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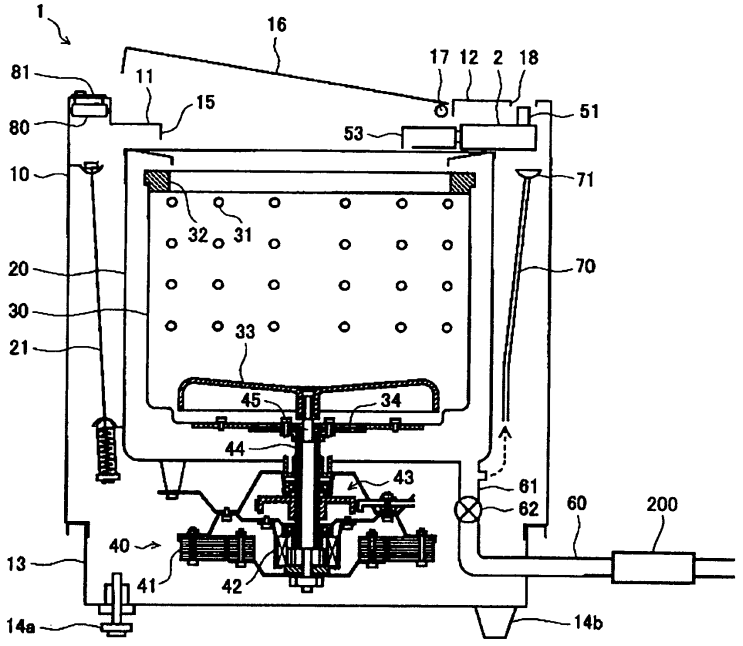
(54) WASHING MACHINE AND METHOD OF RECOVERING METAL ION THEREIN

(57) Provided is a washing machine operable to recover metal ions supplied to water used for laundering. The washing machine (1) comprises a metal ion water generation part (90) for applying the metal ions to water and a metal ion recovery unit (200) disposed so as to contact the water with the metal ions applied by the metal ion water generation part (90), for recovering the metal ions in the water. In a method for recovering the metal ions in the washing machine (1), the metal ion recovery unit (200) is disposed, in the washing machine (1) operable to apply the metal ions to a fabric structure, so as to contact the water used for laundering and recovers the metal ions in the water.

FIG.1



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Description

TECHNICAL FIELD

[0001] The present invention relates generally to washing machines and in particular, to a washing machine which is operable to apply metal ions to a fabric structure.

BACKGROUND ART

[0002] When laundering is performed by using a washing machine, a finishing agent is often added in water and particularly, rinsing water. As a general finishing agent, a softening agent, a sizing agent, or the like can be cited. In recent years, there is a washing machine which can apply metal ions (for example, silver ions) as a finishing agent, in addition to the above-mentioned finishing agent, to a fabric structure as laundry in order to impart antibacterial properties and antibromic properties to the fabric structure.

[0003] Japanese Patent Application Laid-Open Publication No. 2004-24597 (Patent Document 1) discloses a washing machine which can apply metal ions and a softening agent as finishing agents. In addition, Japanese Patent Application Laid-Open Publication No. 2004-33996 (Patent Document 2) discloses a washing machine which can apply metal ions having a constant concentration to be stably supplied to laundry under laundering.

[0004] In these washing machines, the metal ions are supplied to the laundry by adding the metal ions in water used for the laundering, for example, upon rinsing. When the laundry which is in a state in which the metal ions have been permeated together with water thereinside is dried and the water is vaporized, the metal ions are deposited as metal compounds and metal inside the fabric structure as the laundry, thereby imparting the antibacterial properties to the laundry. However, a part of the metal ions does not adhere to the laundry and is discharged together with discharging water.

[0005] As a method for recovering the metal ions, Japanese Patent Application Laid-Open Publication No. 59-104490 (Patent Document 3) discloses a method in which electrolytic treatment is conducted. In addition, Japanese Patent Application Laid-Open Publication No. 61-158796 (Patent Document 4) discloses a method in which the metal ions are recovered by using biomass. Japanese Patent Application Laid-Open Publication No. 6-145828 (Patent Document 5) discloses a method in which the metal ions are precipitated as sulfides and recovered. Japanese Patent Application Laid-Open Publication No. 7-185565 (Patent Document 6) discloses a method using an adsorbent. Japanese Patent Application Laid-Open Publication No. 60-61039 (Patent Document 7) discloses a method using an ion exchange resin.

Patent Document 1: Japanese Patent Application Laid-Open Publication No.2004-24597

Patent Document 2: Japanese Patent Application Laid-Open Publication No.2004-33996

Patent Document 3: Japanese Patent Application Laid-Open Publication No. 59-104490

Patent Document 4: Japanese Patent Application Laid-Open Publication No. 61-158796

Patent Document 5: Japanese Patent Application Laid-Open Publication No. 6-145828

Patent Document 6: Japanese Patent Application Laid-Open Publication No. 7-185568

Patent Document 7: Japanese Patent Application Laid-Open Publication No. 60-61039

DISCLOSURE OF THE INVENTION

Problems to be solved by the invention

[0006] However, the conventional methods for recovering the metal ions are industrially applicable. Discharging water drained from a washing machine is mixed with other discharging water drained from one household and with discharging water drained from other households, and a concentration of the metal ions targeted for recovery is reduced. Therefore, it is made difficult to recover or recycle the metal ions in the discharging water. Therefore, in order to recover the metal ions contained in the discharging water drained from a household appliance such as a washing machine, for example, it is required to collect the discharging water, used for laundering, drained from each household, thereby imposing difficulties.

[0007] Therefore, an object of the present invention is to provide a washing machine which is operable to recover the metal ions supplied to the water used for laundering.

Means for solving the problems

[0008] A washing machine according to the present invention comprises: a metal ion applying unit for applying metal ions to water; and a metal ion recovery unit disposed so as to contact the water with the metal ions applied by the metal ion applying unit, for recovering the metal ions in the water.

[0009] By employing the above-described configuration, the metal ions can be recovered before the metal ions are discharged from the washing machine. The higher a concentration of the metal ions in the water is, the more easily the metal ions can be recovered. However, when the metal ions are once discharged from the washing machine and mixed with other living discharging wa-

ter, the concentration of the metal ions in the water is reduced, thereby making it difficult to recover the metal ions. In addition, in a case where the metal ions are used only in a particular process or a concentration of metal ions used in a particular process is extremely higher than those of the metal ions used in other processes, a concentration of the metal ions in the water is reduced just by mixing the water with the other discharging water, thereby making it difficult to recover the metal ions. For example, in a case where the metal ion water is used only in a final rinsing process in the washing machine, a concentration of the metal ions is reduced when the discharging water used in the final rinsing process is mixed with other discharging water in a washing process or a rinsing process other than the final rinsing process.

[0010] A washing machine operable to apply metal ions to a fabric structure according to the present invention comprises a metal ion recovery unit disposed so as to contact water used for laundering, for recovering the metal ions in the water.

[0011] The metal ion recovery unit is disposed so as to contact the water used for laundering, whereby the metal ions which do not adhere to the washing machine and is still contained in the discharging water can be recovered before these metal ions are discharged from the washing machine.

[0012] By employing the above-described configuration, the metal ions supplied to the water used for laundering can be recovered.

[0013] In the washing machine according to the present invention, it is preferable that the metal ion recovery unit is detachable from the washing machine.

[0014] In general, in a case where the washing machine is recovered and materials thereof are recycled, since manufactures and types of the washing machines are various, dismantling is difficult. Even if the washing machine is dismantled into respective parts, it is difficult to identify materials used for the parts and therefore, it is difficult to dismantle the washing machine into the respective parts and separate to classify the respective parts. Consequently, an entire washing machine may be crushed and separation and classification of metal, a resin, and the like may be performed.

[0015] If the washing machine including the metal ion recovery unit is crushed without removing the metal ion recovery unit therefrom, broken pieces of the metal ion recovery unit are mixed with other broken pieces and only metal scraps having a low concentration of the recovered metal are obtained, thereby making it difficult to recycle the metal in the metal ion recovery unit. In a case where after dismantling a main body of the washing machine, the metal ion recovery unit is collected, dismantling by handwork is required, thereby requiring time and cost for processing.

[0016] By allowing the metal ion recovery unit to be detachable without removing a housing or the like of the washing machine, the metal ion recovery unit can be collected before crushing the main body of the washing machine. The washing machine obtained after the metal ion recovery unit has been collected can be processed in the same process as a process in which a conventional washing machine is processed. In addition, the metal recovered from the metal ion recovery unit can be recycled. As described above, the metal ions which have been conventionally discharged together with the discharging water can be recovered and recycled.

[0017] As described above, when the main body of the washing machine is recovered and the materials used for the main body of the washing machine are recycled, the metal ion recovery unit can be collected without hampering a recycling process and the recovered metal can be reused.

[0018] In the washing machine according to the present invention, it is preferable that the metal ion recovery unit includes an adsorbent for selectively recovering specific metal.

[0019] The water used for the laundering, such as the tap water, contains a lot of metal ions other than the metal ions added as the finishing agent. In general, the metal ions, added for the purpose of exhibiting antibacterial action or the like, whose concentration is approximately 50 μg/L through 10 mg/L are contained in the washing water. It is often the case that general tap water contains sodium ions, calcium ions, potassium ions, and magnesium ions, each of which has a concentration of several tens mg/L or more. The adsorbent which adsorbs such metal ions contained in the tap water does not sufficiently adsorb the metal ions, which have been added as the finishing agent and should be recovered, and come to be saturated. Consequently, a lifetime of the adsorbent is shortened, or it is required to provided a large amount of the adsorbent in the metal ion recovery unit. Therefore, by using the adsorbent which can selectively adsorb the metal ions added as the finishing agent, an effect of the metal ion recovery unit can long last.

[0020] In the washing machine according to the present invention, it is preferable that the specific metal includes at least one of silver ions and copper ions.

[0021] It is often the case that as a finishing agent for laundry, the silver ions having antibacterial properties or the copper ions having antifungal properties are added. Therefore, by using the adsorbent which selectively adsorbs these ions, the metal ions added upon laundering can be efficiently recovered.

[0022] In the washing machine according to the present invention, it is preferable that a water discharging channel is included and the metal ion recovery unit is disposed in the water discharging channel.

[0023] A housing of the washing machine is formed by using a material having a strength so as to meet a requirement of withstanding a shock caused by a vibration and an imbalance which occur upon dewatering performed during the laundering and so as to prevent a user's hand from entering an inside thereof. And the housing thereof is fixed with screws and nails. Therefore, the housing cannot be easily removed from the main body

of the washing machine. On the other hand, the water discharging channel is not particularly required to withstand the vibration or the like and just passes the water therethrough. Therefore, the water discharging channel can be installed in an easily attachable and detachable state and formed by using a flexible resin. By providing the metal ion recovery unit in this position, when the main body of the washing machine is recycled, the metal ion recovery unit can be easily removed.

[0024] As described above, when the washing machine is recovered and recycled, the metal ion recovery unit can be collected without dismantling the main body of the washing machine.

[0025] In the washing machine according to the present invention, it is preferable that the water discharging channel includes a first water discharging channel having the metal ion recovery unit and a second water discharging channel not having the metal ion recovery unit.

[0026] By employing the above-described configuration, the discharging water to which the metal ions as the finishing agent have been added can pass through the first water discharging channel having the metal ion recovery unit and the discharging water to which the metal ions as the finishing agent have not been added can pass through the second water discharging channel not having the metal ion recovery unit. By not passing the water used in the washing process and the like, which contains a lot of the yarn waste or the like and no metal ions, through the metal ion recovery unit, the clogging of the first water discharging channel, which is caused by the yarn waste or the like, can be prevented and a capability of adsorbing the metal ions can be maintained. In addition, in a case where the adsorbent used in the metal ion recovery unit is made of the resin, when a surface activating agent used for washing the laundry is adsorbed onto the surface of the resin, the capability of the adsorbent is reduced. However, by properly using both of the first water discharging channel and the second water discharging channel, a reduction in the adsorbing capability of the adsorbent, which is caused by the adsorption of the surface activating agent, can be prevented.

[0027] It is preferable that the washing machine according to the present invention further comprises a discharging water clogging detection part.

[0028] When discharging water clogging is detected in one water discharging channel, by using another water discharging channel, the water can be discharged. In such a manner, even when the discharging water clogging occurs, the laundering can be completed.

[0029] In a method for recovering metal ions in a washing machine, according to the present invention, it is preferable that in the washing machine operable to apply the metal ions to a fabric structure, a metal ion recovery unit is disposed so as to contact the water used for laundering and the metal ions in water is recovered.

[0030] By disposing the metal ion recovery unit so as to contact the water used for laundering, the metal ions added in the water used for laundering, which do not adhere to laundry and are still contained in the discharging water can be recovered before discharging the metal ions from a household.

[0031] As described above, the metal ions supplied to the water used for laundering can be recovered.

EFFECT OF THE INVENTION

[0032] As described above, according to the present invention, a washing machine operable to recover metal ions supplied to water used for laundering can be provided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033]

Fig. 1 shows a vertical sectional view illustrating a whole configuration of a washing machine of one embodiment according to the present invention.

Fig. 2 shows a schematic vertical sectional view illustrating a feed water device which is viewed from a front face.

Fig. 3 shows a schematic cross sectional view of a metal ion generation part. Fig. 3 (A) shows a schematic horizontal sectional view. Fig. 3 (B) shows a schematic vertical sectional view.

Fig. 4 is a flow chart showing all laundering processes performed in the washing machine of the one embodiment according to the present invention.

Fig. 5 (A) is a diagram illustrating a metal ion recovery unit attached in a water discharging hose. Fig. 5 (B) shows one example of an inside of the metal ion recovery unit. Fig. 5 (C) shows another example of the inside of the metal ion recovery unit.

Fig. 6 shows schematic cross sectional views of a water discharging channel in a washing machine of another embodiment according to the present invention.

Fig. 7 shows a schematic cross sectional view of a water discharging channel in which a filter is provided.

Fig. 8 is a flow chart showing a general water discharging process in a conventional washing machine.

Fig. 9 is a flow chart showing a process of discharging water containing metal ions in a washing machine of the another embodiment according to the present invention.

Fig. 10 is a flow chart showing a process of discharging water containing no metal ions in the washing machine of the another embodiment according to the present invention.

Fig. 11 shows a vertical sectional view illustrating a whole configuration of a washing machine of further another embodiment according to the present invention.

EXPLANATION OF REFERENCE NUMERALS

[0034] 1: washing machine, 60: water discharging hose, 90: metal ion water generation part, 200: metal ion recovery unit, 201: adsorbent, 601: first water discharging hose, 602: second water discharging hose

BEST MODE FOR CARRYING OUT THE INVENTION

[0035] Hereinafter, embodiments according to the present invention will be described with reference to drawings.

<First Embodiment>

[0036] First, a configuration of a washing machine will be described.

[0037] Fig. 1 shows a vertical sectional view illustrating a whole configuration of the washing machine. The washing machine 1 is fully automatic-type.

[0038] As shown in Fig. 1, the washing machine 1 includes a housing 10. The housing 10 is of a rectangular parallelepiped shape and is made of metal or a synthetic resin, having openings on a top surface and a bottom surface. On the opening on the top surface of the housing 10, a top surface plate 11 made of a synthetic resin is laid. This top surface plate 11 is fixed on the housing 10 with screws.

[0039] In Fig. 1, provided that a left side is a front face of the washing machine 1 and a right side is a back face of the washing machine 1, a back panel 12 similarly made of the synthetic resin is laid on an upper surface of the top surface plate 11 located on a back surface side of the washing machine 1. This back panel 12 is fixed on the housing 10 or the top surface plate 11 with screws. On the opening on the bottom surface of the housing 10, a base 13 made of the synthetic resin is laid. This base 13 is fixed on the housing 10 with screws. Note that in Fig. 1, any of the above-mentioned screws are not shown.

[0040] At four corners of the base 13, legs 14a and legs 14b for supporting the housing 10 on a floor are provided. The legs 14a on a front face side are screw legs whose heights are variable. By turning these screw legs, leveling of the washing machine 1 is conducted. The legs 14b on the back face side of the washing machine 1 are fixed legs which are formed integrally with the base 13.

[0041] On the top surface plate 11, a laundry input opening 15 for inputting laundry to the below-described washing tub 30 is provided. A cover 16 is joined to the top surface plate 11 with a hinge part 17, is vertically rotated, and covers the laundry input opening 15 from above.

[0042] Inside the housing 10, a water tub 20 and the washing tub 30 which also serves as a dewatering bin are disposed. Each of the water tub 20 and the washing tub 30 is of a cylindrical shaped-cup shape whose upper surface is open. Each of axis lines thereof is in a vertical direction. The water tub 20 and the washing tub 30 are disposed in a concentric manner such that the water tub 20 is located outside the washing tub 30 and the washing tub 30 is located inside the water tub 20.

[0043] The water tub 20 is suspended by suspension members 21. The suspension members 21 are provided at a total of four positions so as to connect outer surface lower portions of the water tub 20 and inner surface corner portions of the housing 10 and support the water tub 20 such that the water tub 20 can horizontally swing.

[0044] On an edge of an upper opening of the washing tub 30, a looped balancer 32 is attached. The balancer 32 has a function of suppressing a vibration caused when the washing tub 30 is rotated at a high speed in order to dewater the laundry. On an internal bottom surface of the washing tub 30, a pulsator 33 for causing washing water or rinsing water to flow therein is disposed. On a bottom portion of the washing tub 30, which is covered by the pulsator 33, a drain outlet 34 is formed.

[0045] On a bottom surface of the water tub 20, a driving unit 40 is attached. The driving unit 40 includes a motor 41, a clutch mechanism 42, and a brake mechanism 43. From a central portion of the driving unit 40, a dewatering axis 44 and a pulsator axis 45 protrude upward. The dewatering axis 44 and the pulsator axis 45 form a dual axial structure in which the dewatering axis 44 is disposed outside and the pulsator axis 45 is disposed inside. The dewatering axis 44 is inserted into the water tub 20 from a lower side toward an upper side and connected to the washing tub 30 so as to support the washing tub 30. The pulsator axis 45 penetrates through the water tub 20 further into the washing tub 30 from a lower side toward an upper side and is connected to the pulsator 33 so as to support the pulsator 33. Between the dewatering axis 44 and the water tub 20 and between the dewatering axis 44 and the pulsator axis 45, sealing members for preventing water leakage are respectively disposed.

[0046] In a space below the back panel 12, a feed water device 2 is provided. The feed water device 2 is connected to a container-like feed water inlet 53. The feed water inlet 53 is located so as to overlook an inside of the washing tub 30. The feed water device 2 has a connecting pipe 51 which protrudes upward via a through-hole 18 provided on the back panel 12. The connecting pipe 51 is connected to a feed water hose (not shown) for feeding clean water such as tap water and connected via the hose to a tap water faucet. The feed water device 2 has a structure shown in Fig. 2 in which the water is fed via the feed water inlet 53 into the washing tub 30.

[0047] Fig. 2 shows a schematic vertical sectional view illustrating the feed water device 2 which is viewed from a front face.

[0048] As shown in Fig. 2, the feed water device 2 comprises: a main feed water valve 50a; a sub-feed water valve 50b; the connecting pipe 51; a main feed water pipe 52a as a first feed water channel; a sub-feed water pipe 52b as a feed water channel; and a metal ion water

generation part 90 as a metal ion applying unit which applies metal ions to the water flowing through the main feed water pipe 52a.

[0049] A water outlet side of the connecting pipe 51 is connected to the main feed water pipe 52a and the sub-feed water pipe 52b. The main feed water pipe 52a and the sub-feed water pipe 52b are disposed so as to be able to feed the water into the feed water inlet 53. In the main feed water pipe 52a, the metal ion water generation part 90 is provided.

[0050] As shown in Fig. 1, at a bottom portion of the water tub 20, a water discharging hose 60 as a water discharging channel for discharging the water in the water tub 20 and the washing tub 30 out of the housing 10. The water flows into the water discharging hose 60 from a water discharge pipe 61. The water discharge pipe 61 is connected so as to be located in the vicinity to a periphery of the bottom surface of the water tub 20.

[0051] For discharging the water, the water fed into the washing tub 30 is drained through the drain outlet 34 below the washing tub 30 into a space between the washing tub 30 and the water tub 20, passes through the water discharge pipe 61 and a water discharging valve 62, flows into the water discharging hose 60, and is discharged externally. In addition, the water in the washing tub 30 passes through the dewatering holes 31 of the washing tub 30, is drained into the space between the washing tub 30 and the water tub 20, passes through the water discharge pipe 61 and the water discharging valve 62, flows into the water discharging hose 60, and is discharged externally.

[0052] In the water discharging hose 60, a metal ion recovery unit 200 is provided. The water discharged from the washing tub 30 passes through an inside of the metal ion recovery unit 200 when circulating through the water discharging hose 60.

[0053] In the water discharge pipe 61, the water discharging valve 62 which is electromagnetically opened and closed is provided. At a position upstream of the water discharging valve 62 in the water discharge pipe 61, an air trap (not shown) is provided and from the air trap, a pressure guiding tube 70 extends out. At an upper end of the pressure guiding tube 70, a water level switch 71 as water level detection means for the washing tub 30 or the water tub 20 is connected.

[0054] On a front face side of the housing 10, a controller 80 is disposed. The controller 80 is located below the top surface plate 11, receives a user's instruction via an operation/display section 81 provided on an upper surface of the top surface plate 11, and issues an operation instruction to the driving unit 40, the feed water device 2, and the like. In addition, the controller 80 issues a display instruction to the operation/display section 81.

[0055] Fig. 3 shows a schematic cross sectional view of the metal ion generation part. Fig. 3 (A) shows a schematic horizontal sectional view. Fig. 3 (B) shows a schematic vertical sectional view.

[0056] As shown in Fig. 3 (A) and Fig. 3 (B), the metal ion water generation part 90 provided in the feed water device 2 shown in Fig. 2 has a case 91 made of an insulating material such as a synthetic resin. Inside the case 91, platy silver electrodes 92a and 92b are disposed so as to have a distance of approximately 5 mm therebetween and to be in parallel with each other. Each of the silver electrodes has, for example, a size of approximately 20 mm $\times$ 50 mm and a thickness of approximately 1 mm. On the silver electrodes 92a and 92b, connecting terminals 93a and 93b are integrally formed, respectively. The connecting terminals 93a and 93b are connected to the controller 80 through wiring (not shown). In the case 91, a water inlet 94 from which the water flows in and a water outlet 95 from which the water flows out are provided. The water can flow into the case 91 from the water inlet 94 and can flow out of the case 91 from the water outlet 95. In other words, the water flows in parallel with a longitudinal direction of the silver electrodes 92a and 92b.

[0057] In a state in which the water is flowing, with the silver electrodes 92a and 92b immersed in the water, a voltage is applied between the silver electrodes 92a and 92b by the controller 80. On the silver electrode on an anode side, a reaction of $Ag \rightarrow Ag^+ + e^-$ occurs and silver ions (Ag^+) are eluted in the water. When the silver ions (Ag^+) continues to be eluted, the silver electrode on the anode side is depleted. The silver ions eluted from the silver electrode 92a or the silver electrode 92b exhibit excellent bactericidal and antifungal effects. Accordingly, silver ion water which is metal ion water acts as antibacterial water having antibacterial properties. Here, not only sterilization and disinfection of germs and fungi but also inactivation of viruses are referred to as antibacterial or bactericidal action. In *Silver Ion Water* written by Kulskii, L.A and published by Shin Nihon Casting and Forging Association (Publishing Company) in 1993, it is described that the viruses are inactivated by the silver ions.

[0058] On the other hand, on the silver electrode on a cathode side, a reaction of $H^+ + e \rightarrow 1/2H_2$ occurs, hydrogen is generated, and calcium or the like contained in the water is deposited on a surface of the silver electrode as scales of a calcium compound such as calcium carbonate. In addition, chloride and sulfide of silver which is metal of a constituent of the electrode are generated on the surface thereof. Accordingly, when the electrode is used over a long period of time, the scales of calcium carbonate, chloride, sulfide, and the like are deposited in a thickly-accumulated manner on the surface of the electrode, thereby hampering the elution of the silver ions which are the metal ions. This causes an amount of eluted silver ions to be unstable and depletion of the electrodes to be uneven. Therefore, the controller 80 periodically (for example, per 20 seconds) performs a reversal of polarity of the voltage applied between the silver electrodes 92a and 92b in the metal ion water generation part 90, thereby preventing the adhesion of the scales to the silver electrodes 92a and 92b and the depletion of only either one of the silver electrodes.

[0059] The metal of the electrodes may be other kinds of metal than the silver and it is only required for the metal of the electrodes to allow the elution of metal ions having the antibacterial properties. Specifically, the metal of the electrodes can be selected from among copper, an alloy of silver and copper, zinc, etc. The silver ions eluted from the silver electrodes, copper ions eluted from copper electrodes, and zinc ions eluted from zinc electrodes exhibit excellent bactericidal and antifungal effects. From the alloy of silver and copper, the silver ions and the copper ions can be concurrently eluted. In addition, the anode may be an electrode which elutes the metal ions and the cathode may be an electrode which elutes no metal ions. In a case where a configuration of the electrodes includes two or more electrodes, all of the electrodes may be made of a same kind of metal, or either one of the electrodes may be a metal electrode and the other electrode may be a nonmetal electrode (for example, a carbon electrode, a conductive plastic electrode, etc.) or a plated electrode. Further, the other electrode may be a metal electrode (for example, a titanium electrode, an electrode of platinum or gold, either of which is noble metal, etc.) which is hardly ionized. Or a configuration including a plurality of metal electrodes (for example, a configuration including a silver electrode, a copper electrode, etc.) made of different materials may be employed.

[0060] When the silver ions are eluted, constant current control which allows a current value to be constant is performed. In the constant current control, a constant current value is maintained, regardless of a change in a resistance value between the electrodes. However, for example, generation of air bubbles on the surfaces of the electrodes and a change in a distance between the electrodes, which is caused by vibration of the electrodes, cause the resistance value between the electrodes to invariably change. Therefore, it is difficult to maintain the current value to be completely constant and a slight current change occurs. In addition, due to a markedly high resistance value or the like, a constant current cannot be applied by a voltage in a range permissible in a circuit, whereby a reduction in a current may occur. Herein, the control performed such that even when the above-described situations occur, the voltage is changed so as to correspond to the change in the resistance value between the electrodes by increasing the voltage roughly in accordance with an increase in the resistance value and decreasing the voltage roughly in accordance with a decrease in the resistance value, thereby stabilizing the current value between the electrodes, is deemed as the constant current control.

[0061] A silver ion concentration of the silver ion water can be controlled by adjusting quantities of electricity and water which flow between the electrodes. For example, in order to obtain the silver ion water of 90 ppb, it is only required to adjust the water quantity to be 20L/min and the current to be 29 mA in the metal ion water generation part 90. In order to obtain the silver ion water of 600 ppb, it is only required to adjust the water quantity to be 3L/min and the current to be 29 mA. An amount of eluted silver ions is roughly proportional to an electricity quantity (C) = a constant current value (A) $\times$ time (sec), except for a low current region. In addition, when the water quantity is constant, the electricity quantity and a silver concentration of the obtainable silver ion water correlate to each other. Therefore, by adjusting the current value, the water quantity, and an energization time, the silver ion water having a desired concentration can be obtained.

[0062] As described above, by applying a predetermined current to the water, whose flow quantity is constant, between the silver electrodes 92a and 92b, the desired silver ion concentration can be obtained. In addition, since a structure of the feed water valve allows the flow quantity to be nearly fixed, the silver ion water having a roughly constant concentration can be generated by applying a constant current. It is preferable that in order to be able to obtain the silver ion water having various concentrations, combinations of the current value and the time are previously obtained by conducting an experiment.

[0063] The silver ions, copper ions, and zinc ions has no irritating properties against a human body and toxicity thereof is low. Furthermore, the metal ions and a compound thereof are hardly volatilized, unlike hypochlorous acid or the like which is volatilized in a prompted manner by raising a temperature or performing ventilation and thereby, loses antibacterial and antifungal effects and generates an unpleasant odor. However, the metal ions and the compound thereof can maintain the effects for a long period of time without losing the antibacterial and antifungal effects and without generating the unpleasant odor.

[0064] In addition, in the metal ion water generation part 90, it can be selected whether or not the elution of the silver ions which are the metal ions is performed, through applying the voltage or not applying the voltage. Also the amount of the eluted silver ions can be controlled by controlling the current and the voltage application time as described above.

[0065] As the metal ion water generation part 90, instead of the above-described metal ion water generation part in which the electrolysis is performed, a metal ion-containing substance which has a constitution allowing the metal ions to be controlled-released or be dissolved when the substance is immersed in washing water may be used. As a specific example of the metal ion-containing substance, zeolite, silica gel, glass, calcium phosphate, zirconium phosphate, silicate, titanium oxide, whisker, ceramics, etc. which carry the metal ions, or a resin, fiber, etc. which contains the above-mentioned substances.

[0066] Here, a general fluid used in the washing machine, such as water used for cleaning and rinsing and cooling water for dehumidifying, is referred to as the washing water.

[0067] The metal ions which have been added to the washing water by employing the above-described meth-

ods exhibit bacteria elimination action during the laundering in accordance with operations of the washing machine 1 or exhibit antibacterial action, for example, through adhesion of the metal ions to laundry or an inside of the washing machine 1. However, some of the metal ions do not adhere to anywhere, passes through the water discharge pipe 61 and the water discharging valve 62, and flows in the water discharging hose 60. The metal ions having flowed in the water discharging hose 60 flow in the metal ion recovery unit 200 and are removed. Thereafter, the discharging water is drained to a sewerage outlet.

[0068] Next, with reference to Fig. 4, basic operations of the washing machine 1 will be described.

[0069] Fig. 4 is a flow chart showing all laundering processes performed in the washing machine 1.

[0070] As shown in Fig. 4, at step S001, a process of washing the laundry is conducted. Upon feeding the water, the main feed water valve 50a is opened and the water is fed via the main feed water pipe 52a and the feed water inlet 53 into the washing tub 30. At this time, a detergent is also supplied to the washing tub. Note that at this time point, the water discharging valve 62 is closed. When the water level switch 71 detects a set water level, the feed water valve 50a is closed. The pulsator 33 is rotated in a normal and reverse manner and causes the laundry to be soaked in the water. In accordance with user's setting, the motor 41 causes the pulsator 33 to rotate in a predetermined pattern, thereby generating in the washing tub 30 a main water stream for laundering. Laundering of the laundry is performed by this main water stream. The dewatering axis 44 is braked by a braking device 43, and even when the laundry and the washing water move, the washing tub 30 does not rotate. After a period of the main water stream has passed, the pulsator 33 rotates in the normal and reverse manner in small motions, thereby disentangling the laundry and distributing the laundry in a well-balanced manner in the washing tub 30. This is performed in preparation for dewatering rotation of the washing tub 30.

[0071] Next, at step S002, a water discharging process is conducted. First, the water discharging valve 62 is opened, thereby discharging the washing water in the washing tub 30. The water discharging valve 62 is left open during the water discharging process and a dewatering process.

[0072] At step S003, an intermediate dewatering process is conducted. After a dewatering operation at a comparatively low speed has performed, a dewatering operation at a high speed is performed. The energization of the motor 41 is shut off and a stopping process such as braking is conducted. When a large part of the washing water has been removed from the washing tub 30 and the laundry, the clutch mechanism 42 and the brake mechanism 43 are switched. As switching timing of the clutch mechanism 42 and the brake mechanism 43, the switching may be performed before the start of discharging the water or at the same time when the water is discharged. Next, the motor 41 causes the dewatering axis 44 to rotate, whereby the washing tub 30 performs a dewatering operation. At this time, the pulsator 33 rotates together with the washing tub 30. When the washing tub 30 rotates, the laundry is pressed against an inner circumferential wall of the washing tub 30 by a centrifugal force. The washing water soaked in the laundry is collected on an inner surface of the circumferential wall of the washing tub 30. At this time, the washing water on which the centrifugal force is exerted is released from the dewatering holes 31 of the washing tub 30. The washing water released from the dewatering holes 31 is pelted on an inner surface of the water tub 20, travels down on the inner surface of the water tub 20, and drops down on a bottom portion of the water tub 20. The washing water having dropped on the bottom portion of the water tub 20 passes through the water discharge pipe 61 and then, through the water discharging hose 60, and is drained out of the housing 10.

[0073] At step S004, a first rinsing process is conducted. When the metal ions are supplied to the laundry, the main feed water valve 50a is opened, the elution of the silver ions through the electrolysis by using metal ion water generation part 90 is implemented, water containing the metal ions is fed via the main feed water pipe 52a and the feed water inlet 53 into the washing tub 30. When the metal ions are not supplied to the laundry, the electrolysis by using the metal ion water generation part 90 is not implemented.

[0074] In addition, irrespective of whether or not the metal ions are supplied, the sub-feed water valve 50b is opened, concurrent water feeding via the sub-feed water pipe 52b and the feed water inlet 53 is implemented. When a finishing agent such as a softening agent is used, the finishing agent is supplied.

[0075] After the water has been fed up to a set water level, in accordance with user's setting, the motor 41 causes the pulsator 33 to rotate in the predetermined pattern and generates in the washing tub 30 a main water stream for rinsing. This main water stream agitates the laundry, thereby rinsing the laundry. The dewatering axis 44 is braked by the brake mechanism 43, and even when the rinsing water and the laundry move, the washing tub 30 does not rotate. After a period of agitating has passed, the pulsator 33 performs small motions and disentangles the laundry. This causes the laundry to be distributed in the washing tub 30 in a well-balanced manner in preparation for a dewatering process. In the above description, "stored-water rinsing", which is rinsing with water stored in the washing tub 30, is performed. However, "pouring-water rinsing", which is rising with fresh water constantly being fed, or "shower rinsing", which is rinsing with water showered on the laundry via the feed water inlet 53 while the washing tub 30 is being rotated at a low speed, may be performed.

[0076] At step S005, as similarly to at step S002, the water discharging process is conducted.

[0077] At step S006, as similarly to at step S003, the

intermediate dewatering process is conducted.

[0078] At step S007, a final rinsing process is conducted, as similarly to at step S004.

[0079] At step S008, a dewatering process is conducted. First, the water discharging valve 62 is opened, thereby discharging the washing water in the washing tub 30. The water discharging valve 62 is left open during the dewatering process. Next, after a dewatering operation at a comparatively low speed has performed, a dewatering operation at a high speed is performed. The energization of the motor 41 is shut off and a stopping process such as braking is conducted. When a large part of the washing water has been removed from the washing tub 30 and the laundry, the clutch mechanism 42 and the brake mechanism 43 are switched. As switching timing of the clutch mechanism 42 and the brake mechanism 43, the switching may be performed before the start of discharging the water or at the same time when the water is discharged. Next, the motor 41 causes the dewatering axis 44 to rotate, whereby the washing tub 30 performs a dewatering operation. At this time, the pulsator 33 rotates together with the washing tub 30. When the washing tub 30 rotates, the laundry is pressed against an inner circumferential wall of the washing tub 30 by a centrifugal force. The washing water soaked in the laundry is collected on an inner surface of the circumferential wall of the washing tub 30. At this time, the washing water on which the centrifugal force is exerted is released from the dewatering holes 31 of the washing tub 30. The washing water released from the dewatering holes 31 is pelted on an inner surface of the water tub 20, travels down on the inner surface of the water tub 20, and drops down on a bottom portion of the water tub 20. The washing water having dropped on the bottom portion of the water tub 20 passes through the water discharge pipe 61 and then, through the water discharging hose 60, and is drained out of the housing 10.

[0080] In the above-described laundering process, the water discharging valve 62 is open during the water discharging process and the dewatering process, and the water in the washing tub 30 passes through the water discharge pipe 61 and the water discharging valve 62 and flows into the water discharging hose 60. In the water discharging hose 60, the metal ion recovery unit 200 is disposed outside the housing 10 of the washing machine 1.

[0081] In a case where the washing machine includes the metal ion recovery unit and the recovered metal ions are of valuable metal such as the silver and the copper as described above, when a user disposes of the washing machine, a manufacturer, a disposal contractor, or the like can recover the valuable metal by recovering the washing machine and can sell or recycle the valuable metal. Consequently, recovering the washing machine brings about a cost advantage, recovering and recycling the washing machine is facilitated, and illegal disposal can be suppressed.

[0082] Fig. 5 is a diagram illustrating the metal ion recovery unit attached in the water discharging hose. Fig. 5 (A) shows a state in which the metal ion recovery unit is attached in the water discharging hose. Fig. 5 (B) and Fig. 5 (C) each show an inside of the metal ion recovery unit.

[0083] As shown in Fig. 5 (A), the metal ion recovery unit 200 is disposed midway of the water discharging hose 60. A portion connecting the water discharging hose 60 and the metal ion recovery unit 200 is insertion-type and is attachable and detachable.

[0084] In a case where the metal ion recovery unit 200 is installed inside the washing machine, when the metal ion recovery unit 200 is recovered, it is required to dismantle a main body of the washing machine 1 such as the housing 10 to take out the metal ion recovery unit 200 or it is required to crush the washing machine 1 still including the metal ion recovery unit 200.

[0085] In a case where the washing machine main body is dismantled to take out the metal ion recovery unit 200, since it is required to pick out a specific washing machine (the washing machine including the metal ion recovery unit) and for example, to dismantle and crush the washing machine main body by handwork in a process of recycling the washing machine, it is not practical. In particular, because the housing portion of the washing machine is made so as to be robust since the housing portion is required to withstand a vibration caused by the operation of laundering and to support a weight of the water tub 20 and the motor 41 suspended by the suspension members 21, it is difficult to dismantle the housing portion.

[0086] In a case where the washing machine still including the metal ion recovery unit 200 is crushed, substances other than the metal ion recovery unit 200 are contained in the obtained shredder residue, thereby reducing a content percentage of the metal and reducing a recycling efficiency.

[0087] Therefore, as described above, the metal ion recovery unit 200 is installed in the water discharging hose 60 which is located outside the housing 10 of the washing machine, whereby when the washing machine 1 is recovered and recycled, the metal ion recovery unit 200 can be collected without dismantling the main body of the washing machine 1 such as the housing 10, and recovering the metal is facilitated.

[0088] As described above, when the washing machine 1 is recovered and materials used therein are recycled, the metal ion recovery unit 200 can be collected without hampering the recycling process, and the recovered metal can be reused.

[0089] The method of installing the metal ion recovery unit 200 in the water discharging hose 60 is not limited to the insertion-type method as shown in Fig. 5. Since it is only required to allow the metal ion recovery unit 200 to be easily detached from the main body of the washing machine 1, the method may be, for example, a screwing-type method. In addition, at least one part of the water discharging hose may be made of a flexible material so

as to be cut with a cutter or the like.

[0090] Only an upstream portion of the water discharging hose 60 may be attachable to and detachable from the metal ion recovery unit 200. In this case, a downstream portion of the water discharging hose 60 is to be collected together with the metal ion recovery unit 200. When the downstream side of the water discharging hose 60, which is located downstream of the metal ion recovery unit 200, is formed by using an organic material such as a resin, the metal can be isolated by burning the water discharging hose 60 together with the metal ion recovery unit 200. In a case where a metal refining process is arranged so as to include a process of isolating the metal from the metal ion recovery unit 200, the organic material can be easily removed. Therefore, through forming the metal ion recovery unit 200 by using the organic material, the metal can be effectively recovered.

[0091] In a case where the metal ion recovery unit 200 is installed inside the washing machine 1, the portion connecting the metal ion recovery unit 200 and the washing machine 1 is required to withstand a vibration of the washing machine 1. Therefore, it is difficult to adopt a structure, such as an insertion-type structure, which allows easy attachment and detachment. However, when the metal ion recovery unit 200 is installed midway of the water discharging hose 60 and the upstream side of the water discharging hose 60 is formed by using the flexible material, the vibration of the washing machine is not transmitted to the metal ion recovery unit 200 and the structure which allows the easy attachment and detachment can be adopted.

[0092] As described above, when the washing machine is recovered and recycled, the metal ion recovery unit can be collected without dismantling the main body of the washing machine.

[0093] The metal ion recovery unit 200 holds an adsorbent 201 thereinside. By using the adsorbent 201, the metal can be recovered.

[0094] As examples, as shown in Figs. 5 (B) and 5 (C), depressed portions 202 are or a depressed portion 202 is formed in an inner circumferential wall of the metal ion recovery unit 200 and particles of the adsorbent 201 are contained in the depressed portions 202 or the depressed portion 202. At opening portions or an opening portion of the depressed portions 202 or the depressed portion 202, filters 203 are or a filter 203 is attached, and a structure which allows the silver ions to pass therethrough but prevents yarn waste or the like from entering is formed. As shown in Fig. 5 (B), a plurality of the depressed portions 202 may be provided. As shown in Fig. 5 (C), a single depressed portion 202 may be provided.

[0095] By causing the water, which has passed through the filter 203, to contact the adsorbent 201 as described above, adhesion of the yarn waste or the like to the adsorbent 201 or clogging with the yarn waste or the like in the metal ion recovery unit 200 can be prevented. Since the metal ions to be adsorbed have been dissolved in the water, the metal ions can contact the adsorbent 201 and can be adsorbed by the adsorbent 201 without causing any problem even when the filter 203 is present.

[0096] The adsorbent 201 may be kneaded in a resin or the like. In this case, since only a part of the adsorbent, which is present on a surface of an inner wall of the metal ion recovery unit 200, can act, it is preferable that the surface of the inner wall of the metal ion recovery unit 200 is made rough through using plasma or is made porous through foaming. In addition, the adsorbent 201 may be mixed in a paint or the like. The paint or the like may be adhered to the surface of the inner wall of the metal ion recovery unit 200.

[0097] As described above, the metal ions supplied in the water used for laundering can be recovered.

[0098] As the adsorbent 201, for example, a synthetic adsorbent such as a thiol-function polysiloxane compound can be used. When an adsorbent having a surface on which a thiol group is formed is used, since the silver ions are very easily bonded to sulfur, the silver ions and the sulfur in the thiol group react to each other as shown in the below formula and the silver ions are adsorbed to the adsorbent 201.

[0099] $(SiO_3)_n(CH_2)_3SH + Ag^+ \rightarrow (SiO_3)_n(CH_2)_3SAg + H^+$

[0100] The other metal ions contained in the tap water are hardly bonded to the sulfur. Accordingly, this adsorbent can selectively adsorb the silver ions.

[0101] The water used for laundering, such as the tap water, contains a lot of metal ions other than the metal ions added as the finishing agent. In general, the metal ions, added for the purpose of exhibiting antibacterial action or the like, whose concentration is approximately 50 μg/L through 10 mg/L are contained in the washing water. It is often the case that general tap water contains sodium ions, calcium ions, potassium ions, and magnesium ions, each of which has a concentration of several tens mg/L or more. The adsorbent which adsorbs such metal ions contained in the tap water does not sufficiently adsorb the metal ions, which have been added as the finishing agent and should be recovered, and come to be saturated. Consequently, a lifetime of the adsorbent is shortened, or it is required to provided a large amount of the adsorbent in the metal ion recovery unit. Therefore, by using the adsorbent which can selectively adsorb the metal ions added as the finishing agent, an effect of the metal ion recovery unit can long last.

[0102] A synthetic adsorbent to which a functional group, containing the sulfur, such as the thiol and polyurea, is adhered is excellent in adsorptivity and selectivity of the ions, particularly, of the noble metal such as the silver and the copper, and is particularly effective when the metal ions added in the washing water used in the washing machine are the above-mentioned metal ions.

[0103] It is often the case that as the finishing agent for the laundry, the silver ions having the antibacterial properties and/or the copper ions having the antifungal properties are added. Therefore, by using the adsorbent

which selectively adsorbs these ions, the metal ions added upon laundering can be efficiently recovered.

[0104] As the adsorbent, others may be used. Instead of the synthetic adsorbent, for example, zeolite, a cation exchange resin, or the like can be used.

[0105] In addition, microorganisms such as metal ion reduction germs and a metal ion reduction enzyme may be caused to perform reduction, precipitation, adsorption, or the like. As the metal ion reduction germs, germs which selectively reduce the silver ions and precipitate the silver is described in, for example, PNAS96 (24): 13611-13614 "Silver-based crystalline nanoparticles, microbially fabricated".

[0106] Furthermore, by using metal which is less noble than the targeted metal, the reduction and the precipitation may be performed. For example, since the silver is nobler than iron, when a liquid containing the silver ions is caused to contact the iron having a large surface area, such as steel wool, a reaction expressed by the below formula occurs, thereby allowing the recovery of the silver on the surface of the steel wool. This method is a method for selectively recovering the metal ions, such as the silver ions and the copper ions, which are nobler than the iron ions.

[0107] $2Ag^{+}+Fe \rightarrow 2Ag+Fe^{2+}$

[0108] As in the above-described methods, by employing the method of recovery, which allows the added metal ions to be selectively recovered as compared with the metal ions contained in the general tap water, the metal ions added upon laundering can be efficiently recovered.

[0109] In addition, an electrical method, for example, in which metal is deposited on a cathode through electrolysis, may be employed. Specifically, this is the method in which a voltage is applied between electrodes and the metal is precipitated through a cathode reaction expressed by the below formula.

[0110] $Ag^{+}+e^{-} \rightarrow Ag$

[0111] As described above, the metal ion recovery unit 200 which has adsorbed the silver is detached when the washing machine 1 is collected and the metal in the metal ion recovery unit 200 is recycled. As a method for recycling, for example, the organic substance collected together with the metal ion recovery unit 200 is burnt to be removed, and the residue is dissolved at a high temperature and undergoes electrolysis refining. In addition, a refining process for the recovery may be arranged so as to be included in a usual process of refining a copper ore, a silver ore, or the like.

[0112] An organic substance such as an ion exchange resin and a reducing enzyme is used as the adsorbent and a housing of the metal ion recovery unit 200 is also formed by using a resin, whereby by burning the metal ion recovery unit 200, only the metal targeted for the recovery can be obtained. In a case where the metal is isolated from the metal ion recovery unit 200 by including the refining process for the recovery in the usual metal refining process, since the metal can be easily isolated by burning the organic substance, it is effective to form the metal ion recovery unit 200 by using the organic substance.

<Second Embodiment>

[0113] Fig. 6 shows schematic cross sectional views of a water discharging channel in a washing machine of another embodiment according to the present invention. Except for the water discharging channel, a configuration of the washing machine of the second embodiment is the same as the configuration of the washing machine of the first embodiment, shown in Fig. 1. In addition, in the washing machine 1, the controller 80 includes a timer as a discharging water clogging detection part, which measures a time period from the start of discharging water. Completion of discharging the water is detected by a water level switch.

[0114] As shown in Fig. 6, in the water discharging channel of this washing machine, a three-way valve 63 is provided. The water discharging channel is branched via the three-way valve 63 so as to include a first water discharging hose 601 as a first water discharging channel which includes the metal ion recovery unit 200 midway thereof and a second water discharging hose 602 as a second water discharging channel through which the water discharged from the washing machine directly flows into sewers. The three-way valve 63 is controlled by the controller 80, whereby the discharging water can flow into either one or both of the first water discharging hose 601 and the second water discharging hose 602. Arrows shown in Fig. 6 indicate a flow of the water.

[0115] Fig. 6 (A) shows a state in which the three-way valve 63 is closed. Fig. 6 (B) shows a state in which the three-way valve 63 is switched so as to flow the discharging water into only the first water discharging hose 601 having the metal ion recovery unit 200. Fig. 6 (C) shows a state in which the three-way valve 63 is switched so as to flow the discharging water into only the second water discharging hose 602 not having the metal ion recovery unit 200. Fig. 6 (D) shows a state in which the three-way valve 63 is switched so as to flow the discharging water into both of the first water discharging hose 601 and the second water discharging hose 602.

[0116] As shown in Fig. 4, a general sequence of laundering mainly comprises three processes of "washing", "rinsing", and "dewatering'. It is often the case that the rinsing process is conducted a plurality of times, or between the washing process and the rinsing process, a water discharging process and the dewatering process are conducted or a special process is conducted. Supplying metal ions to washing water is conducted in a process at a later stage of the laundering, such as a final rinsing process, thereby allowing enhancement of an efficiency of utilizing the metal ions.

[0117] In the second embodiment, for example, the metal ions are supplied to laundry together with water only when the water is fed in the final rinsing process (at step S007) shown in Fig. 4, and water containing no metal

ions is fed in the washing process (at step S001) and first rinsing process (at step S004). At this time, in the other processes (at step S002, step S003, step S005, and step S006) shown in Fig. 4, the water is discharged via the second water discharging hose 602 not having the metal ion recovery unit 200, and only in the dewatering process after the final rinsing process, the water is discharged via the first water discharging hose 601. This allows the metal ions to be recovered into the metal ion recovery unit 200.

[0118] In the washing process conducted in the washing machine, a mechanical force is applied to the laundry by deforming the laundry and causing pieces of the laundry to contact one another, thereby enhancing a cleaning effect. Therefore, in the washing process at step S001, yarn waste may be generated from the laundry. On the other hand, in order to enhance a speed of adsorbing the metal ions from the discharging water in the metal ion recovery unit 200, it is effective to increase an efficiency of contacting of the discharging water and the adsorbent or the like. In order to implement this, it is required to form the metal ion recovery unit 200 so as to be filter-like or to provide protrusions inside the metal ion recovery unit 200. However, in such a configuration, if the yarn waste is contained in the water discharged from the washing machine, clogging is likely to be caused.

[0119] Therefore, the water discharging hose is branched so as to include the first water discharging hose 601 having the metal ion recovery unit 200 and the second water discharging hose 602 not having the metal ion recovery unit 200. By providing a plurality of the water discharging channels as described above, it is made possible for the water used in the washing process and the like, which contains a lot of the yarn waste and no metal ions, not to pass through the metal ion recovery unit 200, thereby preventing the clogging caused by the yarn waste and allowing the enhancement of the speed of adsorbing the metal ions.

[0120] In particular, when the adsorbent is made of the resin such as the ion exchange resin, a surface activating agent contained in the water discharged after the washing process is adsorbed onto a surface of the resin, and thereby, a capability of the adsorbent may be reduced. This also can be prevented by branching the water discharging hose.

[0121] By employing the above-described configuration, the discharging water to which the metal ions as the finishing agent have been added can pass through the first water discharging hose 601 having the metal ion recovery unit 200 and the discharging water to which the metal ions as the finishing agent have not been added can pass through the second water discharging hose 602 not having the metal ion recovery unit 200. By not passing the water used in the washing process and the like, which contains a lot of the yarn waste or the like and no metal ions, through the metal ion recovery unit 200, the clogging of the first water discharging hose 601, which is caused by the yarn waste or the like, can be prevented and a capability of adsorbing the metal ions can be maintained. In addition, in a case where the adsorbent 201 is made of the resin, when the surface activating agent used for washing the laundry is adsorbed onto the surface of the resin, the capability of the adsorbent is reduced. However, by properly using both of the first water discharging hose 601 and the second water discharging hose 602, a reduction in the adsorbing capability of the adsorbent 201, which is caused by the adsorption of the surface activating agent, can be prevented.

[0122] Fig. 7 shows a schematic cross sectional view of a water discharging hose in which a filter is provided.

[0123] As shown in Fig. 7, the filter 204 may be provided upstream of the metal ion recovery unit 200. The water discharging hose through which the discharging water flows has a configuration in which by switching opening and closing of a first valve 64a and a second valve 64b, the discharging water can flow either one or both of the first water discharging hose 601 and the second water discharging hose 602.

[0124] By employing the above-described configuration, the filter 204 can prevent the yarn waste or the like from entering the metal ion recovery unit 200. In addition, the filter 204 contacts also the water discharged via the second water discharging hose 602, thereby allowing the yarn waste adhering to the filter 204 to be washed off by using the water discharged via the second water discharging hose 602 and enabling prevention of clogging of the filter 204.

[0125] Next, with reference to Fig. 8, a water discharging process in a conventional washing machine will be described.

[0126] Fig. 8 is a flow chart showing the general water discharging process in the conventional washing machine. Predetermined determinations are made by the controller 80.

[0127] As shown in Fig. 8, in a water discharging process, first at step S009, a water discharging valve 62 is opened. Water in a washing tub 30 passes via a water discharge pipe 61 and a water discharging valve 62 and is discharged into a water discharging hose 60. At step S010, it is confirmed whether discharging the water has been completed. When the completion of discharging the water is not detected, discharging the water is continued. When the completion of discharging the water is detected, the water discharging valve 62 is closed and the water discharging process is finished.

[0128] Next, with reference to Fig. 9 and Fig. 10, the water discharging process in the second embodiment according to the present invention will be described.

[0129] Fig. 9 is a flow chart showing a process of discharging the water containing the metal ions in the washing machine of the another embodiment according to the present invention. Predetermined determinations are made by the controller 80.

[0130] In a case where the water containing the metal ions is discharged, first at step S101, the three-way valve 63 is set to be in a state shown in Fig. 6 (B). By setting the three-way valve 63 as mentioned above, the dis-

charging water flows via the first water discharging hose 601 having the metal ion recovery unit 200. Next, at step S102, the water discharging valve 62 is opened and discharging the water is started.

[0131] At step S103, it is confirmed whether discharging the water has been completed. When discharging the water has been completed, the water discharging process proceeds to step S104 and is finished. When discharging the water has not been completed, the water discharging process proceeds to step S105 and it is confirmed whether a predetermined period of time has passed. When the predetermined period of time has not passed, the water discharging process returns to step S103. When the predetermined period of time has passed, indicating that it is detected that discharging the water has not been completed, the water discharging process proceeds to step S106 and the three-way valve is set to be in a state shown in Fig. 6 (D). By setting the three-way valve as mentioned above, the discharging water flows via both of the first water discharging hose 601 and the second water discharging hose 602 as another water discharging channel. Thereafter, the water discharging process proceeds to step S107, and when discharging the water has been completed, the water discharging process proceeds to step S104 and is finished. When discharging the water has not been completed, the water discharging process returns to step S107.

[0132] Fig. 10 is a flow chart showing a process of discharging the water containing no metal ions in the washing machine of the another embodiment according to the present invention.

[0133] In a case where the water containing no metal ions is discharged, first at step S201, the three-way valve 63 is set to be in a state shown in Fig. 6 (C). By setting the three-way valve 63 as mentioned above, the discharging water flows via the second water discharging hose 602 not having the metal ion recovery unit 200. Next, at step S202, the water discharging valve 62 is opened and discharging the water is started.

[0134] At step S203, it is confirmed whether discharging the water has been completed. When discharging the water has been completed, the water discharging process proceeds to step S204 and is finished. When discharging the water has not been completed, the water discharging process proceeds to step S205 and it is confirmed whether a predetermined period of time has passed. When the predetermined period of time has not passed, the water discharging process returns to step S203. When the predetermined period of time has passed, indicating that it is detected that discharging the water has not been completed, the water discharging process proceeds to step S206 and the three-way valve is set to be in a state shown in Fig. 6 (D). By setting the three-way valve as mentioned above, the discharging water flows via both of the second water discharging hose 602 and the first water discharging hose 601 as another water discharging channel. The water discharging process proceeds to step S207, and when discharging the water has been completed, the water discharging process proceeds to step S204 and is finished. When discharging the water has not been completed, the water discharging process returns to step S207.

[0135] As described above, by detecting that discharging the water has not been completed even after the predetermined period of time has passed, discharging water clogging is detected. When the discharging water clogging is detected, by using the another water discharging channel, the water can be discharged. As a result, even when the discharging water clogging occurs, the laundering can be completed. At this time, it is preferable that an arrangement is made such that a user can be notified of an error during the laundering or upon finishing the laundering, since the user can be prompted to cope with the error.

<Third Embodiment>

[0136] Fig. 11 shows a whole cross sectional view of a washing machine of a third embodiment according to the present invention. This washing machine includes a bore-less tub.

[0137] As shown in Fig. 11, a washing tub 30b has a peripheral wall which has a taper shape which gently opens upwardly. This peripheral wall has no opening for allowing a liquid to pass therethrough, except for a plurality of dewatering holes 31 disposed in a ring-manner on an uppermost portion thereof. When water is stored in the washing tub 30b for washing, rinsing, and the like, the water is not stored in an outer tub 20b. In addition, upon dewatering, after a large part of the stored water has been discharged, the water contained in the laundry ascends along the peripheral wall of the washing tub 30b by rotating the washing tub and is discharged into the outer tub 20b from the dewatering holes 31 at uppermost positions.

[0138] In such a washing machine, the metal ion recovery unit 200 is provided in a water discharging channel through which the water is discharged from the outer tub 20b. Further, for example, in a case where the metal ion processing is performed upon the final rinsing, water discharging before the dewatering is not performed for the water used for the rinsing, and the water used for the rinsing is discharged from the dewatering holes 31 by rotating the washing tub 30b, whereby the discharging water containing the metal ions can pass through the metal ion recovery unit 200.

[0139] In this case, unlike in the second embodiment, the water discharged by the intermediate dewatering after the washing process also passes through the metal ion recovery unit 200. However, this water is insubstantial water contained in the laundry, and since it is difficult for the yarn waste to ascend along the peripheral wall of the washing tub 30b and to pass through the dewatering holes 31, this water scarcely contains the yarn waste. Therefore, this water causes no problem.

[0140] In addition, a door 205 is provided at one portion

of the housing 112. The metal ion recovery unit 200 can be detached via the door 205. In addition maintenance of the filter 204 may be implemented via this door 205.

[0141] The present invention is applicable to not only the above-described fully automatic washing machine but also a variety of washing machines such as a horizontal drum-type washing machine (tumbler-type), an inclined drum-type washing machine, a drying machine-cum-washing machine, a dual tub-type washing machine.

[0142] The described embodiments are to be considered in all respects only as illustrative and not restrictive. It is intended that the scope of the invention is, therefore, indicated by the appended claims rather than the foregoing description of the embodiment and that all modifications and variations coming within the meaning and equivalency range of the appended claims are embraced within their scope.

INDUSTRIAL APPLICABILITY

[0143] The present invention is applied to a washing machine operable to apply metal ions to a fabric structure such as clothing, whereby the metal ions supplied to water used for laundering can be recovered.

Claims

1. A washing machine (1) comprising:

a metal ion applying unit (90) for applying metal ions to water; and
a metal ion recovery unit (200) disposed so as to contact the water with the metal ions applied by the metal ion applying unit (90), for recovering the metal ions in the water.

2. A washing machine (1) operable to apply metal ions to a fabric structure, comprising
a metal ion recovery unit (200) disposed so as to contact water used for laundering, for recovering the metal ions in the water.

3. The washing machine (1) according to claim 2, wherein the metal ion recovery unit (200) is detachable from the washing machine (1).

4. The washing machine (1) according to claim 2, wherein the metal ion recovery unit (200) includes an adsorbent (201) for selectively recovering specific metal.

5. The washing machine (1) according to claim 4, wherein the specific metal contains at least one of silver ions and copper ions.

6. The washing machine (1) according to claim 2, comprising a water discharging channel (60), wherein the metal ion recovery unit (200) is disposed in the water discharging channel (60).

7. The washing machine (1) according to claim 6, wherein the water discharging channel (60) includes a first water discharging channel (601) having the metal ion recovery unit (200) and a second water discharging channel (602) not having the metal ion recovery unit (200).

8. The washing machine (1) according to claim 6, further comprising a discharging water clogging detection part.

9. A method for recovering metal ions in water in a washing machine (1) operable to apply the metal ions to a fabric structure, the washing machine (1) including a metal ion recovery unit (200) disposed so as to contact the water used for laundering.

FIG.1

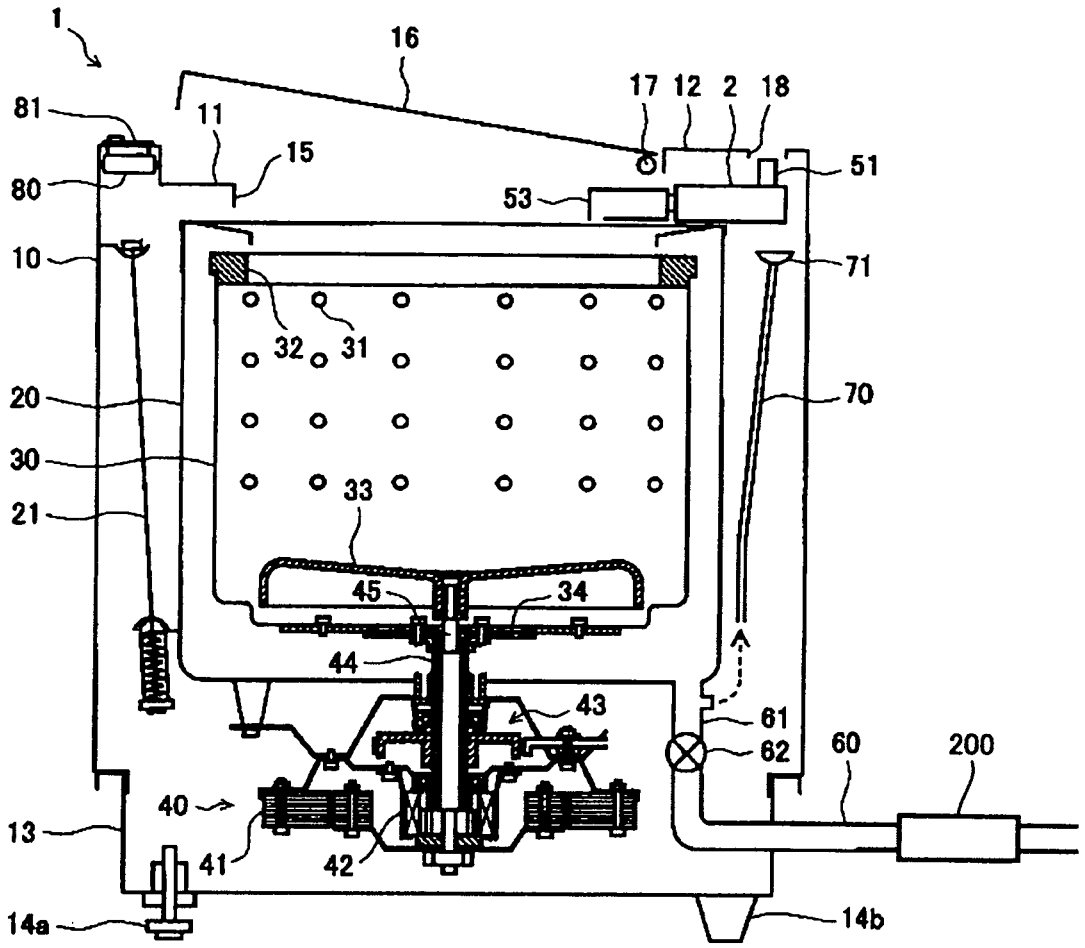

1
16
17
12
2
18
81
11
15
51
80
53
10
71
32
31
20
70
30
33
21
45
34
44
43
61
62
60
200
40
13
41
42
14a
14b

FIG.2

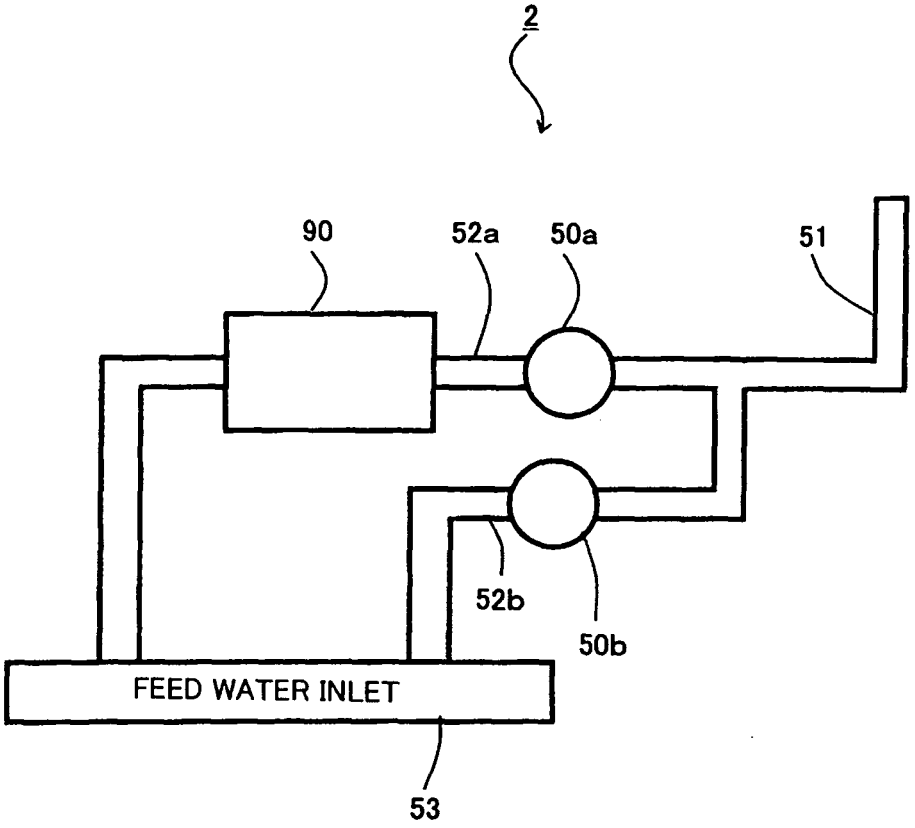


FIG.3

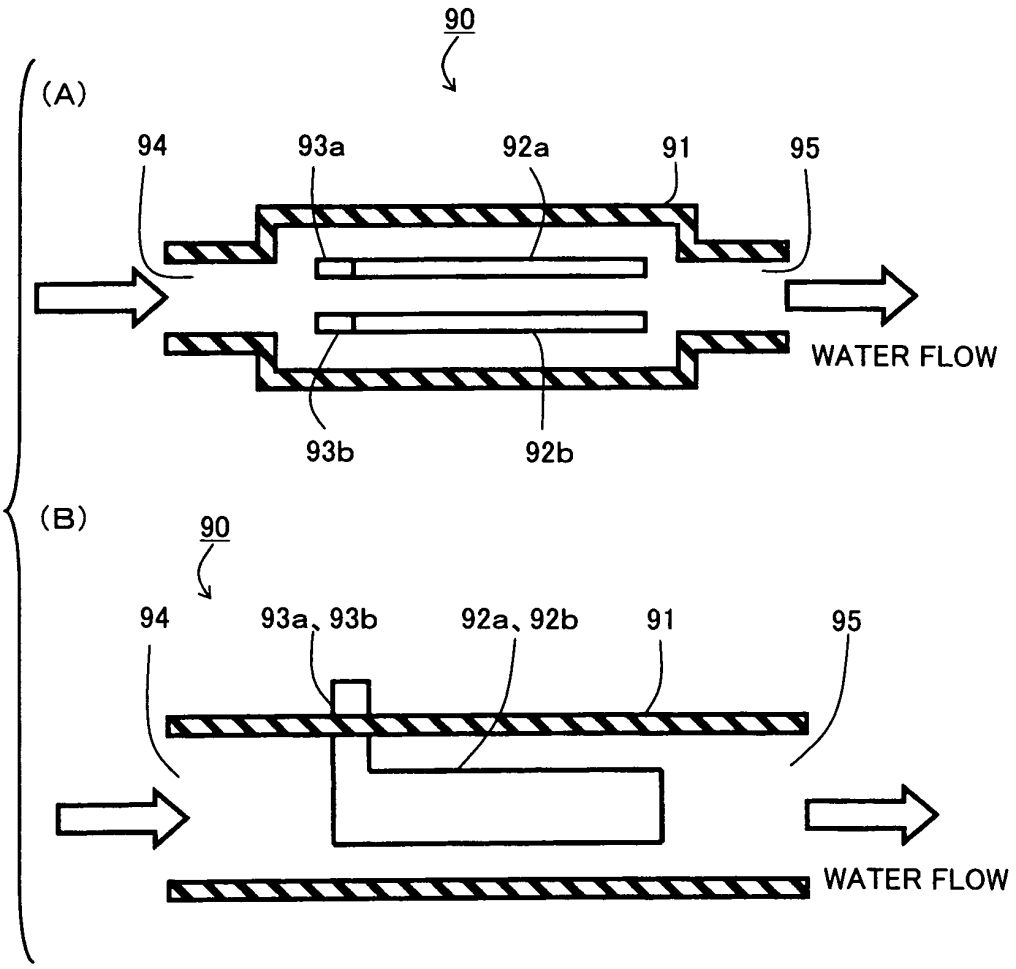

(A)
90
94
93a
92a
91
95
WATER FLOW
93b
92b
(B)
90
94
93a、93b
92a、92b
91
95
WATER FLOW

FIG.4

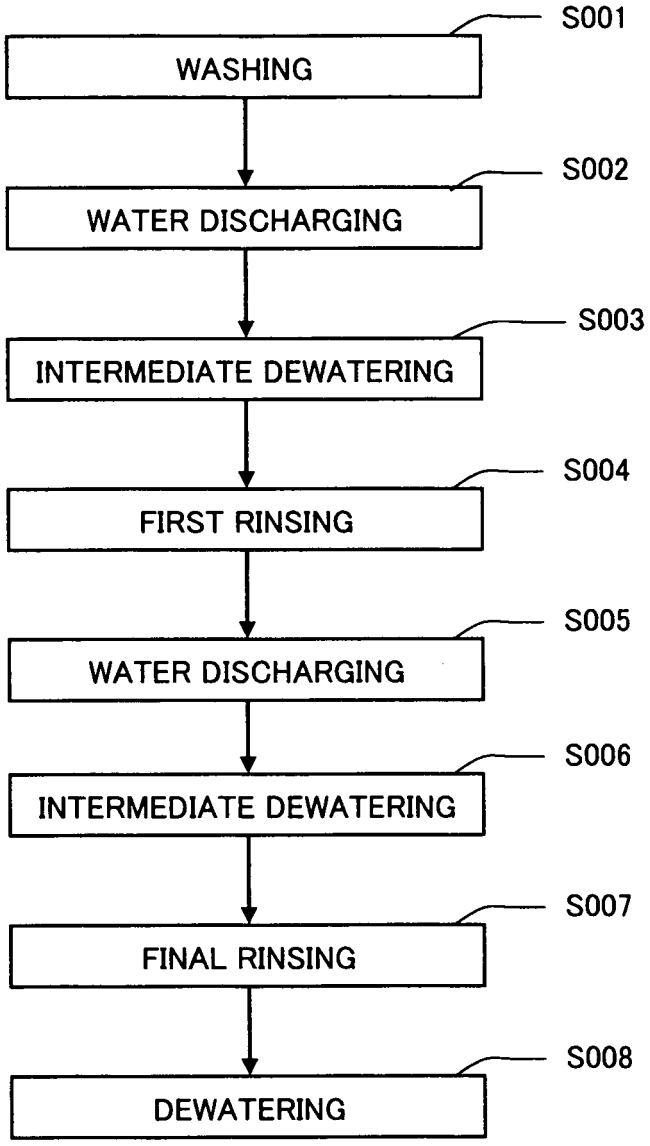

S001
WASHING
S002
WATER DISCHARGING
S003
INTERMEDIATE DEWATERING
S004
FIRST RINSING
S005
WATER DISCHARGING
S006
INTERMEDIATE DEWATERING
S007
FINAL RINSING
S008
DEWATERING

FIG.5

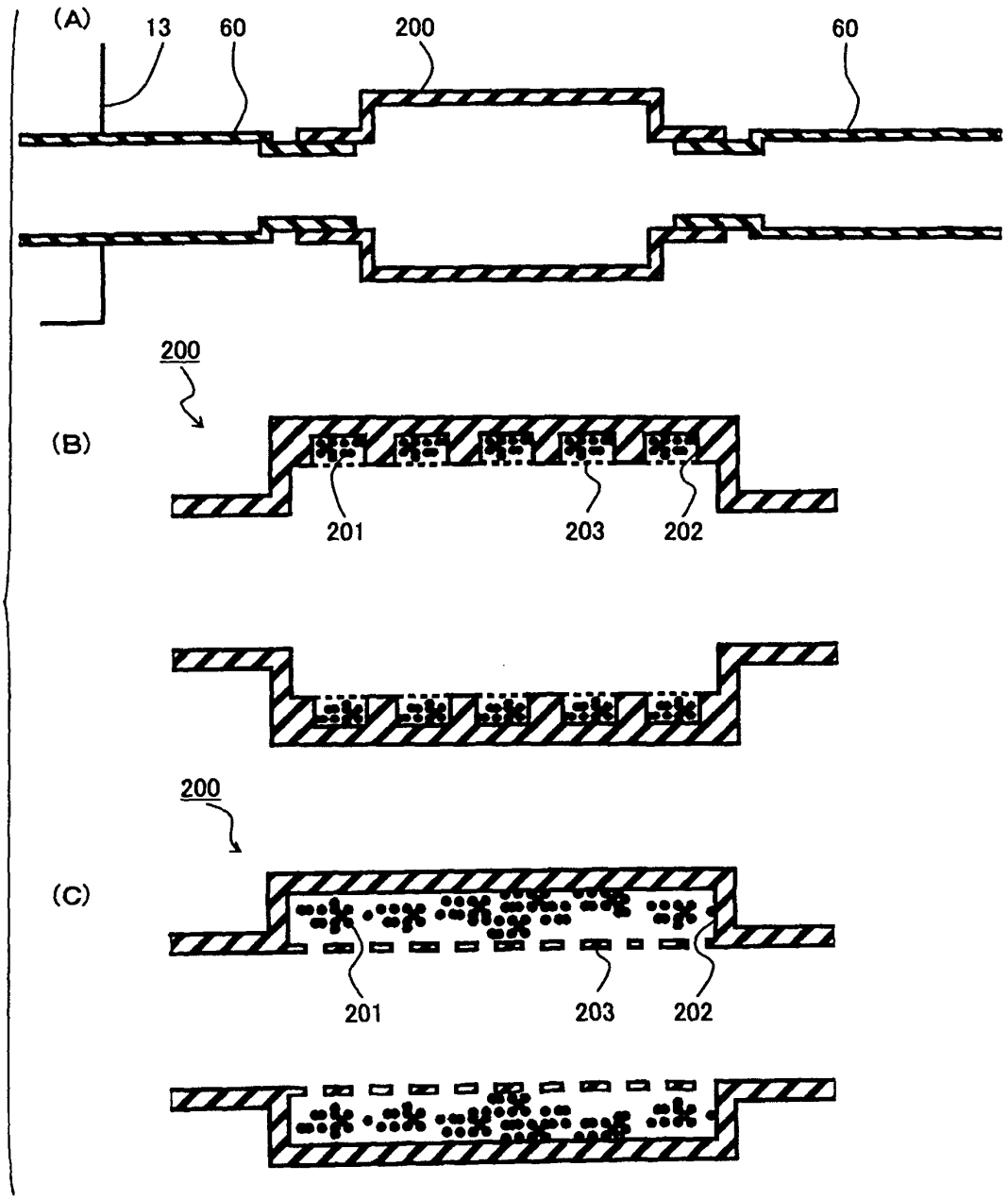


FIG.6

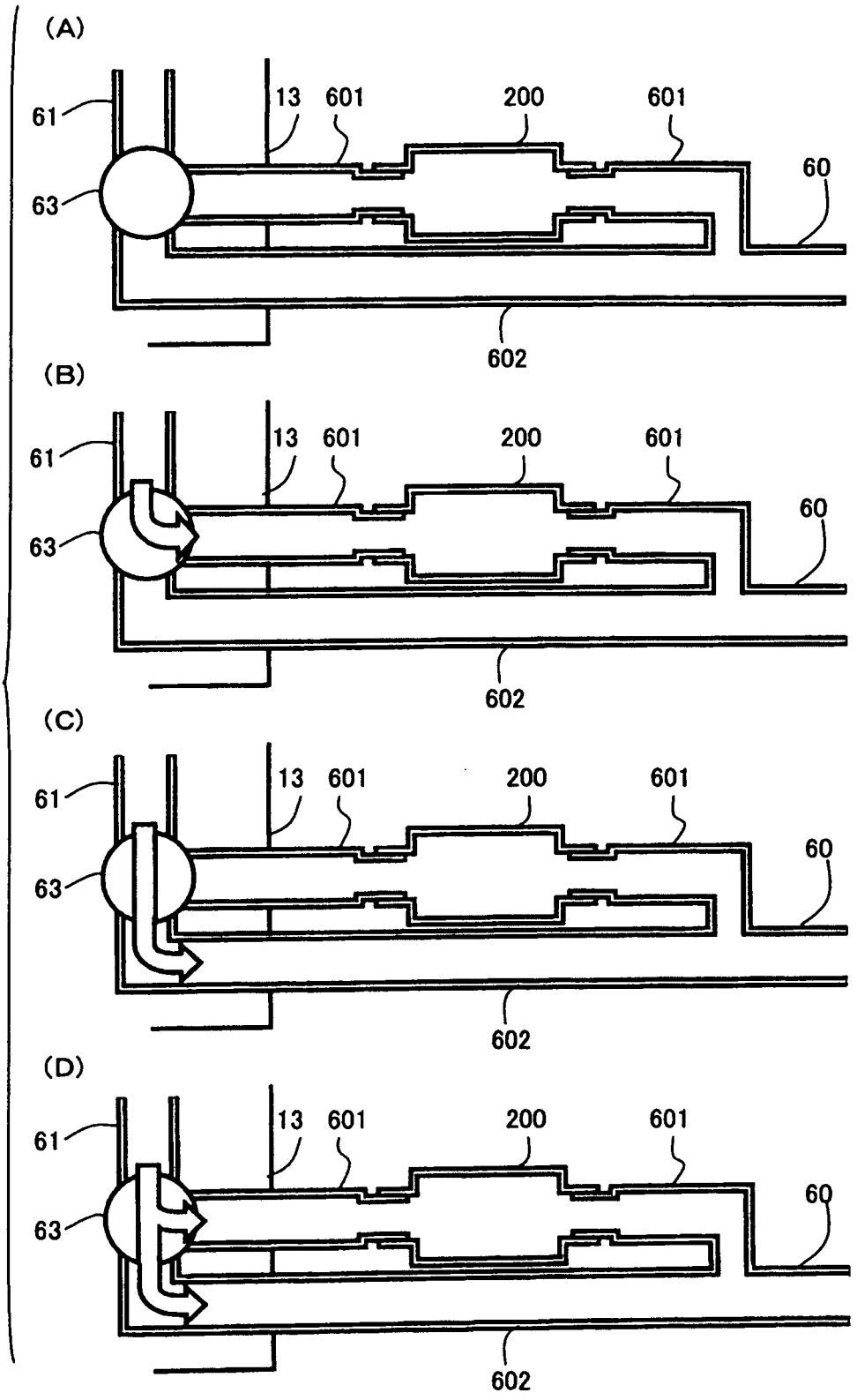

(A)
61
13
601
200
601
60
63
602
(B)
61
13
601
200
601
60
63
602
(C)
61
13
601
200
601
60
63
602
(D)
61
13
601
200
601
60
63
602

FIG.7

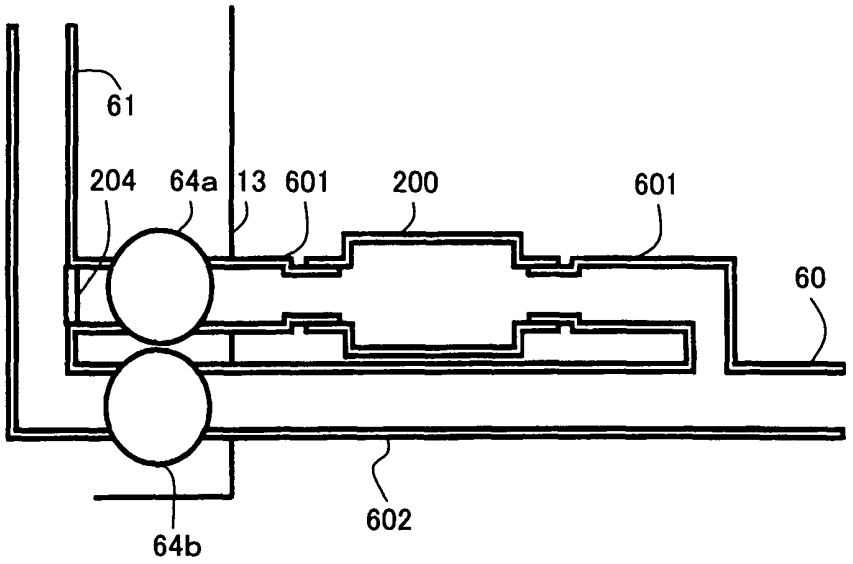

61
204
64a
13
601
200
601
60
602
64b

FIG.8

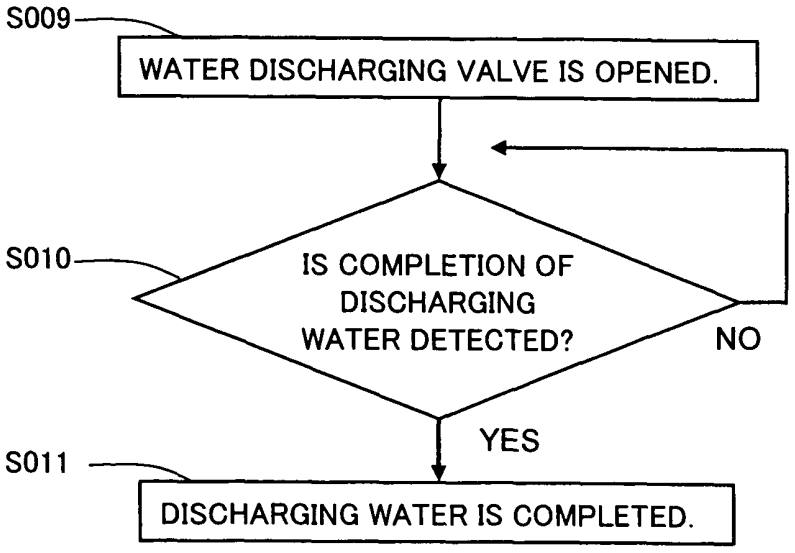

S009
WATER DISCHARGING VALVE IS OPENED.
S010
IS COMPLETION OF DISCHARGING WATER DETECTED?
NO
YES
S011
DISCHARGING WATER IS COMPLETED.

FIG. 9

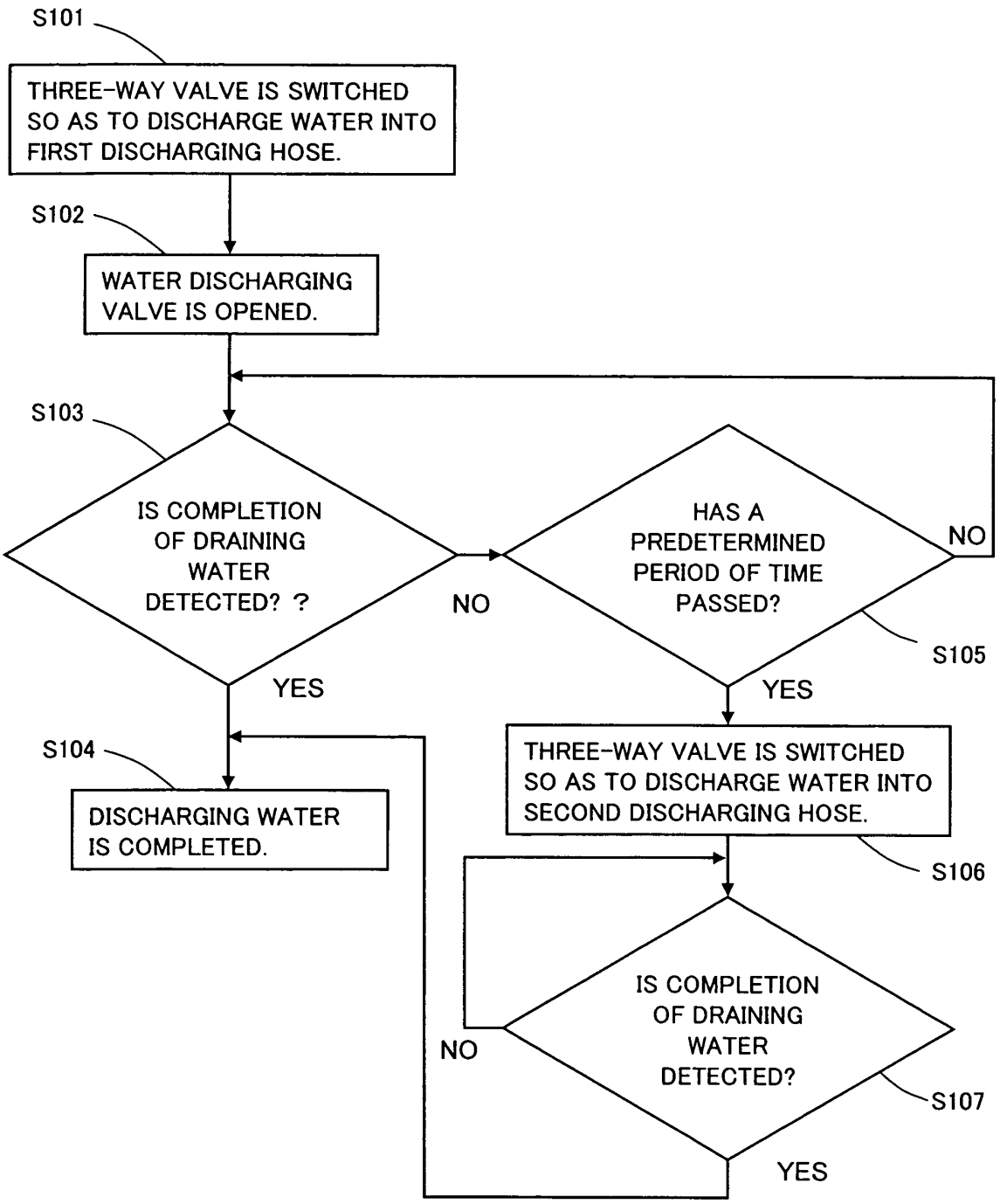

S101
THREE-WAY VALVE IS SWITCHED SO AS TO DISCHARGE WATER INTO FIRST DISCHARGING HOSE.
S102
WATER DISCHARGING VALVE IS OPENED.
S103
IS COMPLETION OF DRAINING WATER DETECTED? ?
NO
HAS A PREDETERMINED PERIOD OF TIME PASSED?
NO
S105
YES
YES
S104
DISCHARGING WATER IS COMPLETED.
THREE-WAY VALVE IS SWITCHED SO AS TO DISCHARGE WATER INTO SECOND DISCHARGING HOSE.
S106
IS COMPLETION OF DRAINING WATER DETECTED?
NO
S107
YES

FIG. 10

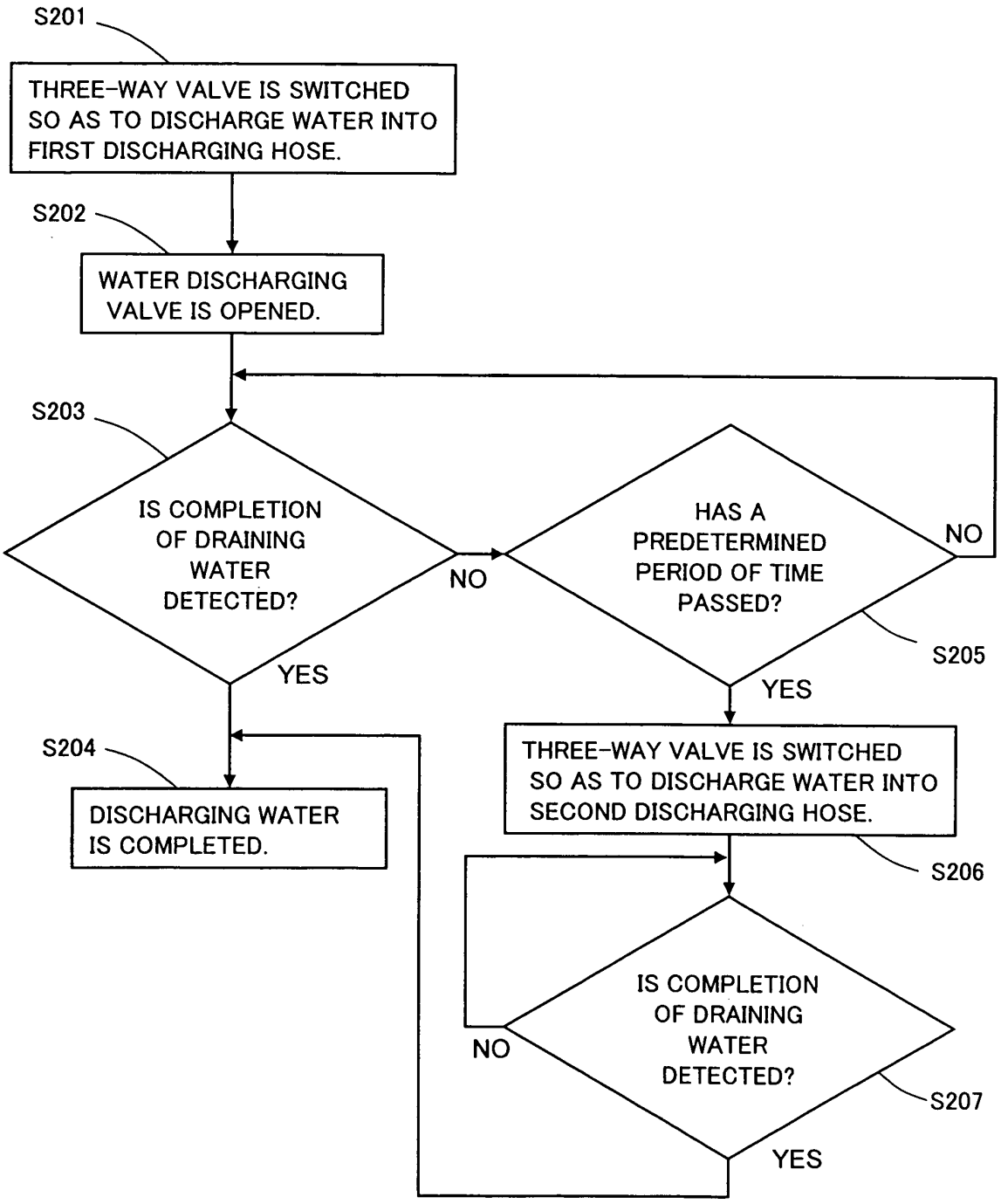
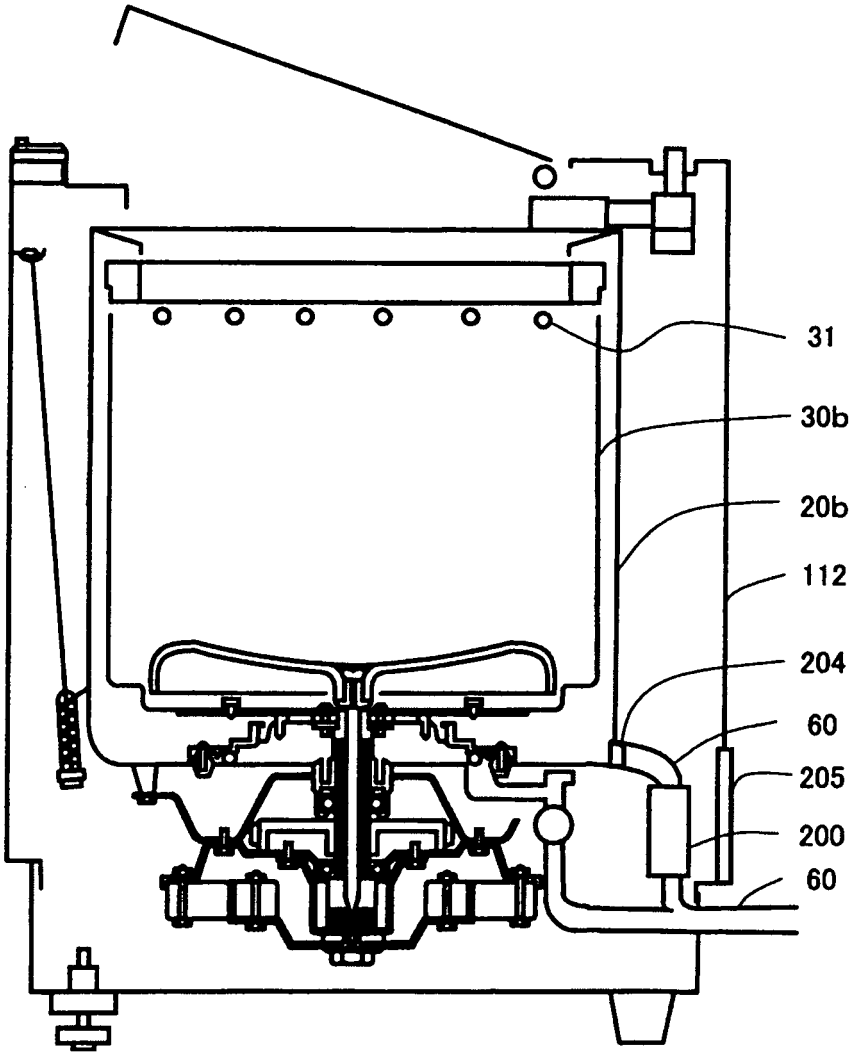

S201
THREE-WAY VALVE IS SWITCHED SO AS TO DISCHARGE WATER INTO FIRST DISCHARGING HOSE.
S202
WATER DISCHARGING VALVE IS OPENED.
S203
IS COMPLETION OF DRAINING WATER DETECTED?
NO
YES
HAS A PREDETERMINED PERIOD OF TIME PASSED?
NO
YES
S205
S204
DISCHARGING WATER IS COMPLETED.
THREE-WAY VALVE IS SWITCHED SO AS TO DISCHARGE WATER INTO SECOND DISCHARGING HOSE.
S206
IS COMPLETION OF DRAINING WATER DETECTED?
NO
YES
S207

FIG.11



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/054641

A. CLASSIFICATION OF SUBJECT MATTER
D06F39/00(2006.01)i, *D06F39/08*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
D06F39/00, D06F39/08

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2007
Kokai Jitsuyo Shinan Koho 1971-2007 Toroku Jitsuyo Shinan Koho 1994-2007

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2004-105692 A (Sharp Corp.), 08 April, 2004 (08.04.04), Full text; all drawings & WO 2004/011710 A1 & CN 001671911 A	1-6,9
Y	JP 54-159293 A (Sharp Corp.), 15 December, 1979 (15.12.79), Page 1, lower left column, line 16 to page 2, upper left column, line 8 (Family: none)	1-6,9
Y	JP 2002-307070 A (Haccpper Advantec Corp.), 22 October, 2002 (22.10.02), Full text; all drawings (Family: none)	1-6,9

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
31 May, 2007 (31.05.07)	12 June, 2007 (12.06.07)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (April 2005)

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- JP 2004033996 A **[0003] [0005]**
- JP 59104490 A **[0005] [0005]**
- JP 61158796 A **[0005] [0005]**
- JP 6145828 A **[0005] [0005]**
- JP 7185565 A **[0005]**
- JP 60061039 A **[0005] [0005]**
- JP 7185568 A **[0005]**