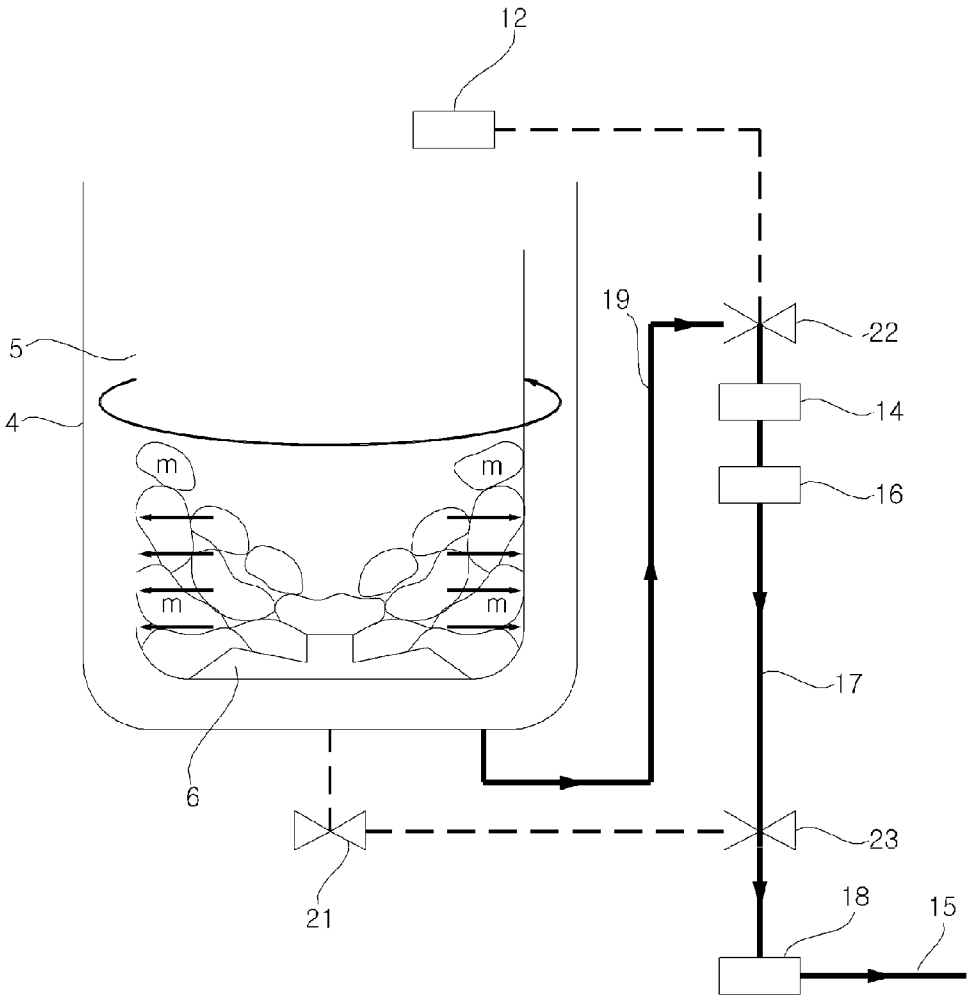


Fig. 4

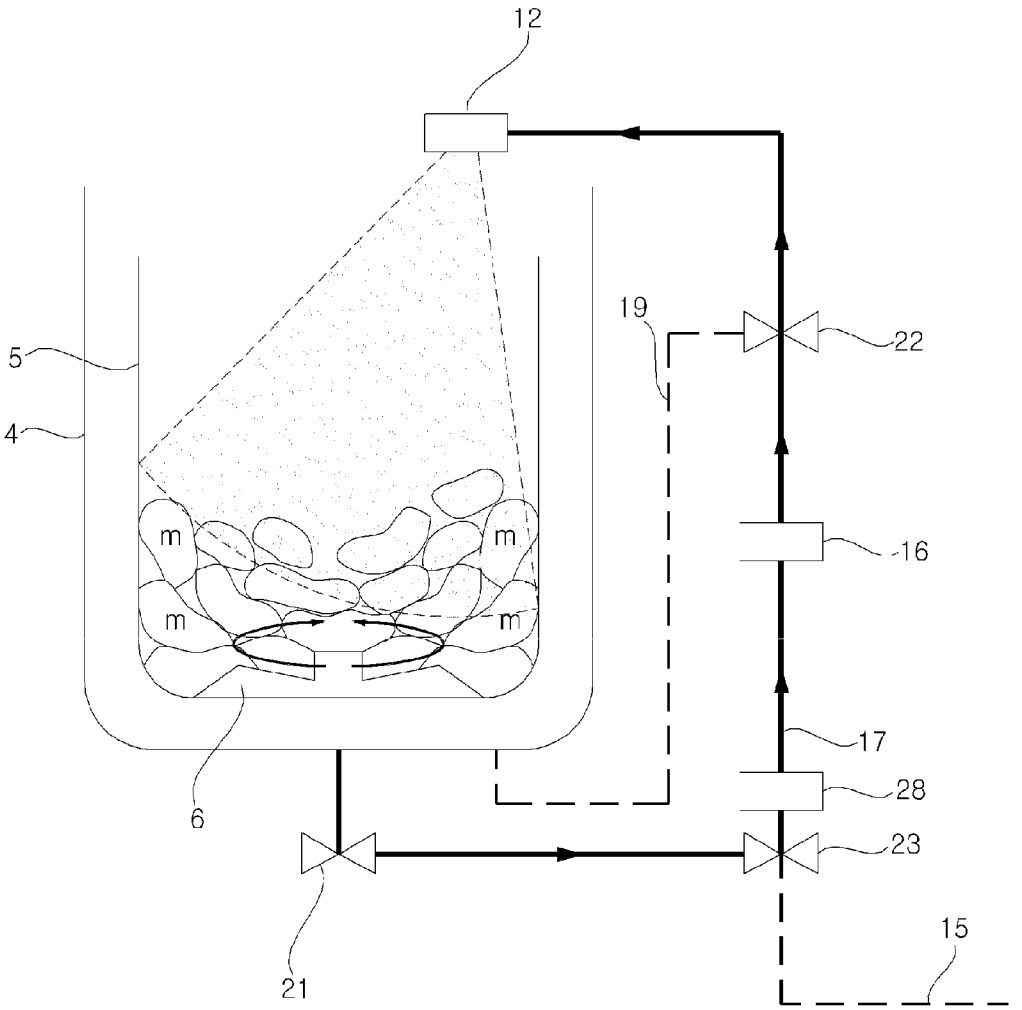


Fig. 5

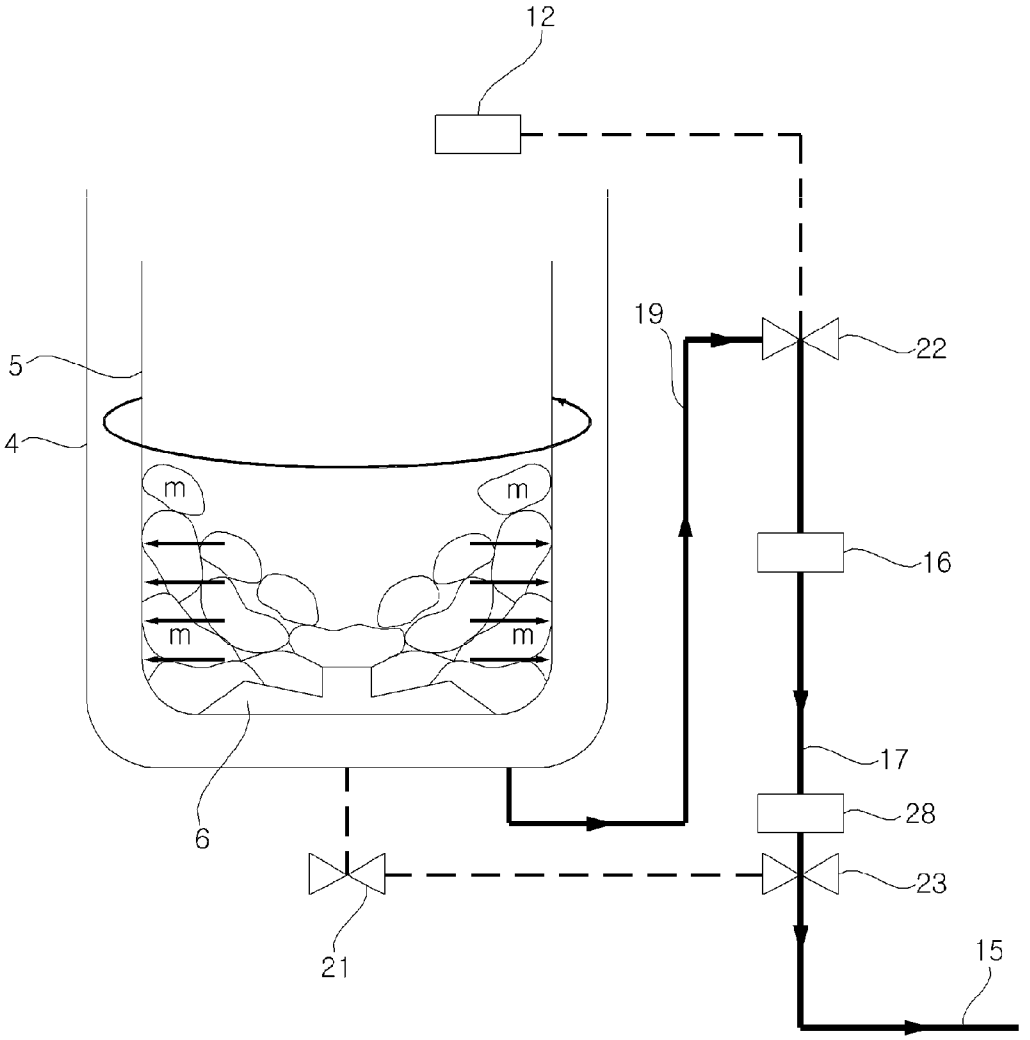


Fig. 6

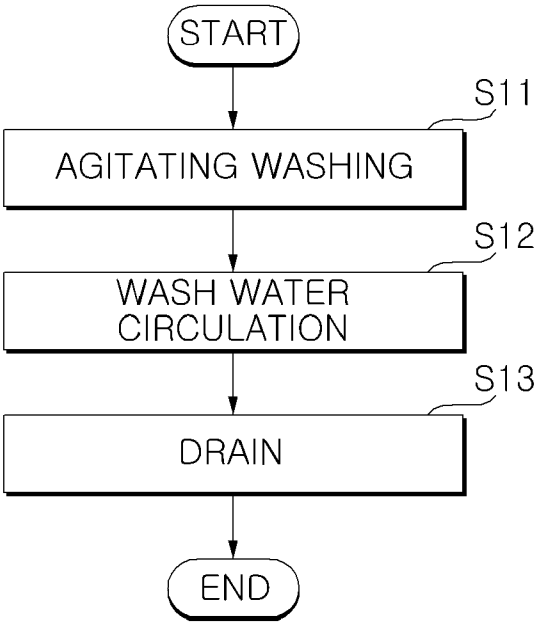

START
S11
AGITATING WASHING
S12
WASH WATER CIRCULATION
S13
DRAIN
END

Fig. 7

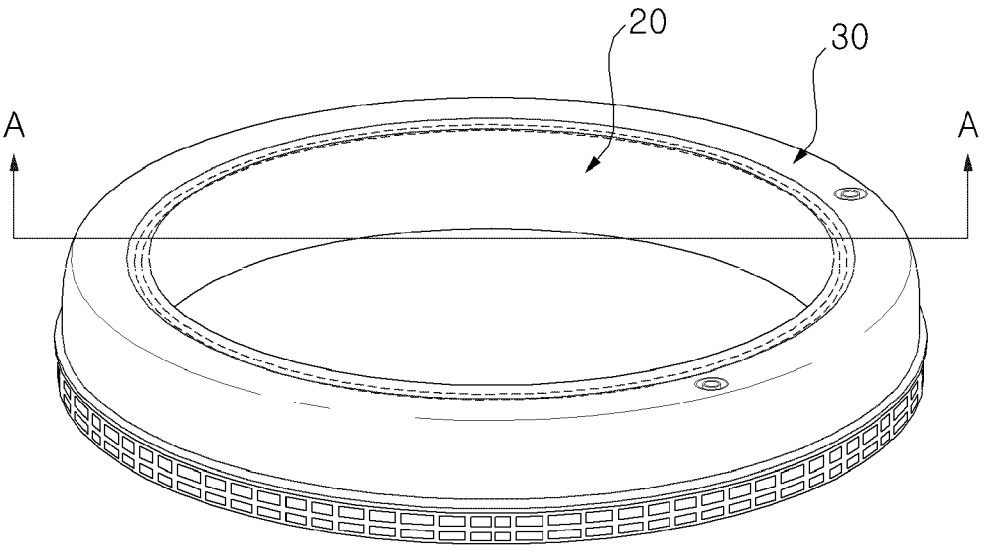

20
30
A
A

Fig. 8

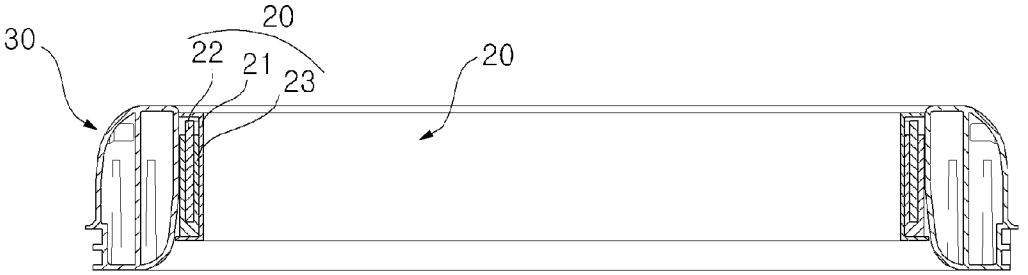


Fig. 9

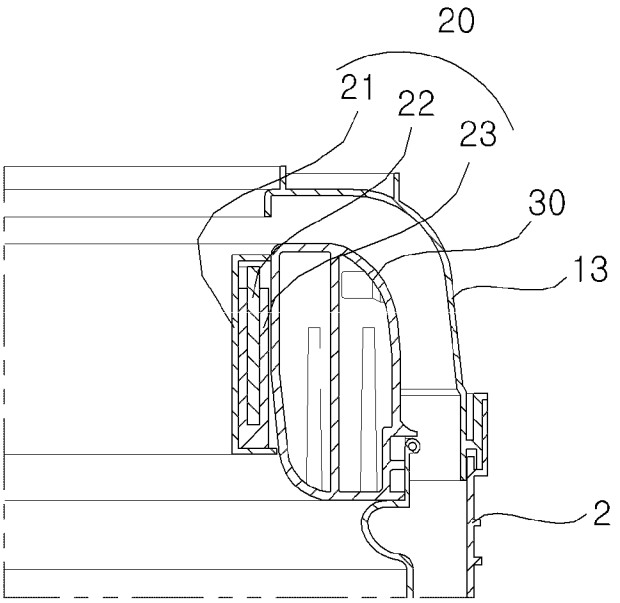


Fig. 10

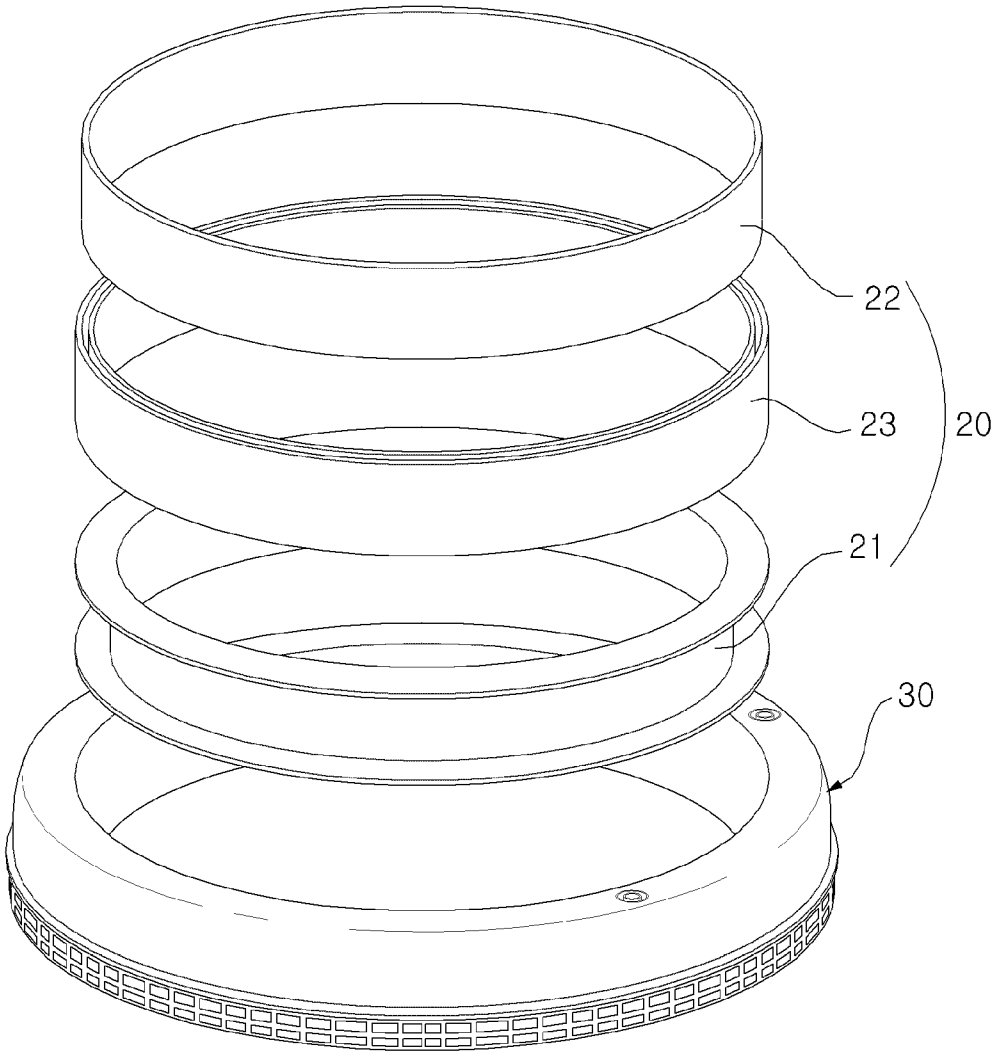


Fig. 11

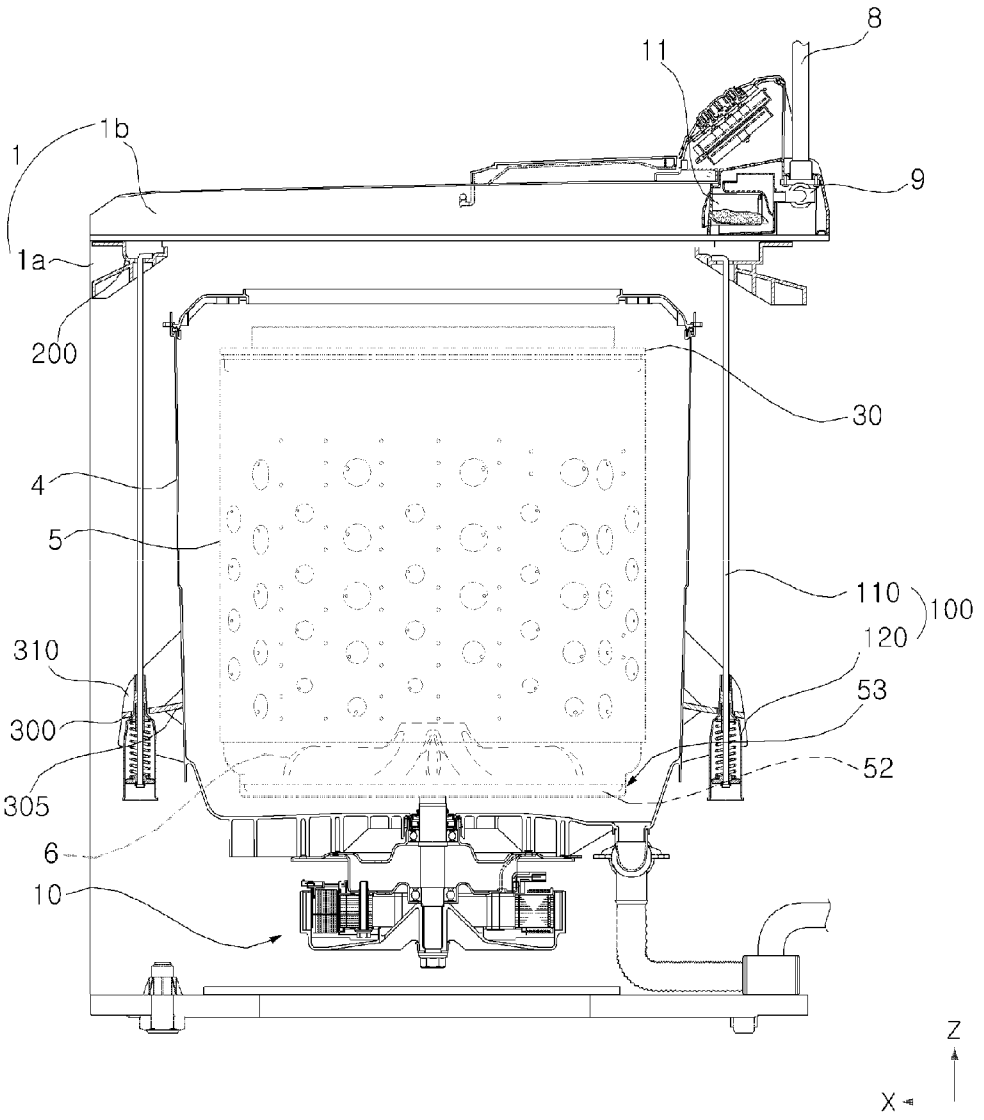


Fig. 12

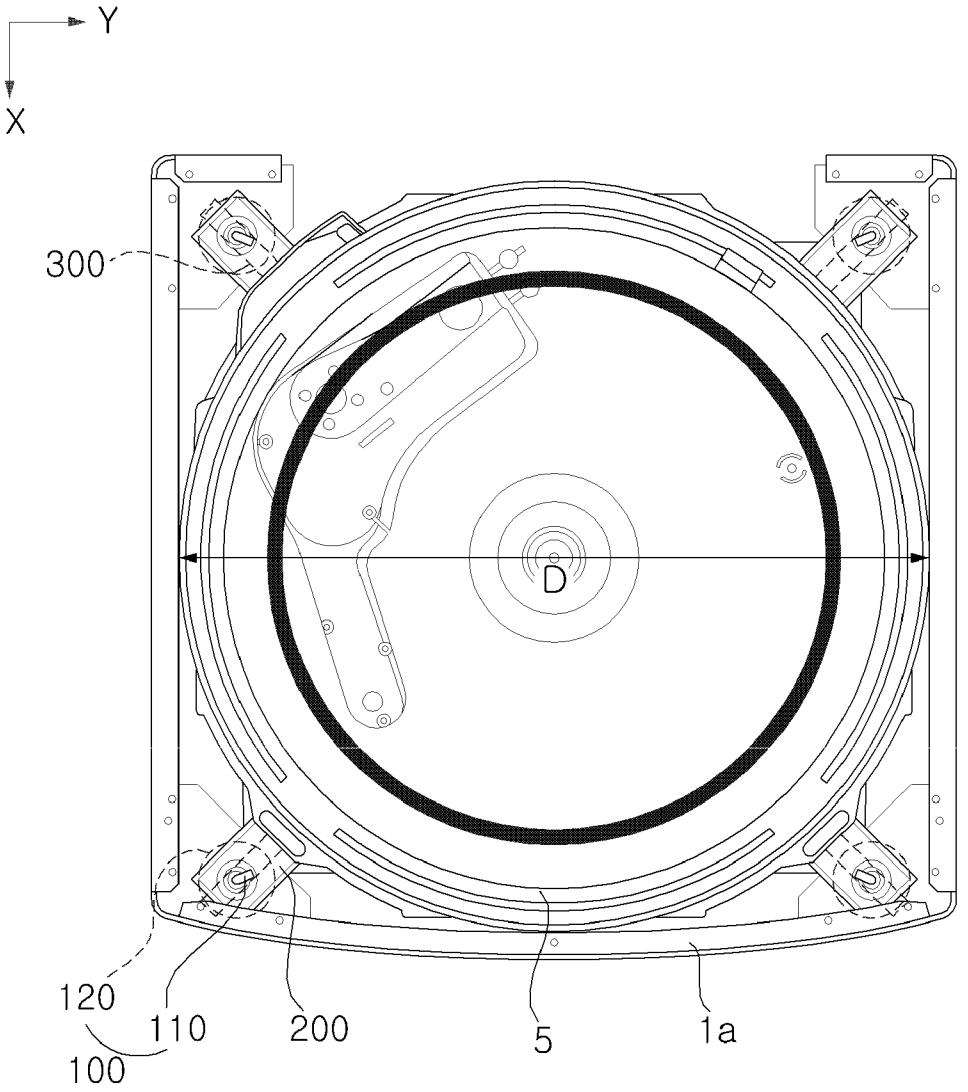


Fig. 13

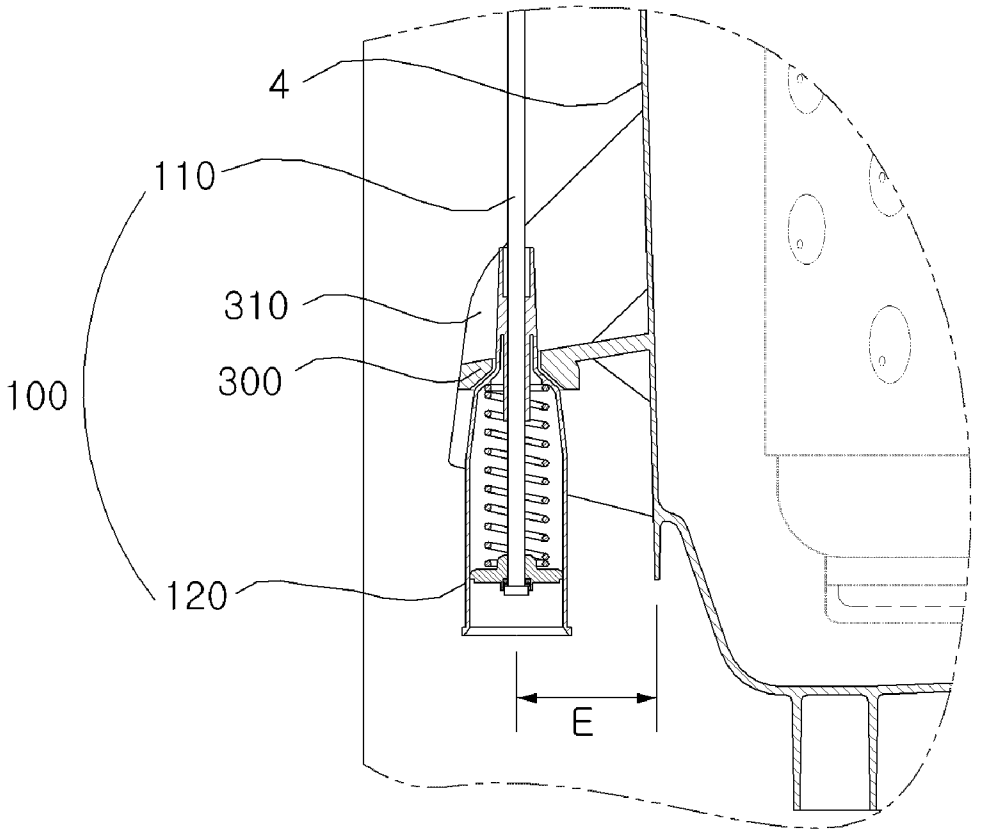


Fig. 14

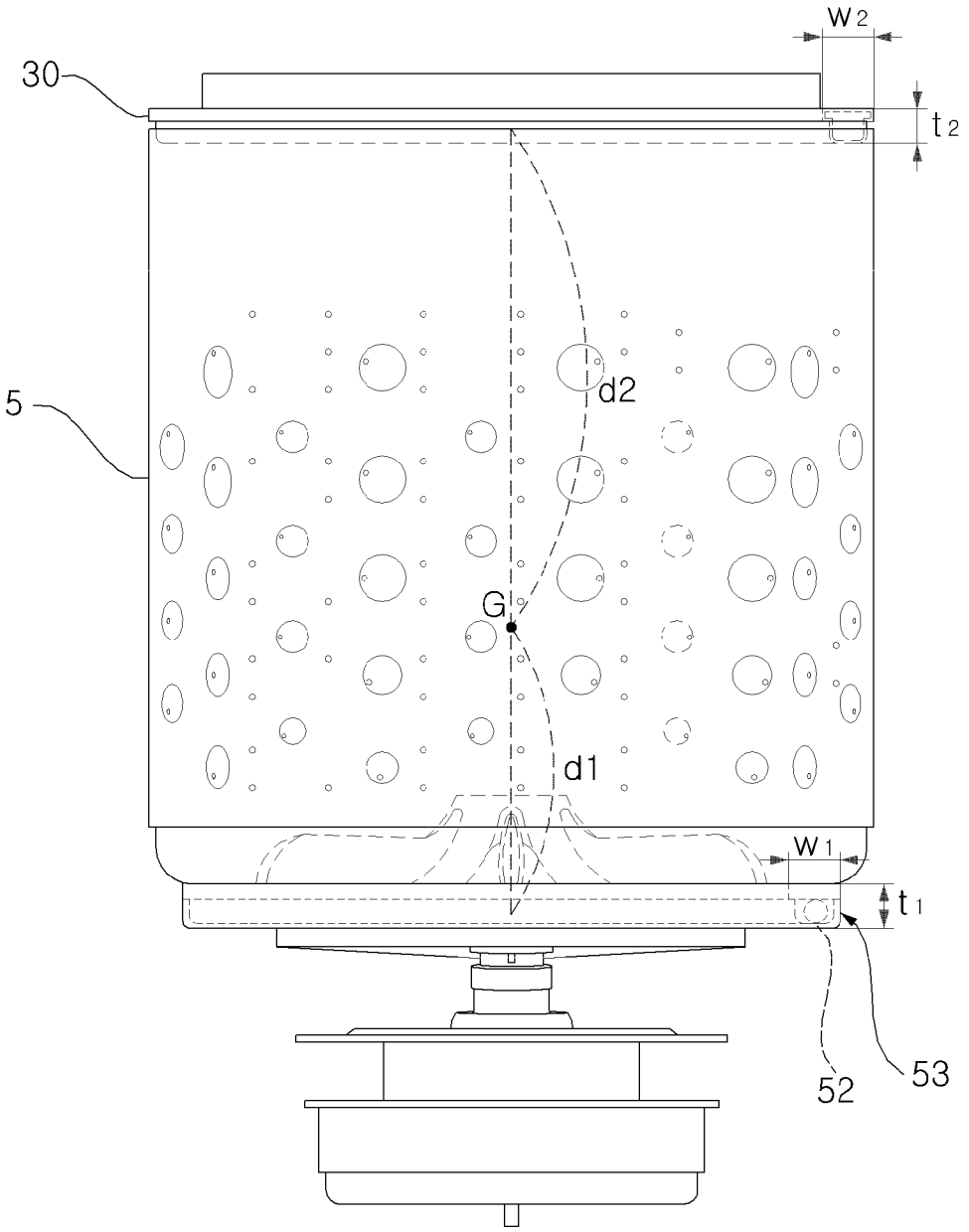


Fig. 15

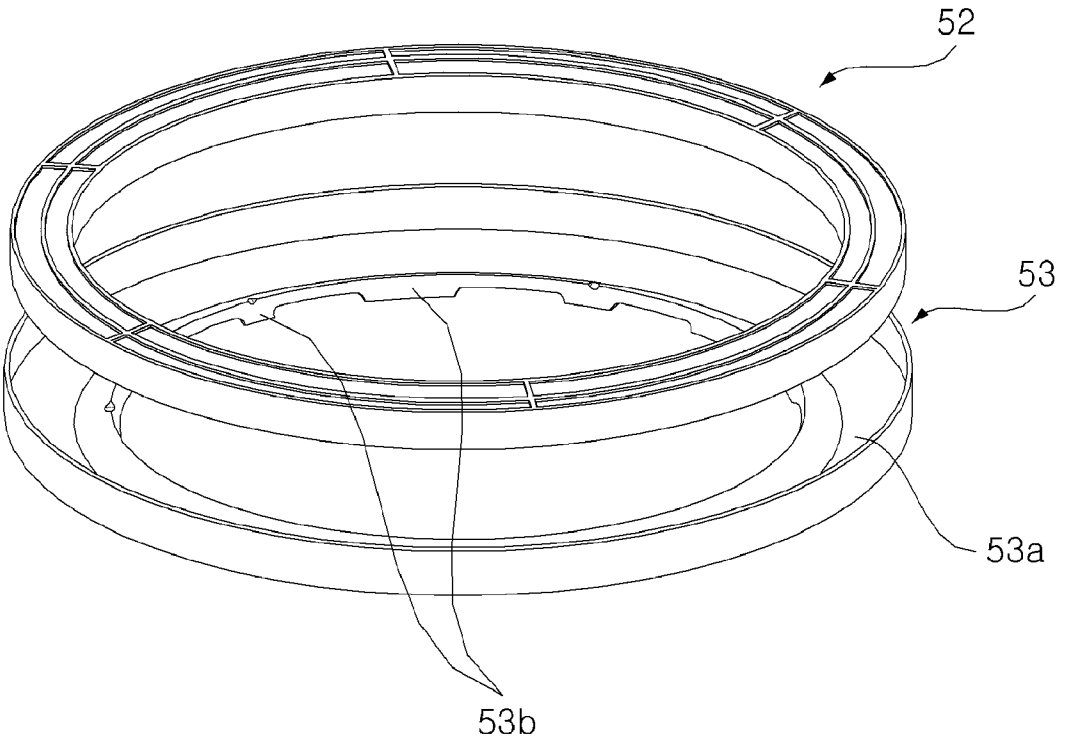


Fig. 16

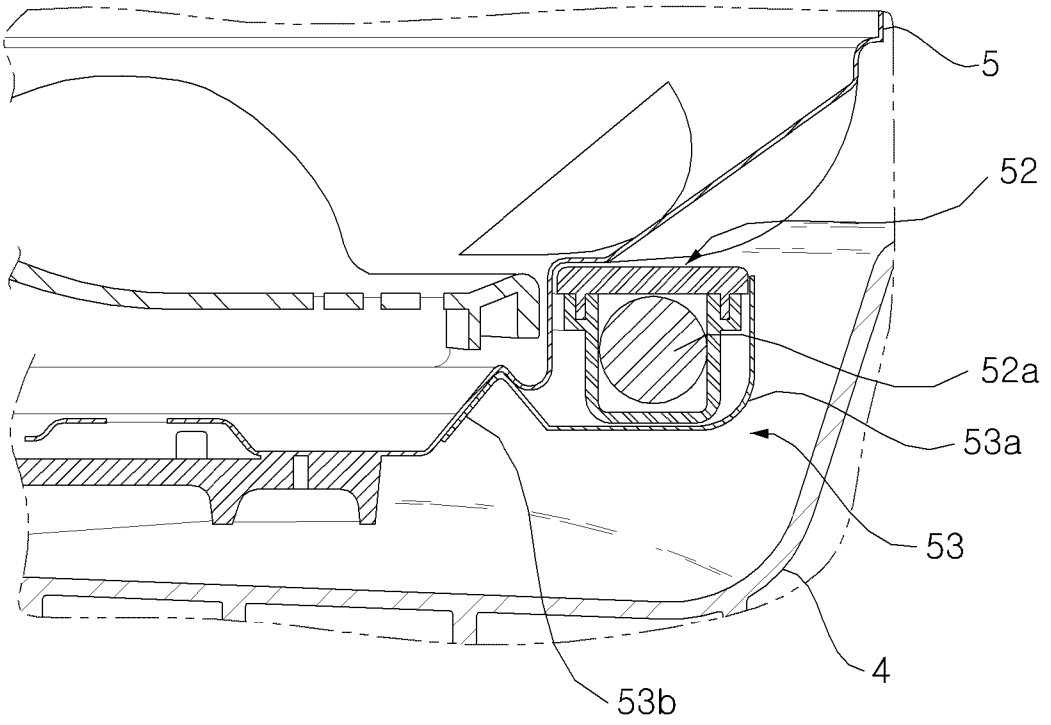
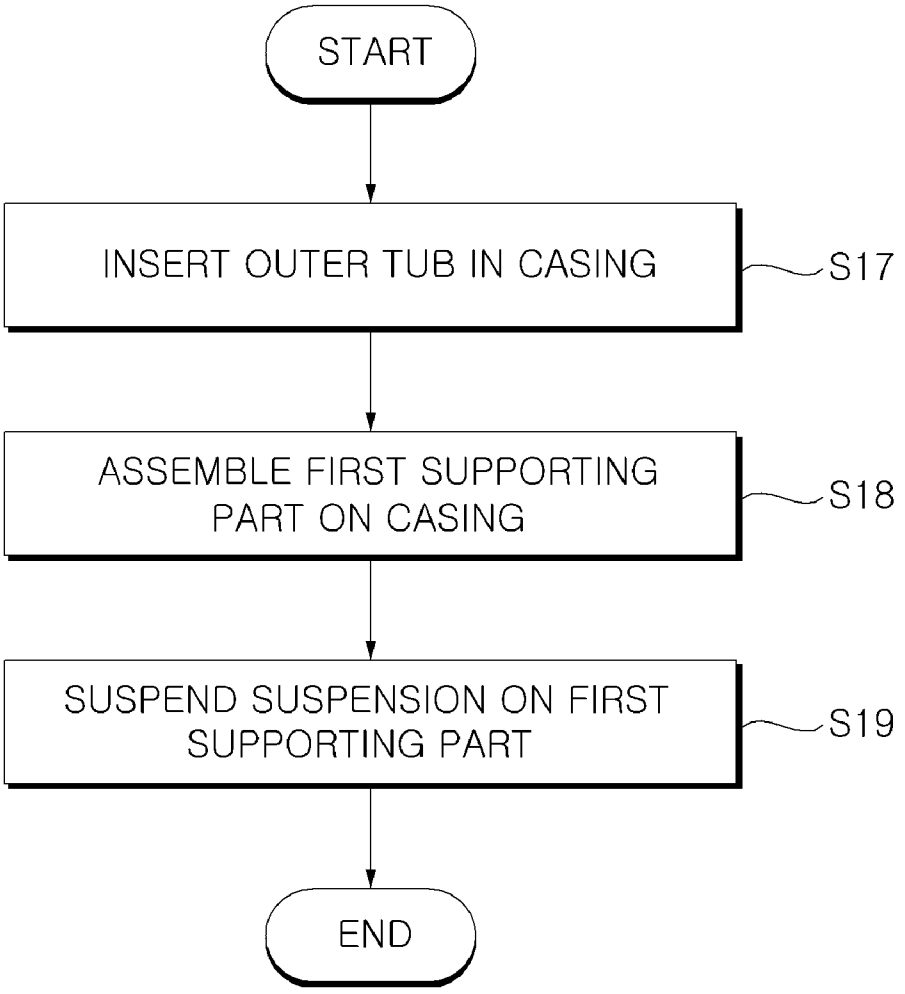


Fig. 17


START
INSERT OUTER TUB IN CASING
S17
ASSEMBLE FIRST SUPPORTING PART ON CASING
S18
SUSPEND SUSPENSION ON FIRST SUPPORTING PART
S19
END

METHOD FOR WASHING AND WASHING MACHINE

[0001] This application claims the benefit of Korean Patent Application No. 10-2010-0089610 filed in Korea on Sep. 13, 2010, No. 10-2010-0112253 filed in Korea on Nov. 11, 2010, and No. 10-2010-0111620 filed in Korea on Nov. 10, 2010, the disclosure of which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a washing machine and, more particularly, to a washing machine and method that collects foreign substances such as lint and the like suspended in wash water using a filter provided on a circulation passage when the wash water drains out of an outer tub and exhausts the collected foreign substances together with the wash water out of the washing machine when draining the wash water out of the washing machine.

[0004] 2. Description of the Related Art

[0005] In general, a washing machine is designed to wash the laundry using emulsification of a detergent, water stream action generated by the rotation of washing blades, and an impact action applied by the washing blades. The washing machine performs washing, rinsing, and/or spinning to remove contaminants from the laundry by using the interaction between the water and the detergent.

[0006] The related art washing machine includes a lint filter for filtering out foreign substances such as lint removed from laundry. However, it is troublesome because the user cleans the lint filter. In addition, when the lint filter is not cleaned in a timely manner and remains in a contaminated state, mildew can grow on the filter producing a rancid smell. Therefore, the user has to keep a close watch on the lint filter and check to determine if the lint filter is contaminated. This is troublesome for the user.

SUMMARY OF THE INVENTION

[0007] According to an aspect of the present invention, there is provided a washing machine including: an outer tub for storing wash water; an inner tub that is rotatably provided in the outer tub and in which laundry is loaded; a spray nozzle spraying the wash water into the inner tub; a circulation passage connecting the outer tub to the spray nozzle; a filter provided in series with the circulation passage; a first pump that directs the wash water circulated from the outer tub to the circulation passage to the spray nozzle so that foreign substances suspended in the wash water can be collected in the filter; a drain passage that connects the outer tub to the circulation passage and is connected between the filter and the spray nozzle; and a second pump that directs the wash water supplied to the circulation passage through the drain passage such that the wash water passes through the filter in a reverse direction and thus the foreign substances collected in the filter are exhausted out of the washing machine together with the wash water.

[0008] According to another aspect of the present invention, there is provided a washing machine including: an outer tub for storing wash water; an inner tub that is rotatably provided in the outer tub and in which laundry is loaded; a spray nozzle spraying the wash water into the inner tub; a circulation passage connecting the outer tub to the spray nozzle; a filter provided in series with the circulation passage; a drain passage that connects the outer tub to the circulation passage and is connected between the filter and the spray nozzle; and a pump that directs the wash water circulated from the outer tub to the circulation passage such that the wash water passes through the filter in a forward direction and thus foreign substances suspended in the wash water can be collected in the filter or directs the wash water supplied to the circulation passage through the drain passage such that the wash water passes through the filter in a reverse direction and thus the foreign substances collected in the filter are exhausted together with the wash water.

[0009] According to still another aspect of the present invention, there is provided a washing method including: performing washing by alternately rotating the pulsator in both directions; allowing a spray nozzle to spray wash water into the inner tub after the wash water circulates out of the outer tub and passes through a filter provided on a circulation passage in a forward direction; and allowing the wash water drained out of the outer tub to pass through the filter in a reverse direction and drain out of a washing machine so that foreign substances collected in the filter can be exhausted out of the washing machine.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and together with the description serve to explain the principles of the invention.

[0011] In the drawings:

[0012] FIG. **1** is a side sectional view of a washing machine according to an exemplary embodiment of the present invention;

[0013] FIG. **2** is a schematic view of a major part of the washing machine of the exemplary embodiment of the present invention, illustrating a process for filtering out foreign substances from the wash water circulating in a circulation passage;

[0014] FIG. **3** is a schematic view of a major part of the washing machine of FIG. **2**, illustrating a process for cleaning the filter;

[0015] FIG. **4** is a schematic view of a major part of a washing machine according to another exemplary embodiment of the present invention, illustrating a process for filtering out the foreign substances from wash water circulating in a circulation passage;

[0016] FIG. **5** is a schematic view of a major part of the washing machine of FIG. **4**, illustrating a process for cleaning the filter;

[0017] FIG. **6** is a flowchart illustrating a washing method according to an exemplary embodiment of the present invention;

[0018] FIG. **7** is a perspective view of a balancer and a dynamic vibration absorber that can be applied to the washing machine of FIG. **1** according to an exemplary embodiment of the present invention;

[0019] FIG. **8** is a sectional view taken along line A-A of FIG. **7**;

[0020] FIG. **9** is a partially enlarged view of FIG. **8**;

[0021] FIG. **10** is an exploded perspective view of FIG. **7**;

[0022] FIG. **11** is a sectional view of a washing machine according to another exemplary embodiment of the present invention;

[0023] FIG. **12** is a plane view of the washing machine of FIG. **11**, with a top cover removed;

[0024] FIG. **13** is a partial sectional view of a lower side portion of the washing machine of FIG. **11**;

[0025] FIG. **14** is a view of an inner tub and balancer illustrated in FIG. **11**;

[0026] FIG. **15** is a perspective view of a lower balancer and fixing bracket illustrated in FIG. **14**;

[0027] FIG. **16** is a partial sectional view of a lower balancer and inner tub illustrated in FIG. **14**; and

[0028] FIG. **17** is a flowchart illustrating a method for assembling the outer tub of the washing machine of FIG. **11** according to an exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0029] The foregoing and other features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings. Exemplary embodiments of the present invention will now be described in detail with reference to the accompanying drawings. The invention may, however, be embodied in many different forms and should not be construed as being limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. In the drawings, the shapes and dimensions may be exaggerated for clarity, and the same reference numerals will be used throughout to designate the same or like components.

[0030] Hereinafter, exemplary embodiment of the present invention will be described in detail with reference to the accompanying drawings.

[0031] FIG. **1** is a side sectional view of a washing machine according to an exemplary embodiment of the present invention. Referring to FIG. **1**, a washing machine of an exemplary embodiment of the present invention includes a casing **1** defining an appearance of the washing machine, an outer tub **4** disposed in the casing **1**, and an inner tub **5** disposed in the outer tub **4**. Casing **1** includes a cabinet **1***a* having an opened top and a top cover **1***b* that covers the opened top of the cabinet **1***a* and is provided with a laundry loading/unloading opening through which the laundry can be loaded and unloaded.

[0032] The outer tub **4** for storing wash water is provided in the cabinet **1***a* and the inner tub **5** in which the laundry is loaded **4** is rotatably provided in the outer tub **4**. A pulsator **6** is rotatably provided on a bottom of the inner tub **5**.

[0033] In addition, a driving unit **10** providing driving force for rotating the inner tub **5** and/or the pulsator **6** is provided in the cabinet **1***a*. A door **3** for opening and closing the laundry loading/unloading opening of the top cover **1***b* is provided on the top cover **1***b*.

[0034] The wash water is supplied through a water supply passage **8** connected to an outer water source such as a water tap. A water supply valve **9** for controlling the supply of the wash water may be provided on the water supply passage **8**. The wash water supplied through the water supply passage **8** is directed into the inner and outer tubs **5** and **4** via a wash aid agent box **11** storing detergent, softener, whitener, and the like. Alternatively, the wash water may be may be sprayed into the inner tub **5** via a spray nozzle **12** (that will be described later) without passing through the wash aid agent box **11**. Meanwhile, the inner tub **5** is provided with a plurality of openings through which the wash water flows between the inner and outer tubs **5** and **4**.

[0035] FIG. **2** is a schematic view of a major part of the washing machine of the exemplary embodiment of the present invention, illustrating a process for filtering out foreign substances from the wash water circulating in a circulation passage. Referring to FIG. **2**, the washing machine of the exemplary embodiment of the present invention further includes a spray nozzle **12** for spraying the wash water into the inner tub **5**, a circulation passage **17** connecting the outer tub **4** to the spray nozzle **12**, a filter **16** for collecting foreign substances such as lint and the like suspended in the wash water, a first pump **14** that pumps out the wash water such that the wash water is directed to the spray nozzle **12** along the circulation passage **17** and sprayed into the inner tub **5**, a drain passage **19** having a first end connected to the outer tub **4** and a second end connected to the circulation passage **17** between the spray nozzle **12** and the first pump **14**, and a second pump **18** for draining the wash water from which the foreign substances are removed by the filter **16**.

[0036] Hereinafter, the first pump **14** will be referred to as "circulation pump" as it allows the wash water drained from the outer tub **4** to be sprayed into the inner tub **5** through the spray nozzle **12** via the circulation passage **17**. The second pump **18** will be referred to as "drain pump" as it is configured to drain the wash water stored in the outer tub **4** out of the washing machine.

[0037] In addition, the washing machine may further include a first valve **21** for controlling the wash water flowing from the outer tub **4** into the circulation passage **17**, a second valve **23** for controlling the wash water flowing from the circulation passage **17** into the circulation pump **14**, a third valve **22** for controlling the wash water flowing into the circulation passage **17** through the drain passage **19**. Here, a valve (not shown) may be further provided on a connecting portion between the outer tub **4** and the drain passage **19** to prevent the wash water from remaining in the drain passage **19**.

[0038] In the washing machine according to the exemplary embodiment of the present invention, when the water supply valve **9** is opened, the wash water is supplied into the inner and outer tubs **5** and **4** through the water supply passage **8** via the wash aid agent box **11**. When the wash water fills in the outer tub **5** to a predetermined water level, the inner tub **5** and/or the pulsator **6** rotates to perform the washing. During this washing, wash water circulation is realized by draining the wash water out of the outer tub **4** and spraying the drained wash water into the inner tub **5** through the spraying nozzle **12**. To realize this, the first valve **21** is opened and the circulation pump **14** operates.

[0039] Here, describing the process of the wash water circulation in more detail, the wash water directed from the outer tub **4** into the circulation passage **17** is sprayed into the inner tub **12** via the filter **16**, the circulation pump **14**, and the spray nozzle **12** in this order. When the wash water passes through the filter **16**, the foreign substances such as the lint and the like suspended in the water are filtered out by the filter **16**.

[0040] Meanwhile, while the circulation pump **14** operates, the pulsator **6** may alternately rotate in both directions to perform agitation washing. At this point, the driving unit **10** may be driven such that the pulsator **6** rotates shortly in one

direction in one rotation cycle and rotates shortly in the other direction within the one rotational cycle.

[0041] In the washing machine according to the exemplary embodiment of the present invention, the washing is realized by rotating the inner tub **5** or the pulsator **6** in a variety of patterns. When the pulsator **6** rotates, foreign substances such as lint and the like are removed from the laundry by friction between the pulsator **6** and the laundry and suspended in the wash water. The foreign substances are effectively collected by the filter **16** during the circulation of the wash water through the circulation passage **17**.

[0042] FIG. **3** is a schematic view of a major part of the washing machine of FIG. **2**, illustrating a process for cleaning the filter **16**. Referring to FIG. **3**, in the washing machine of the exemplary embodiment of the present invention, in order to exhaust the foreign substances collected by the filter **16** together with the wash water that is being drained, the wash water drained from the outer tub **4** passes through the filter **16** in a reverse direction when draining the wash water outer of the washing machine. Here, defining the direction in which the wash water passes through the filter **16**, as shown in FIG. **2**, as the direction in which the wash water passes through the filter **16** so that the foreign substances are collected in the filter **16** is defined as a forward direction. On the other hand, as shown in FIG. **3**, the direction in which the wash water passes through the filter **16** so that the foreign substances collected in the filter **16** can be exhausted outside of the washing machine is defined as the reverse direction.

[0043] When the wash water is drained while passing through the filter **16** in the reverse direction, the foreign substances collected in the filter **16** are exhausted out of the washing machine together with the wash water that is being drained out of the washing machine. At this point, the third valve **22** is opened so that the wash water drained from the outer tub **4** is introduced into the circulation passage **17** through the drain passage **19**. In addition, the second valve **23** is opened so that the wash water is introduced into the drain pump **18** through the circulation passage **17**, after which the drain pump **18** is operated. Meanwhile, when draining the wash water, it can be considered to open not only the third valve **22** but also the first valve **21**. In this case, the draining time can be shortened.

[0044] In addition, as shown in FIG. **3**, when draining the wash water in the outer tub **4** out of the washing machine, the inner tub **5** may continuously rotate in a direction. At this point, an RPM of the inner tub **5** may be a degree at which the laundry m is attached to the inner wall of the inner tub **5** to rotate together with the inner tub **5** by centrifugal force. In this case, a certain amount of the water contained in the laundry m is removed from the laundry m by the centrifugal force and is drained.

[0045] Meanwhile, while the wash water is drained out of the washing machine, it can be also considered to spray the wash water into the inner tub **5** through the spray nozzle **12** to rinse the laundry m. For this, a passage (not shown) connecting the spray nozzle **12** to the water supply passage **8** may be formed. While the wash water in the outer tub **4** is drained out of the washing machine, the wash water is sprayed through the spray nozzle **12** and, at the same time, the inner tub **5** may continuously rotate in one direction. The wash water sprayed from the spray nozzle **12** is uniformly soaked in the laundry and thus the rinsing can be effectively realized. The water removed from the laundry m by the centrifugal force is continuously drained to the outer tub **4** through the openings formed through the inner tub **5** and thus the recontamination of the laundry by the wash water used for rinsing can be prevented. At this point, in order for the laundry to adhere to the inner wall of the inner tub **5** and integrally rotate together with the inner tub **5**, the inner tub **5** may rotate at an RPM at which the centrifugal force can be sufficiently generated.

[0046] FIG. **4** is a schematic view of a major part of a washing machine according to another exemplary embodiment of the present invention, illustrating a process for filtering out the foreign substances from the wash water circulating in the circulation passage **17**. FIG. **5** is a schematic view of a major part of the washing machine of FIG. **4**, illustrating a process for cleaning the filter **16**.

[0047] In the washing machine of this exemplary embodiment of the present invention, a process for allowing the wash water to pass through the filter **16** in the forward direction so that the foreign substances suspended in the wash water can be filtered out by the filter **16** is the same as the exemplary embodiment described with reference to FIG. **2** and the process for allowing the wash water to pass through the filter **16** in the reverse direction so as to clean the filter **16** is the same as the exemplary embodiment described with reference to FIG. **3**.

[0048] However, the washing machine of this exemplary embodiment of the present invention is different from the washing machine of the foregoing exemplary embodiment in that the circulation and draining of the wash water are realized by one pump **28**. In this exemplary embodiment, since the circulation and draining of the wash water is selectively realized by one pump **28**, the pump **28** will be referred to as "circulation/drain pump," hereinafter.

[0049] The washing machine of this exemplary embodiment will be described hereinafter while omitting the description of components that are same as those of FIGS. **2** and **3**.

[0050] Referring to FIG. **4**, in this exemplary embodiment, in order to collect the foreign substances suspended in the wash water using the filter **16**, the wash water in the outer tub **4** is circulated to the circulation passage **17** and is directed to the spray nozzle **12** while passing through the filter **16** in the forward direction. At this point, the circulation/drain pump **28** pumps out the wash water such that the wash water can be sprayed through the spray nozzle **12** via the circulation passage **17**.

[0051] Referring to FIG. **5**, when draining the wash water out of the outer tub **4**, the circulation/drain pump **28** is operated such that the wash water drained from the outer tub **4** can pass through the filter **16** in the reverse direction. The circulation/drain pump **28** may include an impeller driven by a motor. The circulation and draining of the wash water may be determined in accordance with the rotational direction of the impeller.

[0052] That is, the forward direction may be defined as the direction in which the impeller rotates such that the wash water passes through the filter **16** in the direction shown in FIG. **4**. Where the reverse direction may be defined as the direction in which the impeller rotates such that the wash water passes through the filter **16** as shown in FIG. **5**.

[0053] According to the washing machine of this exemplary embodiment, the wash water is circulated or drained by one circulation/drain pump **28**. When the wash water is circulated, the foreign substances contained in the wash water are collected by the filter **16**. When the wash water is drained, the foreign substances collected in the filter **16** are exhausted out of the washing machine.

[0054] FIG. **6** is a flowchart illustrating a washing method according to an exemplary embodiment of the present invention.

[0055] Referring to FIG. **6**, in the washing machine of the present invention, an agitating washing at S**11** may be performed by alternately rotating the pulsator **6** in clockwise and counter-clockwise directions in a short cycle (hereinafter, referred to as "agitating washing"). In order for the filter **16** to collect the foreign substances such as lint and the like that are removed from the laundry and suspended in the wash water during the agitating washing step S**11**, the wash water in the outer tub **4** is circulated to the circulation passage **17** at S**12** such that the wash water is sprayed into the inner tub **5** through the spray nozzle **12** after passing through the filter **16** in the forward direction (hereinafter, referred to as "wash water circulation").

[0056] During the agitating washing step S**11**, the driving unit **10** may be driven such that the pulsator **6** rotates shortly in one direction in one rotation cycle and rotates shortly in the other direction within the one rotational cycle.

[0057] In the wash water circulation step S**12**, the wash water is drained from the outer tub **4** to the circulation passage **17** and sprayed through the spray nozzle **12** after passing through the filter **16** in the forward direction by the pump. At this point, the first valve **21** is opened and the second and third valves **23** and **22** are closed.

[0058] In a draining step S**13**, the wash water drained from the outer tub **4** to the draining passage **19** passes through the filter **16** in the reverse direction along the circulation passage **17**, after which the wash water is drained out of the washing machine. In the draining step S**13**, the wash water may be sprayed through the spray nozzle **12** through a passage (not shown) branched off from the water supply passage **8**. At this point, the inner tub **5** may continuously rotate in a direction at an RPM at which the laundry m is attached to the inner wall of the inner tub **5** to rotate together with the inner tub **5** by centrifugal force.

[0059] According to the washing machine and washing method that are described with reference to FIGS. **1** to **6**, because the filter is automatically cleaned during the draining, there is no need for a user to clean the filter. In addition, because the filter is frequently cleaned, a cleaned state is always maintained.

[0060] FIG. **7** is a perspective view of a balancer **30** and a dynamic vibration absorber **20** that can be applied to the washing machine of FIG. **1** according to an exemplary embodiment of the present invention. FIG. **8** is a sectional view taken along line A-A of FIG. **7**. FIG. **9** is a partially enlarged view of FIG. **8**. FIG. **10** is an exploded perspective view of FIG. **7**.

[0061] The following will describe the dynamic vibration absorber **20** for absorbing vibration generated when the inner tub **5** rotates with reference to FIGS. **7** to **10**. The dynamic vibration absorber **20** is a mass-elastometer provided on the inner tub **5** to attenuate the vibration of the inner tub **5**. The dynamic vibration absorber **20** includes a vibration body (or a mass body) **22** that absorbs the vibration, which is generated when the inner tub **5** rotates, and vibrates by itself and an elastic body **23** elastically supporting the vibration body **22**.

[0062] The vibration body **22** is formed in a circular shape and provided along a circumference of the inner tub **5**. The elastic body **23** elastically supports the vibration body **22**. Since the dynamic vibration absorber **20** is formed in the circular shape, it can effectively absorb the vibration regardless of the vibration direction of the inner tub **5**.

[0063] The vibration body **22** may be provided on any one of the inner or outer circumferences of the inner tub **5**. In order to maintain a sufficient space between the inner and outer tubs **5** and **4**, the vibration body **22** may be provided on the inner circumference of the inner tub **5**.

[0064] The dynamic vibration absorber **20** may further include a receiving portion **21** extending along the circumference of the inner tub **5**. The vibration body **22** and the elastic body **23** are received in the receiving portion **21**.

[0065] Likewise the vibration body **22**, the elastic body **23** is formed in a circular shape and provided with a circular opening in which the vibration body **22** can be inserted.

[0066] The vibration body **22** may be formed of high density metal and the elastic body **23** may be formed of rubber or synthetic resin having elastic force.

[0067] Meanwhile, the balancer **30** may be provided on an upper portion of the inner tub **5** (see FIG. **1**). Liquid is filled in the balancer **30**. When the inner tub **5** rotates, the liquid in the balancer **30** is positioned in an opposite direction to a weight center of the inner tub **5** to compensate the unbalance. The receiving portion **21** may be coupled to an inner circumference of the balancer **30**. Accordingly, a space for receiving the vibration body **22** and the elastic body **23** is formed between the inner circumference of the balancer **30** and the receiving portion **21**.

[0068] The balancer **30** may be formed along any one of the inner or outer circumferences of the inner tub **5**. Hereinafter, a case where the dynamic vibration absorber **20** is provided along the inner circumference of the balancer **30** will be exemplarily described.

[0069] When the inner tub **5** rotates and generates the vibration, the vibration body **22** also vibrates. At this point, since some of the energy exciting the vibration of the inner tub **5** is consumed to vibrate the vibration body **22**, the vibration of the inner tub **5** is gradually attenuated. That is, since some of the vibration energy of the whole system is absorbed in the dynamic vibration absorber **20**, the vibration of the inner tub **5** is reduced.

[0070] The elastic body **23** is elastically deformed as the vibration body **22** vibrates. Since the inner tub **5** is a rigid body that rotates and the elastic body **23** and the vibration body **22** are provided on the inner tub **5** that is the rigid body, the force applied from the elastic body **23** to the vibration body **22** acts in an opposite direction to the vibration force of the inner tub **5**. Accordingly, the vibration of the inner tub **5** is not excited by the vibration of the vibration body **22** but reduced.

[0071] When it is assumed that the natural frequency of the inner tub **5** is w**1** and the resonant frequency of the inner tub **5** without the dynamic vibration absorber **20** is w**0**, the resonant frequency of the inner tub **5** with the dynamic vibration absorber **20** may be separated into w**0'** and w**0"**. Accordingly, in the washing machine of the exemplary embodiment of the present invention, no resonant phenomenon occurs even when the vibration of the inner tub **5** is excited with the frequency w**0**. Needless to say, the inner tub **5** is designed such that an operational frequency of the inner tub **5** avoids the frequencies w**0'** and w**0"**.

[0072] Since the vibration generated when the inner tub **5** rotates can be reduced by the dynamic vibration absorber **20**, the inner tub **5** can stably rotate. Accordingly, since the uniform space can be maintained between the inner and outer

tubs **5** and **4**, collisions between the inner and outer tubs **5** and **4** may be prevented. In addition, the tub **5** can be rotated at a higher RPM during spinning

[0073] FIG. **11** is a sectional view of a washing machine according to another exemplary embodiment of the present invention. FIG. **12** is a plane view of the washing machine of FIG. **11**, with a top cover removed. FIG. **13** is a partial sectional view of a lower side portion of the washing machine of FIG. **11**.

[0074] As shown in FIGS. **11** and **12**, in order to more accurately describe the washing machine, a length direction Y, a horizontal direction X normal to the length direction Y, a vertical direction Z normal to the length and horizontal directions Y and X are denoted with reference to the washing machine.

[0075] The washing machine of FIG. **11** is a top-loading type washing machine in which an inner tub **5** rotates about a vertical axis. An outer tub **4** is suspended on the casing **1** by a plurality of suspensions **100**.

[0076] Each suspension **100** includes a supporting rod **110** and a damper **120**. The supporting rod **110** is for suspending the outer tub **4** on the casing **1**, having a first end connected to the casing **1** through a first supporting part **200** and a second end connected to the outer tub **4** by the damper **120** and a second supporting part **300**.

[0077] The damper **120** damps vibrations of the outer tub **4** during the operation of the washing machine. The damper **120** is fixed on an outer-lower side portion of the outer tub **4** by the second supporting part **300** provided on the outer-lower side portion of the outer tub **4**.

[0078] Suspensions **100** are aligned in a vertical direction in parallel with each other. Accordingly, the supporting rods **110** and the dampers **120** are aligned in the vertical direction in parallel with the vertical direction. Generally, during the rotation of the inner tub **5**, horizontal components in the horizontal direction X or the length direction Y may be generated by a variety of factors such as unbalancing of the laundry loaded in the inner tub **5**, an RPM or resonant property of the inner tub **5**, and the like.

[0079] According to the washing machine of this exemplary embodiment, since the suspensions **100** are aligned in the vertical direction Z parallel with each other, the horizontal component caused by the vibration of the outer tub **4** can be reduced and thus the amplitude in the horizontal direction X or the length direction Y can be reduced. Accordingly, a diameter D of the outer tub **4** can be enlarged and thus the laundry loading volume can be increased.

[0080] As the suspensions **100** are aligned in the vertical direction parallel with each other, as shown in FIG. **12**, the first supporting part **200** supporting the first end of the suspension **100** and the second supporting part **300** supporting the second end of the suspension **100** may be disposed to at least partly overlap with each other when viewed from the top.

[0081] Meanwhile, in order to align the suspensions **100** in the vertical direction parallel with each other, the second supporting part **300** may include an extending portion **305** that fixes the damper **120** to the outer side portion of the outer tub **4** such that the damper **120** is spaced apart from the outer side portion of the outer tub **4** by a predetermined distance.

[0082] As shown in FIG. **13**, the second supporting part **300** may include a reinforcing portion **310** formed in a blade shape to enhance strength and reliably fix the suspension **100** to the outer tub **4**. The reinforcing portion **310** may be integrally formed with the outer tub **4** or separately formed and coupled to the outer tub **4**. The reinforcing portion **310** may be a rib that extends in a vertical direction and is connected to the side portion of the outer tub **4**.

[0083] FIG. **14** is a view of the inner tub **5** and balancer **30** illustrated in FIG. **11** and FIG. **15** is a perspective view of a lower balancer **52** and fixing bracket **53** illustrated in FIG. **14**. FIG. **16** is a partial sectional view of the lower balancer **52** and inner tub **5** illustrated in FIG. **14**.

[0084] At least one balancer **30**, **52** may be installed on the inner tub **5** to prevent the unbalancing of the inner tub **5** or the generation of vibrations caused by unevenly loaded laundry.

[0085] In the present invention, the balancers **30**, **52** are disposed at upper and lower portions. That is, the balancers may be defined as an upper balancer **30** disposed at the upper portion of the inner tub **5** and a lower balancer **52** disposed at the lower portion of the inner tub **5**.

[0086] In one embodiment, the upper balancer **30** may be a hydraulic balancer in which a liquid is filled and the lower balancer **52** may be a ball balancer having a ball **52***a*. The hydraulic balancer may be filled with the liquid to generate a distributed load while the ball balancer may generate a concentrated load as the ball is forced in a sideways direction.

[0087] Accordingly, in order to minimize a rotational moment generated by the concentrated load of the ball balancer, the ball balancer may be disposed at a location closer to a weight center G of the inner tub **5** than the liquid balancer.

[0088] That is, a spaced distance dl in a vertical direction between the weight center G of the inner tub **5** and the ball balancer **52** may be less than a spaced distance d**2** in a vertical direction between the weight center G of the inner tub **5** and the hydraulic balancer **30**.

[0089] Since the weight center G of the inner tub **5** is located at the lower portion of the inner tub **5**, the ball balancer may preferably be used as the lower balancer **52** and the liquid balancer may preferably be used as the upper balancer **30**.

[0090] In addition, since the upper balancer **30** is disposed at the upper portion of the inner tub **5**, when the thickness of the upper balancer **30** in the vertical direction is reduced, the utilization of the inner space of the washing machine may be increased.

[0091] In this exemplary embodiment, since both the lower balancer **52** and the upper balancer **30** are provided, the thickness of the upper balancer **30** in the vertical direction can be reduced as compared with the prior art.

[0092] In addition, a width w**2** in a radial direction of the upper balancer **30** may be equal to a width w**1** in the radial direction of the lower balancer **52**. At this point, the thickness t**2** in the vertical direction of the balancer **30** may be less than the thickness t**1** in the vertical direction of the lower balancer **52**. As the thickness of the upper balancer **30** in the vertical direction is reduced, the utilization of the inner space of the washing machine may be increased and thus the volume of the washing machine can be increased as compared with the prior art.

[0093] The upper balancer **30** may be formed in a ring shape and is filled with a liquid such as salt water or the like.

[0094] The upper balancer **30** may be coupled to the upper portion of the inner tub **5** by a coupling member.

[0095] The lower balancer **52** may be formed in a ring shape. A plurality of the balls **52***a* may be disposed in the lower balancer **52**. The lower balancer **52** may be filled with silicon oil to allow the balls **52***a* to smoothly move therein.

[0096] Meanwhile, referring to FIGS. **14** and **16**, the lower balancer **52** may be coupled to the lower portion of the inner tub **5** by a fixing bracket **53**.

[0097] The fixing bracket **53** may be formed in a ring shape corresponding to the lower balancer **52** and configured to support a lower portion of the lower balancer **52**.

[0098] The fixing bracket **53** may have a first flange portion **53***a* that is formed on an outer circumferential surface and bent upward so that the outer circumferential surface of the fixing bracket **53** encloses an outer circumferential surface of the lower balancer **52**.

[0099] The fixing bracket **53** may have a second flange portion **53***b* that is formed on an inner circumferential surface and bent upward so that the inner circumferential surface of the fixing bracket **53** encloses an inner circumferential surface of the lower balancer **52**.

[0100] The flange portion **53***b* may be formed in a shape corresponding to a lower-outer wall of the inner tub **5**. The second flange portion **53***b* may be formed at a plurality of locations that are spaced apart from the inner circumferential surface of the fixing bracket **53** by a predetermined distance.

[0101] The second flange portion **53***b* may be coupled to the lower-outer wall of the inner tub **5** by a coupling member such as a screw or the like.

[0102] As described above, as the upper and lower balancers are respectively disposed at the upper and lower portions of the inner tub **5** and different types of the upper and lower balancers are used, the vibration can be more effectively reduced.

[0103] In addition, the volume of the liquid balancer that is the upper balancer can be more reduced than the prior art.

[0104] Further, since the ball balancer is disposed at the lower portion of the inner tub **5**, it may be closer to the center of the inner tub **5** and thus the rotational moment can be reduced.

[0105] FIG. **17** is a flowchart illustrating a method for assembling the outer tub of the washing machine of FIG. **11** according to an exemplary embodiment of the present invention.

[0106] Referring to FIG. **17**, a method for assembling the outer tub includes inserting the outer tub **4** into the casing **1** (S**17**), assembling the first supporting part **200** on the casing **1** (S**18**), and suspending the suspensions **100** on the first supporting part **200** (S**19**). At this point, the suspensions **100** are disposed in the vertical direction in parallel with each other.

[0107] That is, for the prior art washing machine, the outer tub **4** is inserted in the casing **1** after the first supporting part **200** is assembled on the casing **1**, after which the suspensions **100** are suspended on the first supporting part **200**. Therefore, it is difficult to align the suspensions **100** in the vertical direction in parallel with each other. Accordingly, the suspensions are not aligned in the vertical direction and thus the vibration in the horizontal direction of the outer tub **4** cannot be effectively attenuated when the washing machine operates.

[0108] As the washing machine is manufactured in accordance with the above-described assembling method of the exemplary embodiment of the present invention, the suspensions **100** can be aligned in the vertical direction in parallel with each other. Accordingly, the horizontal component of the vibration of the outer tub **4** can be effectively reduced when the washing machine operates. In addition, the diameter of the outer tub **4** can be increased by the reduced horizontal component, the space utilization can be improved and the laundry loading volume can be increased. As a result, user convenience and reliability of the washing machine can be improved.

[0109] The effects of the present invention are not limited to the effects described above, and other effects that have not been set forth herein will be clearly understood from the appended claims by those skilled in the art.

[0110] Although the preferred embodiments of the invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

What is claimed is:

1. A washing machine comprising:
- an outer tub for storing wash water;
- an inner tub that is rotatably provided in the outer tub and in which laundry is loaded;
- a spray nozzle configured to spray the wash water into the inner tub;
- a circulation passage connecting the outer tub to the spray nozzle;
- a filter provided in series with the circulation passage;
- a first pump that directs the wash water circulated from the outer tub to the circulation passage to the spray nozzle so that foreign substances suspended in the wash water can be collected in the filter;
- a drain passage that connects the outer tub to the circulation passage and is connected between the filter and the spray nozzle; and
- a second pump that directs the wash water supplied to the circulation passage through the drain passage such that the wash water passes through the filter in a reverse direction and thus the foreign substances collected in the filter are exhausted out of the washing machine together with the wash water.

2. The washing machine of claim **1**, further comprising:
- a pulsator rotatably provided in the inner tub, wherein the pulsator rotates during operation of the first pump.

3. The washing machine of claim **1**, wherein the pulsator alternately rotates in a clockwise and a counter-clockwise direction.

4. The washing machine of claim **1**, wherein the inner tub continuously rotates in one direction during operation of the second pump.

5. The washing machine of claim **4**, the wash water is sprayed into the inner tub by the spray nozzle during the operation of the second pump and continuous rotation of the inner tub in the one direction.

6. The washing machine of claim **4**, wherein the inner tub rotates at an RPM at which the laundry adheres to the inner tub by centrifugal force and rotates together with the inner tub.

7. The washing machine of claim **5**, wherein the inner tub rotates at an RPM at which the laundry adheres to the inner tub by centrifugal force and rotates together with the inner tub.

8. The washing machine of claim **1**, further comprising a first valve for controlling the wash water drained from the outer tub to the circulation passage.

9. The washing machine of claim **8**, wherein the first valve is opened when the first pump operates.

10. The washing machine of claim **1**, further comprising a second valve for controlling the wash water directed from the circulation passage to the second pump.

11. The washing machine of claim **10**, wherein the second valve is opened when the second pump operates.

12. The washing machine of claim **1**, further comprising a third valve for controlling the wash water directed from the drain passage to the circulation passage.

13. The washing machine of claim **12**, wherein the third valve is opened when the second pump operates.

14. A washing machine comprising:

an outer tub for storing wash water;

an inner tub that is rotatably provided in the outer tub and in which laundry is loaded;

a spray nozzle configured to spray the wash water into the inner tub;

a circulation passage connecting the outer tub to the spray nozzle;

a filter provided in series with the circulation passage;

a drain passage that connects the outer tub to the circulation passage and is connected between the filter and the spray nozzle; and

a pump that directs the wash water circulated from the outer tub to the circulation passage such that the wash water passes through the filter in a forward direction and thus foreign substances suspended in the wash water can be collected in the filter or directs the wash water supplied to the circulation passage through the drain passage such that the wash water passes through the filter in a reverse direction and thus the foreign substances collected in the filter are exhausted out of the washing machine together with the wash water.

15. The washing machine of claim **14**, further comprising:

a pulsator rotatably provided in the inner tub, wherein the pulsator alternately rotates in a clockwise and a counter-clockwise direction when the pump operates to allow the wash water to pass through the filter in the forward direction.

16. The washing machine of claim **15**, wherein the inner tub continuously rotates in one direction when the pump operates to allow the wash water to pass through the filter in the reverse direction.

17. A washing method comprising:

performing washing by alternately rotating the pulsator in a clockwise and a counter-clockwise direction;

circulating wash water from an outer tub into an inner tub after the wash water passes through a filter provided in series with a circulation passage in a forward direction; and

allowing the wash water drained out of the outer tub to pass through the filter in a reverse direction and drain out of a washing machine so that foreign substances collected in the filter can be exhausted out of the washing machine together with the wash water.

18. The washing method of claim **17**, wherein discharging wash water from the spray nozzle occurs while continuously rotating the inner tub in one direction.

19. The washing method of claim **18**, wherein the inner tub rotates at an RPM at which laundry within the inner tub adheres to the inner tub by centrifugal force and rotates together with the inner tub.

20. The washing method of claim **19**, wherein the circulating the wash water comprises discharging the wash water from a spray nozzle into the inner tub.

* * * * *